INT.J.BIOL.BIOTECH., 10 (4): 651-656, 2013.

EFFECT OF DIFFERENT PLANTING AND HARVESTING TIMES ON YIELD AND YIELD RELATED TRAITS OF CASSAVA (*MANIHOT ESCULENTA* CRANTZ) IN COASTAL AREA OF BALOCHISTAN, PAKISTAN

Javaid Akhtar[1], S.A.R. Kazmi[1] and Abdul Hameed Solangi[2]

[1]*Crop Diseases Research Institute, PARC, Karachi University Campus, Karachi-75270*
[2]*Coastal Agricultural Research Station, SARC, PARC, Karachi, Pakistan.*

ABSTRACT

Cassava occupies an important position among root crops; therefore it was important to study the impact of different planting times with respect to different intervals of harvesting time as the crop offers a flexible harvesting period. The experiment was carried out at Coastal Agricultural Research Station (Bhawani) of Pakistan Agricultural Research Council during the years 2007-2009. The cuttings were planted in March & December (2007) and harvested at four different intervals (8, 12, 18 and 24 months). The crop showed better performance with respect to sprouting percentage and most of the other parameters of growth when planted in March as compared to December. Plants of March plantation showed maximum growth. The parameters under investigation showed great variation both with respect to time of plantation and different intervals of harvesting period. Maximum total fresh root weight per plant and yield / hectare (tons) was obtained when plantation was carried out in March and harvested at 18 & 24 months of growth. In December plantation yield was substantially low.

Keywords: Cassava (*Manihot esculenta*), plantation time, harvesting intervals, yield.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) belongs to the family Euphorbiaceae. It originated in the Americas (Jos, 1969). It is a tropical, perennial shrub that is not well known in temperate zone. The Cassava leaf protein is bio-chemically equal in quality to the egg protein (Nassar and Marques, 2006). In the tropics and subtropics Cassava starchy root is a staple food for million of people. If a major Catastrophe should strike the Cassava crop, there would be widespread famine in developing countries (IAEA, 2002; Scott *et. al*., 2000). World wide maize, potato and wheat dominate the starch market (Fungulani and Maseko, 2001; Itaye, 2001; Munthali, 2001), but Cassava is bound to make a large impact in near future by producing relatively higher quality starch on comparatively cheaper rate. The incorporation of dietary starch in food has gained importance as it is considered to be a good replacement of dietary fat. Consumption of starch in adequate amount instead of fat has been associated with prevention of some chronic diseases like, coronary heart disease, cancer, and diverticulosis (Asp and Bjork, 1992; Kamal *et. al*., 2000; Lopez *et. al.*, 2001; Topping and Clifton 2001). Modified starch of Cassava may be used as cheaper substitute of other starches in manufacturing and production of Alcohol, for sizing of paper and textile, glues, sweeteners, biodegradable products (FAO, 2001).

As cassava occupies an important position among root crops, it is important that its growth pattern in relation to planting and harvesting time be understood properly to achieve optimum growth, development and yield of Cassava with reference to coastal area of Balochistan. Therefore, the present study was designed with the aim to study the effect of different planting and harvesting times on yield and yield related traits of Cassava.

MATERIALS AND METHODS

The present experiment was carried out at Coastal Agricultural Research Station (Bhawani) of Pakistan Agricultural Research Council during two consecutive years from 2007-2008 to 2008-2009. The climate of the area is arid, temperature is high and rainfall is low. The climatic characteristics (rainfall, atmospheric temperature and relative humidity during the experimental period are presented in Table 1.

The experiment was laid out in randomized complete block design (RCBD) using two different planting times (March and December) and four different harvesting times (after 8, 12, 18, and 24 months of plantation). The treatments were replicated four times for each treatment. Thus the whole experiment comprised of ninety six plants.

The plants were propagated by vegetative means, for which 30 cm long healthy, diseased free, mature semi hard wood cuttings (stakes) were selected and planted in each planting time separately. Cuttings were planted vertically in the soil up to the depth of 12-15 cm because depth of vertical planting, from 5 to 20 cm, is known not to affect yield (Corpuz, 1980). The size of individual hill was kept 30 x 30 x 30 cm. One stalk was planted in each hill as recommended by (Villamayor *et al*., 1987), the row to row and plant to plant distance was kept 120 cm x 120 cm.

