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Correlation of Growth Parameters with Yield of Two Cassava Varieties

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ABSTRACT
The correlation of major growth parameters with the yield of cassava in different growth phases was investigated in 2013 and 2014. This experiment was conducted to assess the effect of two cassava varieties and the different growth phases to the yield and yield components. In experiment, the varieties as treatment were arranged in a randomized complete block design (RCBD) with three replications. Two varieties consisted of superior Adira-4 and local varieties Singgah were used. The growth parameters (plant height, stem diameter, leaf number) and yield components (number of tuber, weight per tuber and tuber yield) in early growth phase, maximum vegetative growth phase and charging tuber phase, were observed. Based on the correlation results, the growth parameters and the yield highly affected to the final outcome of cassava tubers at different growth phases. In the early growth phase, occurs high demand to assimilate with the expense of storage root. However, from the maximum vegetative phase, growth parameters began to show a significant positive contribution to the tuber weight. Weight of fresh tuber in both varieties increased at the charging of tubers phase and thereafter (enlarged bulb). The early growth phase and maximum vegetative phase might not generate a significant contribution to the final yield of cassava tuber. Making those two periods were not suitable time for optimum harvesting result, and it still depended on the variety and its allocation.

Keywords: Growth Parameters, Yield, Growth Phase, Yield Components

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a perennial woody shrub with edible roots, grown in tropical and subtropical parts of the world (Oliveira and Miglioranza, 2014). Cassava is one of the most consumed roots crops in the world and the second important staple food for energy. World production of this plant in 2012 is estimated at 250 million tonnes (FAO, 2013). Nigeria, Brazil, Congo, Thailand and Indonesia dominate 60% of cassava production level in the world (Noerwijati and Budiono, 2015). The crops has a wide and produces yield in various agro-ecological and agronomic conditions (Akdamar *et al.*, 2002).

Cassava is grown mainly for its roots and leaves which are consumed in various forms. Recently, cultivation of cassava for stem has become a profitable venture for many farmers (Edet *et al*., 2015). Apart from cassava use as food, it is also as major source of feed for animals and raw materials for various industries. Furthermore, cassava products are also popular in international trade, contributing to the economy of the exporting countries (Scott *et al*., 2000). However, the results and performance of important crops may be affected by genetic as well as vorius environmental factors which could be linked to inclement temperatures, water deficit, inefficient distribution of assimilates in favor of he root and time of harvest (Grant *et al*., 1985; Chang, 1991). The productivity of cassava is also limited by soil nutrient status, increased yield due to fertilizer application has been severaly reported (Fermont *et al*, 2010;.Okpara *et al.*, 2010; Edet *et al*., 2013). In cassava, the result is closely associated with tuber diameter, size and weight (Ntawuruhunga and Dixon, 2010; Agahiu, 2011). The shoot and root compete for photosynthetic assimilates due to cassava unique simultaneous development of sinks organ (El-Sharkawy. 2014), however to achieve high yield, shoot and root growth must be well balanced. Tewodros and Ayenew, (2012), observed that plant height showed a strong and positive correlation with most of the characters including leaf area, fresh root and dry matter yield. Positive contribution of LAI to yield of cassava (Ekanayake, 1996; Edet *et al.*, 2015). Partitioning of assimilates in favor of cassava shoot due to age (Githunguri *et al*., 1998). According Apea-Bah *et al*. (2011), higher accumulation of starch at later stage of growth.

It is important to understand the correlation between the growth parameters and their contribution to the yield at different gorwth phases in cassava. This study assessed the agronomic characteristic and its relevance at different growth phases in cassava. It is hoped that our result can guide the farmers to the right time of optimum harvesting result to gain fresh tubers according to the expectation needs. This research was conducted to assess the contribution of various cassava growth parameters to the yield and yield related components at different growth phases.

MATERIALS AND METHODS

The research was conducted in experiment station, Universitas Gadjah Mada in Yogyakarta, Indonesia, at altitude 113 m above sea level on inceptisol. Two varieties (Adira-4 and Singgah) as treatments were arranged in a randomized complete block design (RBD) with three replications. Cassava cuttings were planted at a distance of 1m x 1m, fertilizer were applied at planting, while weeding were done in 1, 2 and 3 month after planting (MAP). A commercial type composed of 92% livestock dung mixed with a market waste, fortified with 2% SP36 and 6% Urea were used as organic fertilizer.

