

Production Of 5 Clones Of Cassava Is Applied Plant Regulator Growth, Microbial Fertilizer, NPK And Harvested At Different Age

Hanapi, Kahar Mustari, Elkawakib Syam'un, Kaimuddin

Abstract: Cassava is an important crop plants as a source of carbohydrate, raw materials for industrial, cosmetic, feed and energy. The study aims to determine the 5 clones of cassava production is applied Hormax regulator growth + Organox microbial fertilizer + NPK and harvested at different age. The experiment was conducted in the form of three-factor factorial experiment based on randomized complete block design. Study result shows that the interaction between the clone MLG 0311 and Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and the age of 9 month when the cassava crop is harvested produced the highest weight of tuber yield per tree (4.870 kg), the highest of total wet weight of sugar level (0.65 %), conversion of fresh peeled tuber with the highest ethanol (155.00 ml.kg⁻¹). clone of ADIRA-4 with Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ + water + NPK 150 kg.ha⁻¹ and harvest age of 9 month resulted in the highest harvest index (94.261 %). Klon MAL-6 with Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age of 9 month produced the highest of dry weight yield starch content (70.24 %).

Index Term: Cassava; plant regulator growth; microbial fertilizer; NPK, harvest age

1. INTRODUCTION

Cassava (*Manihot esculentum*) is one of the staple food crops of more than 700 million people in the world, which is produced in the tropics (Rijssen *et al.*, 2013)[1]. As a source of carbohydrate, protein and non protein such as nitrite, nitrate, and cyanogens compounds (Zvinavashe *et al.*, 2011)[2], raw materials for industry, cosmetics, food and energy, cassava also can be processed into starch, glucose, fructose, sorbitol, ethanol, citric acid, monosodium glutamate (Rukmana, 1997)[3] and bioethanol (Oyeleke *et al.*, 2012)[4]. Increasing population and demand for food, feed, and biofuels cause the cassava production should be a priority to be developed over the coming decades. (Sayre *et al.*, 2011)[5]. The application of technology for culture and cultivation tend to use high cost with provision of increasing inputs as a result of declining soil quality with the use of inorganic fertilizer continuously without keep in balance by the use of organic fertilizer. The use of inorganic fertilizer leads to an increase crop productivity, but in a relatively long period of time caused side effect that make farms harder resulting in lower productivity. Fertilization in the more marginal land is important in order to improve soil fertility. (Utomo dan Sigit, 2012)[6].

Microbial activity in soil directly related to soil organic, organic content really on marginal soil in Indonesia decreased drastically and consequently microbial activity also decreased as a result of the limited energy source for microbes. Introducing microbe into the soil is considered more efficient in increasing activities of the add organic matter into the soil. Through the introducing or application of the biofertilizer increased the efficiency of the supply of nutrients and the use of chemical fertilizer can be reduced (Goenadi dan Saraswati, 2001)[7]. Propagation by cutting of cassava will produce plants similar to the parents. To accelerate the cassava cutting should be given hormones to grow crops and organic fertilizer, one of which is Hormax and Organox. Hormax hormones contain *indol acetic acid* 108.56 ppm, cytokinin (kinetin 98.34 ppm dan zeatin 107.81 ppm), ABA 89.35 ppm, IBA 83.72 ppm, gibberelin (GA₃ 118.40 ppm), etilen 168 ppm, traumalin acid 212 ppm dan humic acid 354 ppm, whereas Organox liquid organic fertilizer show that the fertilizer contain organic C 21.42 %, N total 0.84 %, P₂O₅ 0.96 %, K₂O 1.16 %, Cu 84.7 ppm, Zn 62.9 ppm, Mn 58.4 ppm, Fe 106.1 ppm and B 62.7 ppm. Also contain microbes consist of *Azospirillum* sp 1.10 x 10⁷ Mpn/ml, *Pseudomonas* sp 3.5 x 10⁷ Cfu/ml, *Rhizobium* sp 3.3 x 10⁸ Cfu/ml, *Basillus* sp sp 2.0 x 10⁸ Cfu/ml, and *Azotobacter* sp 2.5 x 10⁵ Cfu/ml (Supadno, 2011)[8]. The study aims to determine the production of 5 clones of cassava is applied plant regulator growth, microbial fertilizer, NPK and harvested at different age.