These cuttings were intercropped in already established Beri plantation. The missing hills were replanted within 10 to 15 days after plantation in order to reduce the drastic effect on yield of missing plants as suggested by (Villamayor, 1988). The plants were irrigated through tap water in basin system, for which a separate basin was formed around each plant. All the cultural practices were kept constant through out the experiment. The plants were irrigated weekly during first month in order to establish the roots after that the interval of irrigation was kept at 15 days. No organic and inorganic fertilizer application was carried out. The soil of the experimental area is sand- clay loam. The crop was harvested at four different suggested times (after 8, 12, 18, and 24 months of plantations). Each harvest had four replicates selected randomly. The parameters studied were Sprouting percentage after plantation, Plant height, Number of branches per plant, Stem circumference, Root length, Root circumference, Number of root branches per plant, Root weight per branch per root (g), Total fresh root weight per plant (g), and Yield per hectare (tons).

The dilution method of soil: water (1:2) ratio was employed for measurement of soil EC_e ($ds.m^{-1}$) and pH and AB-DTPA (Ammonium Bicarbonate Diethylene Tri Amine Penta Acetic Acid method) was used to measure the P and K (ppm) amount in the soil.

Table 1. Average Precipitation (Rainfall) (mm), Relative Humidity (%) and Temperature (°C) during period of plantation in Lasbella District, Balochistan.

Months	Precipitation/ Rainfall (mm)			Relative Humidity (%)			Temperature min-max (°C)		
	Year			Year			Year		
	2007	2008	2009	2007	2008	2009	2007	2008	2009
January	Trace	7.3	13.6	69.0-28	66.0-29.0	78	27.2-10.0	24.4-6.9	25.5-11.8
February	5.2	0	7.5	81.0-35.0	60.0-14.0	32	29.9-14.4	28.6-6.9	29.8-13.4
March	31	Trace	30.7	79.0-29.0	70.0-19.0	75	32.1-16.8	36.9-14.9	34.7-18.1
April	23.2	Trace	5.7	78.0-29.0	71.0-27.0	64	39.6-22.3	38.7-19.9	38.7-20.3
May	45	9.7	0	78.0-29.0	82.0-43.0	72	42.0-25.4	40.0-24.7	44.0-25.7
June	16.1	12.3	9.8	80.0-47.0	80.0-49.0	76	40.4-28.1	40.1-27.9	42.5-27.2
July	39.4	10	13.1	84.0-53.0	79.0-47.0	77	38.0-28.0	38.8-26.5	26.8-27.0
August	35.9	87.6	3.1	84.0-51.0	84.0-54.0	78	37.8-26.6	36.0-25.0	39.0-27.1
September	0	2.5	0	84.0-42.0	79.0-39.0	80	38.9-25.2	38.5-23.6	39.0-25.1
October	0	0	0	73.0-20.0	81.0-34.0	73	37.7-17.3	38.8- ?	39.3-17.8
November	0	0	0	79.0-25.0	66.0-22.0	58	35.2-15.1	33.9-13.0	33.2-10.3
December	0	124.5	19.8	77.0-28.0	84.0-45.0	80	27.8-9.4	27.0-12.3	27.6-10.8
Mean (yearly)	17.8	25.39	8.60	78.8-34.7	75.2-35.0	70.4	35.5-19.9	35.1 - ?	35.0-19.7

Source of data: Pakistan Meteorological Department, University Road, Karachi.

RESULTS AND DISCUSSION

The soil of the experimental field was sandy and average soil pH and EC_e (dsm^{-1}) of experimental area was 9.2 and 0.63 (Table 2). It had low Phosphorus. The growth performance of March and December plantations is presented in Table 3 and 4, respectively. In both plantations sprouting was completed during 8 months of planting but there was more sprouting in March plantation as compared to the December plantation. The reason of higher sprouting percentage when planted in March could be due to favourable climatic conditions with respect to rainfall, relative humidity and temperature during March-August 2007 (Table 1).