Data from fresh root bud yield and number of storage roots per plant were collected. Samples of 250 g of fresh shredded roots were oven-dried at 65^{o}C to a constant weight to obtain the root dry matter yield, then converted to ton/ha. The data was subjected to ANOVA procedure of the generalize linear model of SAS and correlation coefficient analysis. The treatment means were compared by using Duncan Multiple Range Test (DMRT) at alpha 5%.

RESULTS AND DISCUSSION

The growth of cassava consistently increased by the change of growth phases, indicated by increasing each growth parameters value (Table 1). The plant height of Adira-4 variety was higher than Singgah at the early growth and the maximum vegetative phases. The stem diameter of both varieties tend to be the same at the early growth stage. When it entered the maximum vegetative and tuber charging phases, the stem diameter of Adira-4 variety was bigger than Singgah. Adira-4 variety had more number of leaves than Singgah variety at the early growth phase, and tend to be the same on the remain phases.

Both of cassava varieties produced fresh tuber weight, tuber dry matter, fresh stem weight and harvest index tends to increase up to filling of tuber phase. The number of tuber increased only in maximum vegetative phase and decreased in the filling of tuber phase (Table 2). Fresh tuber weight from Adira-4 variety was heavier than Singgah variety at the filling of tuber phase. The number of tuber and dry matter of tuber from Singgah variety were heavier than Adira-4 variety in all growth phases. The fresh stem weight of Adira-4 variety is heavier than Singgah variety in all growth phases.

The tuber weight positively correlated with the tuber weight per crop in the charging of tuber phase and with harvest index (HI) at the maximum vegetative phase. The correlation between yield and yield component was different in each growth phases for both varieties (Table 3 and 4). In Adira-4 variety, the number and diameter of tuber at the early growth phase negatively correlated with the tuber weight,and the length and diameter of tuber at the maximum vegetative phase negatively correlated with the tuber weight as well (Table 3). The number of tuber and the tuber weight in the early growth and maximum vegetative phase positively correlated with the tuber weight, as well as the number, length, diameter and weight of the tuber . In Singgah variety, only the tuber length in the charging of tuber phase negatively correlated with the tuber weight, while the other components positively correlated with the tuber weight in all growth phases (Table 4).

The negative correlation between plant height, stem diameter and number of leaves on fresh tuber weight in early growth phase of Adira-4 variety (Table 3), was an impact of preferential partition excess that assimilated with the stem development, which actively led toward an assimilation that reduced tuber translocation. Thus, the plant height, the tuber diameter and the number of leaves at early growth and maximum vegetative phases of Singgah variety, all had negative correlation with fresh tuber weight (Table 4). It indicated that those parameters caused a decrease of the fresh

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Table 1. Growth parameters of cassava plant at 3 different growth phases

Growth phase	Growth parameters					
	Plant height		Stem diamater		Number of leaves	
	Adira-4	Singgah	Adira-4	Singgah	Adira-4	Singgah
2013						
First growth	44.29a	40.42b	1.00a	0.85a	18.76a	15.73b
Maximum vegetative	97.39a	92.05b	2.09a	1.74b	54.14a	50.46a
Tubers charging	223.77b	227.01a	3.00a	2.67b	99.71a	96.31a
2014						
First growth	40.29a	37.48b	1.04a	0.98a	17.78a	15.54b
Maximum vegetative	93.39a	89.05b	2.01a	1.87b	52.19	50.18a
Tubers charging	203.78b	224.05a	3.08a	2.67b	98.24a	95.48a

Remarks: The numbers followed by same letter in the same line in each parameter show no significant difference based on Duncan Multiple Range Test at alpha 5%.

Table 2. Cassava yield and yield related components

Growth phase	Number of tuber		Weight per tuber (g)		Tuber Yield (t^{-2} ha^{-1})	
	Adira-4	Singgah	Adira-4	Singgah	Adira-4	Singgah
Early growth	8.78c	10.00b	27.60a	25.97a	6.40a	4.95b
Maximum vegetative	10.11b	12.09a	90.04a	63.51b	7.15a	5.40b
Tubers charging	9.78b	10.44a	304.44a	247.17b	7.45a	6.20b

Remarks: The numbers followed by same letter in the same line in each parameter show no significant difference based on Duncan Multiple Range Test at alpha 5%.

Table 3. Relationship of cassava growth with yield, yield related components and yield of cassava of Adira-4 early growth phase.maximum vegetative, and charging of tuber.