2. MATERIALS AND METHODS

2.1 Materials

The materials used were 5 clones of cassava cutting, plant growth regulator, biological fertilizer, soil, manure, water and labels.

2.2 Methods

The study was conducted in the village Moncongloe, Moncongloe District, Regency of Maros, South Sulawesi, Indonesia., from June 2013 until February 2014. Soil analysis carried out in the laboratory of Chemistry and Soil Fertility, Faculty of Agriculture, Hasanuddin University, the result of cassava yield analysis conducted at the Chemical Laboratory,

- Hanapi: Dept. of Agrotechnology, Faculty of Agriculture, University Islam Makassar, 90245, South Sulawesi, Indonesia E-mail: hanafi.syam@yahoo.co.id
- Kahar Mustari: Dept. of Agrotechnology, Faculty of Agriculture, Hasanuddin University, Makassar, 90245, South Sulawesi, Indonesia
- Elkawakib Syam'un: Dept. of Agrotechnology, Faculty of Agriculture, Hasanuddin University, Makassar, 90245, South Sulawesi, Indonesia.
- Kaimuddin: Dept. of Agrotechnology, Faculty of Agriculture, Hasanuddin University, Makassar, 90245, South Sulawesi, Indonesia.

Faculty of Animal Husbandry, Hasanuddin University. The experiment was conducted in the form of three-factor factorial experiment based on randomized complete block design. The first factor is cassava clones consist of 5 clones that is local mix, MAL-6, DAHI, MLG 0311 and ADIRA-4. The second factor is the concentration of Hormax growth regulator in combination with Organox microbial fertilizer and dose of NPK fertilizer consist of 3 levels ie : 0 mL.L⁻¹ water + NPK 150 kg.ha⁻¹, 20 mL Hormax + 40 mL Organox.L⁻¹ water + NPK 150 kg.ha⁻¹, and 30 mL Hormax + 60 mL Organox.L⁻¹ water + NPK 100 kg.ha⁻¹. The third factor is the age of cassava when harvested which consist of 3 levels ie: 9 month, 8 month, dan 7 month. There are 45 combinations of treatments were repeated 3 times. Cassava cutting soaked for 30 minutes in a solution of appropriate treated then planted at a spacing of 0.8 m x 0.7 m.

2.3 Data Analysis

Plants responses were analyzed using *Univariate Analysis* and SPSS program for windows version 21. Test significant different between two middle values performed with the use of Duncan's multiple range test of 5% level.

3. RESULTS AND DISCUSSION

The result of the analysis of physical and chemical soil at land that used in this study are: class of clayey loam soil texture with the composition of sand 22 %, slit 39 %, dan clay 39 %. pH 5.4, organic C content 0.89 %, N total 0.11 %, C/N ratio 8, P₂O₅ Bray I 7.0 ppm, Ca 1.36 cmol.kg⁻¹, Mg 0.52 cmol.kg⁻¹, K 0.08 cmol.kg⁻¹, Na 0.14 cmol.kg⁻¹, KTK 16.59 cmol.kg⁻¹, and KB 13 %. Result of variance analysis showed that the interaction between clones with concentration of Hormax + Organox + dose of NPK and plant age at cassava harvest was very significant effect on tuber weight per tree, harvest index, total sugar content of wet weight, total starch content of dry weight, and conversion of fresh tubers into ethanol.

Table 1. Average of Tuber Weight per Tree (5 kg) of 5 Clones Cassava on the Concentration of Hormax + Organox and Dose of NPK and Age of Harvest.