The data given in Table 3 show no significant effect among harvesting intervals of 8, 18 and 24 months regarding sprouting percentage. Most of the sprouting, however, took place during 8 months of the planting. Age of plants had significant effect on most of the growth parameters. By considering plant height, significant effect was observed amongst all the four intervals. The number of branches per plants / showed significant effect among intervals of 8, 12 and 24 months, whereas non-significant effect was observed between intervals of 8 and 18 months and 12 and 24 months. Stem circumference (cm) generally remained non-significant with respect to all the growth intervals. Similarly, root circumference (cm) was higher in 12, 18 and 24 months of growth but non-significantly different with each other. It was, however quite higher than that of the 8 month old plantation. The data regarding number of root branches per root increased with age significantly, except that non-significant effect was observed

between intervals of 12 and 18 months. Fresh root weight per plant (g) showed regular and gradual rise with age. Yield per hectare (tons) showed a similar pattern.

The data given in Table 4 revealed no significant effect in sprouting percentage when cassava was planted during the month of December. Plant height increased in irregular fashion. Number of branches per plant increased after a8 months of growth. Stem circumference remained indifferent in plants of 8, 12, 18 and 24 months but increased significantly in plantation of 24 months of age. The root length and circumference data showed insignificant effect with respect to the plant age as compared to the growth after 8 months. Number of branches per root per plant gave significant differences between 8 and 12, 18 and 24 months, whereas intervals of 12, 18 and 24 months remains non-significant with each other. Root weight per branch per root was the maximum after 8 months of growth but declined thereafter. Total fresh root per plant fluctuated significantly among the harvests and was the highest after 8 months of growth. The yield per hectare (tons) behaved similarly.

The cuttings planted during the month of March produced the lowest plant height of 101 cm after 8 months and highest plant height was observed after 24 months i.e. 396.66 cm. Whereas the value remain 215.11 and 310.66 after 12 and 18 months (Table 3). The plants planted during December produced an average height of 209, 318.33, 325.67 and 216 cm after 8, 12, 18 and 12 months respectively (Table 4). The average number of branches ranged between (2.61 and 7.33) when planted during March (Table 3). The same values ranged between (3.00 and 6.00) when planted during December (Table 4). The data indicated that average maximum stem circumference (20.76 cm) was developed after 18 months of growth when cutting was planted during March (Table 3). In December plantation maximum stem circumference (cm) was attained after 24 months of plantation (Table 4). The plants produced root of length of 26.16, 68.33, 53.33 and 54.0 cm after 8, 12, 18 and 12 months of growth in, respectively when planted in the month of March (Table 3), 53.67, 49.33, 38.33 and 32 cm, respectively in December plantation (Table 4). Maximum root length was observed after 12 months in March plantation and after 8 months in December plantation (Table 3 and 4).

Table 2. Soil analysis of the experimental site.

S. No.	Depth (cm)	EC_e (dsm^{-1})	pH	P (ppm)	K (ppm)	Texture
1	15	0.65	9.2	2.0	65	Hilly Sand
2	30	0.61	9.2	1.8	90	Hilly Sand
Mean	22.5	0.63	9.2	1.9	77.5	Hilly Sand

Table 3. Vegetative parameters and yield of Cassava (*Manihot esculenta*) in coastal area of Lasbella, Balochistan. Plantation time: March (2007); Harvesting intervals: After 8, 12, 18 and 24 months

Parameters (Average)	8 months	12 months	18 months	24 months	LSD (p<0.05)
Sprouting (%)	98± 0.32a	97.33 ± 5.49ab	96.3 ± 2.52bc	95.66 ± 2.40 c	1.33
Plant height (cm)	101 ± 4.93d	215.11 ± 2.47c	310.66 ± 6.36b	396.66 ± 8.82a	19.88
No. of branches per plant	2.61 ±0.19b	7.22 ± 0.77a	4.2 ± 0.41b	7.33 ± 0.87a	2.05
Stem circumference (cm)	15.86 ±1.07ab	19.05 ± 0.53ab	20.76 ± 1.30a	20.66 ±1.45a	4.55
Root length (cm)	26.16 ±1.47c	68.33 ±1.20a	53.33 ± 1.76b	54.00 ± 2.31b	5.66
Root circumference (cm)	4.46 ± 0.28 b	26.66 ± 1.85a	27.00 ± 1.15a	27.66 ±1.45a	4.30
No. of roots branches per plant	7.00 ±1.15b	4.66 ± 1.85b	17.66 ± 1.45a	18.66 ± 1.20a	3.88
Root weight per branch per root (g)	143 ±43.42c	1466.66 ±176.59b	1316.66 ± 44.17b	2116 ± 72.73a	319.30
Total fresh root weight per plant (g)	816.66 ± 60.16b	6233.33 ± 2333.94ab	15983.33a ± 7228.90	15816.67 ± 1256.5ab	12376.24
Yield per hectare (tons)	2.22 ± 0.30d	16.96 ± 0.58a	14.49 ± 2.52b	43.05 ± 2.47c	0.100