		Ph	Sd	Nl	Nt	WpT	Ty
Plant height	Pearson Correlation	1	.867**	.884**	.056	-.422	-.109
		1	.820**	.969**	.148	.010	.024
		1	.344	.284	.541	.206	.363
Stem diameter	Pearson Correlation	.867**	1	.926**	-.327	-.240	-.392
		.820**	1	.844**	-.153	-.226	-.253
		.344	1	.769**	-.108	-.171	-.198
Number of leaves	Pearson Correlation	.884**	.926**	1	-.199	-.196	-.260
		.969**	.844**	1	.095	.145	.124
		.284	.769**	1	-.107	.032	-.640*
Number of tuber	Pearson Correlation	.484	.236	.348	1	-.765**	-.164
					1		
		.541	-.108	-.107	1	.280	.301
Weight per tuber	Pearson Correlation					1	
		.010	-.226	.145	.459	1	.965**
		.206	-.171	.032	.280	1	.219
Tuber yield	Pearson Correlation						1
							1
		.363	-.198	-.640*	.301	.219	1

Remarks: Ph= Plant high, Sd = Stem diameter, Number of leaves, Nt= Number of tubers, WpT = Weight per tuber, Ty = Tuber yield, *. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Table 4. Relationship of cassava growth with yield, yield related components and yield of cassava Singgah in early growth phase.maximum vegetative, and charcingpf the tuber.

		Ph	Sd	Nl	Nt	WpT	Ty
Plant height	Pearson Correlation	1	.553	.615	-.710*	-.693*	-.221
		1	-.215	.340	.204	-.108	-.170
		1	.681*	.358	-.548	.019	.072
Stem diameter	Pearson Correlation	.553	1	.445	-.360	-.789**	-.346
		-.215	1	.338	.192	-.324	-.043
		.681*	1	.234	-.038	.332	.376
Number of leaves	Pearson Correlation	.615	.445	1	-.590	-.528	-.305
		.340	.338	1	-.349	-.349	-.497
		.358	.234	1	-.484	-.673*	-.656*
Number of tuber	Pearson Correlation	-.710*	-.360	-.590	1	.763*	.639*
		.204	.192	-.349	1	-.235	.029
		-.548	-.038	-.484	1	.607	.338
Weight per tuber	Pearson Correlation	-.693*	-.789**	-.528	.763*	1	.484
		-.108	-.324	-.349	-.235	1	.609
		.019	.332	-.673*	.607	1	.875**
Tuber yield	Pearson Correlation	-.221	-.346	-.305	.639*	.484	1
		-.170	-.043	-.497	.029	.609	1
		.072	.376	-.656*	.338	.875**	1

Remarks: Ph= Plant high, Sd = Stem diameter, Number of leaves, Nt= Number of tubers, WpT = Weight per tuber, Ty = Tuber yield, *. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

tuber yield in those phases. This may be due to high demand toward assimilation of vegetative growth phase and caused the detriment of the root tuber. It meant the tuber yield in Singgah variety could still be increased if the harvesting time was suspended for several months. The increasing of tuber yield for harvesing was on 12 MAP (tuber enlargement phase) or after the charging of tuber phase (Ngeve, 1985 ;. Nweke *et al*., 1994; Alleman and Dugmore, 2004; Okparaet al, 2010).

CONCLUSION

Based on the correlation result in this study, the growth and yield parameters had some profound effects on the final tuber yields in different growth phases. In the early growth phase, occurs high demand to assimilate with the expense of storage root. However, from the maximum vegetative phase, growth parameters began to show a significant positive contribution to the tuber weight. Weight of fresh tuber in both varieties increased at the charging of tubers phase and thereafter (enlarged bulb). The early growth phase and maximum vegetative phase might not generate a significant contribution to the final yield of cassava tuber. Making those two periods were not suitable time for optimum harvesting result, and it still depended on the variety and its allocation.

REFERENCES

Agahiu, A. E., K. P. Baiyeri and R.O. Ogbuji. 2011. Correlation Analysis of Tuber Yield and Yield Related Characters in Two Cassava *(Manihot esculenta* Crantz) Morphological-Types Grown Under Nine Weed Management Systems in The Guinea Savanna zone of Nigeria. *Journal of Applied Bioscience,* 48: 3316- 3321.

Akdamar, M., S. Tayyar. and A. Gokkus. 2002. Effects of Different Sowing Times on Yield and Yield Related Traits in Breed Wheatgrown in Canakkale. *Akdeniz Universitesi Ziraat Fakultesi Dergisi,* 15(2): 81-87.

Allemann, J. and N. Dugmore. 2004. The Potential for Cassava Production in Bathrust Region of Eastern Cape Province of South Africa. *African Crop Science Journal,* 12: 275-281.