Clones	Concentr. (Hormax + Organox) mL.L ⁻¹ water+NPK kg.ha ⁻¹	Age of Harvest (Month)		
		9	8	7
Local mix	0 + 0 + 150	w ^{1.979} _b	w ^{1.801} _a	w ^{1.212} _a
	20 + 40 + 150	y ^{2.944} _b	w ^{1.889} _a	x ^{1.644} _a
	30 + 60 + 100	w ^{2.299} _b	w ^{1.843} _a	w ^{1.494} _a
MAL-6	0 + 0 + 150	w ^{1.924} _b	w ^{1.786} _a	w ^{1.178} _a
	20 + 40 + 150	w ^{2.120} _a	w ^{2.013} _a	x ^{1.826} _a
	30 + 60 + 100	w ^{2.086} _a	w ^{1.909} _a	w ^{1.497} _a
DAHI	0 + 0 + 150	x ^{2.699} _b	w ^{1.822} _a	w ^{1.157} _a
	20 + 40 + 150	y ^{3.600} _c	x ^{2.842} _b	w ^{1.359} _a
	30 + 60 + 100	x ^{3.454} _c	w ^{2.434} _b	w ^{1.345} _a
MLG 0311	0 + 0 + 150	w ^{2.722} _b	w ^{2.388} _b	w ^{1.525} _a
	20 + 40 + 150	z ^{4.870} _d	y ^{4.210} _b	w ^{1.746} _a
	30 + 60 + 100	y ^{3.435} _b	x ^{2.824} _b	w ^{1.550} _a
ADIRA-4	0 + 0 + 150	x ^{3.815} _c	w ^{2.173} _b	w ^{1.109} _a
	20 + 40 + 150	y ^{4.123} _b	x ^{3.543} _b	x ^{2.037} _a
	30 + 60 + 100	y ^{3.300} _c	w ^{2.248} _b	w ^{1.086} _a

Note: Values followed by the same letter in row (a,b,c) or column (k,l,m,n,w,x,y,z) are not significantly different (DMRT P<0.05).

Duncan's α 0,05 multiple range test result in Table 1, show the interaction between the clonek of MLG 0311 and Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹

and harvest age 9 month resulted in the highest weight of tubers per tree (4.870 kg) significantly different from other treatments. Interaction between clone of ADIRA-4 and Hormax 30 mL.L⁻¹ water + Organox 60 mL.L⁻¹ water + NPK 100 kg.ha⁻¹ and harvest age 7 month resulted the lowest weight of tubers per tree (1.083 kg), do not differ significantly with 20 other treatments. Cassava clones that produce high tuber weight can be used as an indicator of effective solution in selecting clones of cassava which contain high and potential starch.

Table 2. Average of Index Harvest (%) of 5 Clones Cassava on the Concentration of Hormax+Organox and Dose of NPK and Age of Harvest.

Clones	Concentr. (Hormax + Organox) mL.L ⁻¹ water+NPK kg.ha ⁻¹	Age of Harvest (Month)		
		9	8	7
Local mix	0 + 0 + 150	w ^{41.196} _a	w ^{57.962} _b	x ^{57.211} _b
	20 + 40 + 150	y ^{79.035} _a	x ^{69.410} _a	y ^{77.988} _a
	30 + 60 + 100	w ^{51.156} _a	x ^{61.661} _a	y ^{66.901} _b
MAL-6	0 + 0 + 150	w ^{44.440} _a	w ^{57.890} _a	x ^{46.573} _b
	20 + 40 + 150	w ^{50.848} _a	x ^{63.396} _a	y ^{67.820} _b
	30 + 60 + 100	w ^{47.205} _a	x ^{62.908} _b	x ^{60.002} _a
DAHI	0 + 0 + 150	x ^{57.439} _b	w ^{42.646} _a	w ^{37.913} _a
	20 + 40 + 150	y ^{74.948} _b	x ^{73.546} _b	x ^{53.103} _a
	30 + 60 + 100	x ^{62.577} _a	w ^{58.085} _a	x ^{49.276} _a
MLG 0311	0 + 0 + 150	w ^{45.648} _a	w ^{54.148} _b	w ^{33.399} _a
	20 + 40 + 150	y ^{77.568} _b	y ^{76.149} _b	w ^{41.106} _a
	30 + 60 + 100	x ^{58.236} _b	x ^{61.543} _b	w ^{38.131} _a
ADIRA-4	0 + 0 + 150	x ^{70.321} _b	x ^{58.939} _b	w ^{26.841} _a
	20 + 40 + 150	z ^{94.261} _b	x ^{72.318} _a	x ^{60.380} _a
	30 + 60 + 100	y ^{76.956} _c	x ^{59.938} _b	w ^{32.500} _a

Note: Values followed by the same letter in row (a,b,c) or column (k,l,m,n,o,w,x,y,z) are not significantly different (DMRT, P<0.05).