Table 4. Vegetative parameters and yield of Cassava (*Manihot esculenta*) in coastal area of Lasbella, Balochistan. Plantation time: December (2007); Harvesting intervals: After 8, 12, 18 and 24 months

Parameters (Average)	8 months	12 months	18 months	24 months	LSD ($p<0.05$)
Sprouting (%)	70 ± 1.15a	70 ± 2.31a	70 ±1.52a	70 ± 2.08a	5.65
Plant height (cm)	209.0 ± 39.97b	318.33 ± 10.14a	325.67 ± 8.67a	216.0 ± 0.57b	74.03
No. of branches per plant	03.00 ± 0.57b	03.00 ± 0.57b	05.00 ± 0.57a	6.00 ± 0.57a	1.88
Stem circumference (cm)	20 ± 2.00b	16.33 ± 0.87b	17.33 ±1.45b	36 ± 2.08a	5.46
Root length (cm)	53.67 ± 8.11a	49.33 ± 1.76a	38.33 ± 4.41ab	32.0 ±1.52b	15.52
Root circumference (cm)	26.7 ± 0.87a	31.0 ±1.52a	28.3 ± 4.98a	28.8 ± 0.0.66a	2.75
No. of roots branches per plant	5.3 ±0.32b	07 ± 0.57a	07 ± 0.57a	7.7 ± 0.32a	1.53
Root weight per branch per root (g)	641.11 ± 329.90a	403.33 ±14.54ab	52.17 ± 7.50b	425 ± 38.23ab	541.63
Total fresh root weight per plant (g)	4146.67 ± 1087.03a	3500 ± 115.60a	3891.2 ± 161.14a	2733.33 ± 145.46a	568.15
Yield per hectare (tons)	11.28 ± 0.32a	9.52 ± 0.31b	1.05 ± 0.06d	7.43 ± 0.29c	0.89

Fig. 1. A) Cassava plantation at farmer's field from where the Cassava cuttings were initially obtained. B) Preparation of basin around the Cassava plant. C) Data collection of Cassava roots. D) Harvest of Cassava roots.

Data regarding number of root branches per plant varied from 7.00 to 18.66 when planted during the month of March (Table 3), whereas it ranged between 5.33and 7.67 in December plantation (Table 4) and also maximum number of root branches (18.66) harvested after 24 months and minimum number in this respect was produced (4.66) after 12 months in same duration. The average root weight per branch per root (g) remains 100.76, 1466.66, 1316.66 and 2116.66 gm respectively when planted during the month of March, whereas in December the plants produces average root weight per branch per root (g), 641.11, 403.33, 52.17 and 425 g respectively. In both the conditions the harvesting was carried out at an interval of 8, 12, 18 and 24 months. Total fresh root weight per plant (g) was obtained after harvesting intervals of 8, 12, 18 and 24 months in both the plantation months (March and December), it remained 816.66, 6233.33, 15983.33 and 15816.67g in plants planted during March whereas in December plantation it remains 4146.67, 3500, 3891.2 and 2733.33 g, respectively.

The data regarding root yield per hectare (tons) revealed that maximum root yield (43.49) was harvested after 18 months of growth of plants when planted during March, whereas minimum yield of 1.05 tons per hectare was harvested after 18 months of plantation when planted during December. The March plantation gave a flexible harvesting period with maximum yield and for shorter harvesting intervals plantation can be made at both times - March or December.