Apea-Bah, F. B., I. Oduyo, W. O. Ellis and O. Safo-Kantaka. 2011. Factor Analysis and Age at Harvest Effect on Quality of Flour from Four Cassava Varieties. *World Journal of Dairy and Food Sciences*, 6(1): 43-54.

Chang, J. H. 1991. Corn Yield in Relation to Planting Period Light, Temperature and Solar Radiation. *Agricultural Meteorology,* 24: 251–254.

Edet, M. A., H. Tijani-Eniola and R.U. Okechukwu.

2013. Comparative Evaluation of Organomineral Fertilzer and NPK 15-15-15 on Growth and Yield of Cassava Varieties in Ibadan, South-Western Nigeria. *African Journal of Root Crops.,* 10(1): 9-14.

Edet, M. A., H. Tijani-Eniola., S.T.O Lagoke and G. Tarawati. 2015. Relationship of Cassava Growth Parameters with Yield, Yield Related Components and Harvest Time in Ibadan, Southwesters Nigeria. *Journal of Natural Sciences Ressearch*, 5(9): 87-93.

Ekanayake, I. J. 1996. *Cassava Crop Physiology Root and Tuber Improved Program Archival Annual Report for 1993-1995*. Ibadan, Nigeria: Crop Improvement Division, International Institute of Agriculture, pp. 46.

El-Sharkawy, M. A. 2014. Global Warming: Causes and Impacts on Agroecosystems Productivity and Food Security with Emphasis on Cassava Comparative Advantage in the Tropics/Subtropics. *Photosynthetica*, 52(2): 161-178.

FAO. 2013. *Statistic Division Website.* [online] Available at: http://www.fao.org/statistics/en/ [Accessed 26 September 2013].

Fermont, A. M., A. Pablo, Y. Titonell, P. Baguma, P. Ntawuruhunga and K. E. Giller. 2010. Towards Understanding Factors that Govern Fertilizer Response in Cassava: Lessons from East Africa. *Nutrient Cycle Agroecosystem,* 86: 133-151.

Githunguri, C. M., J. A. Chweya, I. J. Ekanayake, and A. G. O. Dixon. 1998. Climatic and Growth Stage Influence on Tuberous Root Yield and Cyanogenic Potential, Leaf Water Potential and Leaf Area Duration on Divergent Cassava (*Manihot esculenta* Crantz). *Proceedings of the International Society of Tropical Root Crops-Africa Branch (ISTRC-AB)*: 272-279.

Grant, R. F., B. S. Jackson, J. R. Kiniry and G. F. Arkin. 1985. Water Deficit Timing Effects on Yield Components in Cassava. *Agronomy Journal,* 81: 61–64.

Ngeve, J. M. 1985. Effects of Location and Age at Harvest on Yield and Culinary Qualities of Cassava (*Manihot esculenta* Crantz). *Proceedings of 6th Triennial symposium of ISTRC-AB*: 349-352.

Noerwijati, K. and R. Budiono. 2015. Yield and Yield Components Evaluation of Cassava (*Manihot esculenta* Crantz) Clones in Different Altitudes. *Energy Procedia,* 65: 155-161.

Ntawuruhunga, P. and A. Dixon. 2010. Quantitative Variation and Interrelationship Between Factors Influencing Cassava Yield. *Journal of Applied Biosciences,* 26: 1594-1602.

Nweke, F. I., A. G. O. Dixon, R. Asiedu and S. A. Folayan. 1994. *Cassava Varietal Needs of Farmers and The Potential for Production and Growth in Africa*. Ibadan, Nigeria: International Institute of Tropical Agriculture. pp. 239.

Okpara, D. A., U.S. Agoha and M. Iroegbu. 2010. Response of Cassava Variety TMS 98/0505 to Potassium Fertilization and Time of Harvest in South Eastern Nigeria. *Nigeria Agricultural Journal,* 41(1) 84-92.

Oliveira, E.C. and E. Miglioranza. 2014. Stomatal Density in Six Genotypes of Cassava. *International Journal of Engineering Science and Innovative Technology (IJESIT),* 3(3):205-208.

Scott, G. J., M.W. Rosegrant and M. W. Ringler. 2000. *Roots and Tubers for The 21st Century: Trends, Projections and Policy Options*. Washington, DC, USA: International Food Policy Research Institute, pp. 64.

Tewodros, M., and B. Ayenew. 2012. Cassava (*Manihot esculenta* Crantz) Varieties and Harvesting Stages Influenced by Yield and Yield Related Components. *Journal of Natural Science Research*, 2(10): 122-128.