Duncan's α 0,05 multiple range test result in Table 2, show the interaction between the clonek of ADIRA-4 and Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age 9 month resulted in the highest weight of tubers per tree (94.261%) significantly different from other treatments. Interaction between clone of ADIRA-4 and Hormax 0 mL.L⁻¹ water + Organox 0 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and age harvest 7 months resulted the lowest harvest index (26.841 %), do not differ significantly with 12 other treatments. Harvest index is a measure of the productivity of the cassava plant, a low harvest index value (>50%) indicated the productive plant, harvest index had a positive correlation with the weight of tuber.

Table 3. Average of the Total Sugar Content of Wet Weight (%) 5 Clones of Cassava on the Concentration of Hormax + Organox and Dose of NPK and Harvest Age.

Clones	Consentr. (Hormax + Organox) mL.L ⁻¹ water+NPK kg.ha ⁻¹	Age of Harvest (Month)		
		9	8	7
Local mix	0 + 0 + 150	r,0.26 ^c	s,0.19 ^b	,0.15 ^a
	20 + 40 + 150	z,0.65 ^c	v,0.30 ^b	s,0.19 ^a
	30 + 60 + 100	r,0.27 ^c	t,0.22 ^b	,0.16 ^a
MAL-6	0 + 0 + 150	r,0.27 ^c	t,0.22 ^b	,0.15 ^a
	20 + 40 + 150	v,0.48 ^c	x,0.44 ^b	,0.22 ^a
	30 + 60 + 100	t,0.33 ^b	u,0.26 ^b	s,0.19 ^a
DAHI	0 + 0 + 150	u,0.42 ^c	w,0.33 ^b	r,0.15 ^a
	20 + 40 + 150	y,0.61 ^c	w,0.55 ^b	,0.23 ^a
	30 + 60 + 100	x,0.56 ^c	w,0.34 ^b	s,0.18 ^a
MLG 0311	0 + 0 + 150	u,0.42 ^b	,0.15 ^a	,0.15 ^a
	20 + 40 + 150	z,0.65 ^c	x,0.46 ^b	u,0.41 ^b
	30 + 60 + 100	w,0.52 ^c	s,0.19 ^b	,0.16 ^a
ADIRA-4	0 + 0 + 150	r,0.25 ^b	,0.15 ^a	,0.15 ^a
	20 + 40 + 150	s,0.30 ^c	u,0.26 ^b	,0.15 ^a
	30 + 60 + 100	s,0.30 ^c	s,0.18 ^b	,0.15 ^a

Note: Values followed by the same letter in row (a,b,c) or column (k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z) are not significantly different (DMRT, P<0.05).

Duncan's α 0,05 multiple range test result in Table 3, show the interaction between the clones of local mix and Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age 9 month resulted in the highest of total sugar content of wet weight (0.65%), do not differ significantly with interaction between clone of MLG 0311 and Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age 9 month (0.65 %) and significantly different with other treatments. Interaction between clone of local mix and Hormax 0 mL.L⁻¹ water + Organox 0 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age 7 month resulted in the lowest of total sugar content of wet weight (0.15 %), do not differ significantly with 10 treatments. Information of total sugar content of wet weight was necessary to determine weight of the tubers as a raw material for ethanol because total sugar content for fermentation media was 15 %. Total sugar is the amount of sugar (as glucose) which is naturally contained in the tube starch and sugar from chemical hydrolysis. The higher of the total total sugar content of fresh tubers, the lower of the weight of the tubers are required in the manufacture of bioethanol. Duncan's α 0,05 multiple range test result in Table 4, show the interaction between the clones of MAL-6 with Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and age harvest 9 must resulted the highest of dry weight of the starch content (70.24 %), significantly different with other treatments. Interaction between clone of local mix and Hormax 0 mL.L⁻¹ water + Organox 0 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age 7 month resulted the lowest of dry weight of the starch content (57.22 %) significantly different with other treatments.