CONCLUSION

The plantation of cassava during the month of March proved the best time for plantation for maximum sprouting, plant height, number of branches per plant, root length, number of root branches per plant, root weight / branch / root (g), total fresh root weight and also ultimate yield per hectare (tons). Whereas in December plantation, the plants produces only thickest stem and root circumference. In comparison of four different harvesting intervals, cassava planted during March produced maximum fresh root weight per plant (g) and yield per hectare (tons) after 18 and 24 months in March plantation. The plants planted in the month of March offer a flexible harvesting time as compared to those planted in the month of December.

REFERENCES

Asp, N.G. and I. Bjork (1992). Resistant Starch. *Trends Food Sci. Technol*. 3: 111-4.

Corpuz, E.U. (1980). *The influence of different depth of planting stakes on the yield of Golden Yellow cassava*. BS thesis, USM, Kabacan Cotabato. 21 p.

FAO (2001). A Global Cassava Development Strategy and Implementation Plan. In: Plucknett D. L. and R-B . Kagbo (Eds). *Proceedings of the Validation Forum on the Global Cassava Strategy.* Rome , 26-28 April 2000, 1 : p.70.

Fungulani, T. and E. Maseko (2001). Utilization of Cassava Starch in Textile Industry. In: Mahungu, N. M., Banda, J. W. and C. Mataya (Eds). *Cassava Commercialisation for Economic Development in Malawi*. Proceeding of the symposium held at Kwacha International Conference Centre, Blantyre, Malawi, 21-23 May 2001, pp. 98-99

IAEA (International Atomic Energy Agency) (2002). Case study: Sub-Saharan Africa: Promises Food Security and Income for Millions. In *: IAEA Press Release 2008/20.* Nuclear Science for Food Security, 2.

Itaye, S. (2001). The use of Starch in the Production of Corrugated Cartons. In: Mahungu, N.M. Banda, J. W. and C. Mataya (Eds). *Cassava Commercialisation for Economic Development in Malawi*. Proceeding of the symposium held at Kwacha International Conference Centre, Blantyre, Malawi, 21-23 May 2001, pp. 105-107.

Jos, J. S. (1969). Cytological aspects of cassava. In: Hrishi, N., Nair, R. G. (Eds). *Cassava Production Technologies*. Central Tuber Research Institute, Trivandrum, India, pp. 10-44.

Kamal, E. A., Frank, J., Razdan, A., Tengblad, S., Basu, S. and B. Vessy. (2000). Effects of dietary phenolic compound on Tocopherol, cholesterol, and fatty acid in rats. *Lipds***,** 35: 427-35

Lopez, H. W., Levrat-Werny, M., Coudry, C., Besson, C., Krespine, V., Message, A., Demigne, C. and C. Remesy, (2001). Class 2 resistant starch lower plasma and liver lipids and improves minerals retention in rats, *J. Nutri.*, 131: 1283-9.

Munthali, H. M. (2001). The use of starch in the manufacturing of batteries. In: Mahungu, N . M., J.W. and C. Mataya (Eds). *Cassava Commercialisation for Economic Development in Malawi.* Proceeding of the symposium held at Kwacha International Conference Centre, Blantyre, Malawi, 21-23 May 2001, p. 122.

Nassar, N.M.A. and A. O. Marques, (2006). Cassava leaves as a source of protein. *J. of Food, Agriculture & Environment*, 4 (1): 187-188.

Scott, G. J., Rosegrant, M. W. and C. Ringler, (2000). Global projections of root and tuber crops to the year 2020. *Food Policy*, 25: 561-597.

Topping, D. L. and P. M. Clifton, (2001). Short-Chain fatty acids and human colonic functions: role of resistant starch and non-starch polysaccharides. *Physiol. Rev.*, 81: 1031-64.

Villamayor, F.G. (1988). Recent progress in cassava agronomy research in the Philippines. *In*: R.H. Howeler (Eds) *Cassava Breeding and Agronomy Research in Asia*. Proc. 2nd Regional Workshop, held in Rayong, Thailand. Oct. 26-28, 1987. pp. 261-296.

Villamayor, F.G. Jr., C. Eronico and N. Euldan (1987). *Yield survey of root crops in Leyte*. Progress Report for 1987. ViSCA, Baybay, Leyte.

(*Accepted for publication October 2013*)