Table 4. Average of Dry Weight of the Starch Content (%) 5 Clones of Cassava on the Concentration of Hormax + Organox and dose of NPK and Harvest Age.

Clones	Consentr. (Hormax + Organox) mL.L ⁻¹ water+NPK kg.ha ⁻¹	Age of Harvest (Month)		
		9	8	7
Local mix	0 + 0 + 150	,65.43 ^c	,61.17 ^b	,57.22 ^a
	20 + 40 + 150	x,68.99 ^c	w,65.91 ^b	q,60.35 ^a
	30 + 60 + 100	q,65.26 ^c	t,63.91 ^b	m,59.29 ^a
MAL-6	0 + 0 + 150	n,64.29 ^c	q,62.92 ^b	m,59.32 ^a
	20 + 40 + 150	z,70.24 ^c	y,66.96 ^b	v,62.68 ^a
	30 + 60 + 100	y,69.26 ^c	s,63.66 ^b	p,59.88 ^a
DAHI	0 + 0 + 150	m,62.42 ^c	m,61.90 ^b	,60.41 ^a
	20 + 40 + 150	t,66.04 ^c	u,64.62 ^b	t,61.63 ^a
	30 + 60 + 100	s,65.81 ^c	n,61.95 ^b	s,60.80 ^a
MLG 0311	0 + 0 + 150	,62.40 ^c	o,62.34 ^b	o,59.77 ^a
	20 + 40 + 150	p,64.72 ^c	r,63.48 ^b	u,61.89 ^a
	30 + 60 + 100	o,64.44 ^c	p,62.43 ^b	u,61.87 ^a
ADIRA-4	0 + 0 + 150	o,66.40 ^c	p,62.43 ^b	n,59.34 ^a
	20 + 40 + 150	w,68.29 ^c	v,64.72 ^b	x,66.18 ^a
	30 + 60 + 100	v,66.69 ^c	z,67.82 ^b	w,65.93 ^a

Note: Values followed by the same letter in row (a,b,c) or column (l,m,n,o,p,q,r,s,t,u,v,w,x,y,z) are not significantly different (DMRT, P<0.05).

Cassava is one of the types of tubes a that are thought to have a pattern of relationship between harvest age, texture, and starch content. This is in accordance with Abbot dan Harker (2001)[9] and Wills et al.(2005)[10] stating that increasing of harvest age, causing tubers become harder texture and starch content increases, but if too old, the fiber content increased and starch content decreased. Cassava harvest time was depending on the variety and usefulness, but it was generally 9-12 months.

Table 5. Average of Conversion of Fresh Peeled Tubers Become Ethanol (ml/kg) 5 Clones of Cassava on the Concentration of Hormax + Organox and Dose of NPK and Harvest Age.

Clones	Consentr. (Hormax + Organox) mL.L ⁻¹ water+NPK kg.ha ⁻¹	Age of Harvest (Month)		
		9	8	7
Local mix	0 + 0 + 150	w,147.00 ^b	v,146.00 ^b	u,141.00 ^a
	20 + 40 + 150	x,150.00 ^{ab}	x,149.00 ^a	x,148.00 ^a
	30 + 60 + 100	x,150.00 ^{ab}	w,147.00 ^a	w,146.00 ^a
MAL-6	0 + 0 + 150	w,148.00 ^b	w,147.00 ^b	v,144.00 ^a
	20 + 40 + 150	z,155.00 ^c	x,150.00 ^b	x,148.00 ^a
	30 + 60 + 100	y,153.00 ^b	x,149.00 ^a	x,148.00 ^a
DAHI	0 + 0 + 150	x,151.00 ^c	v,146.00 ^b	v,144.00 ^a
	20 + 40 + 150	y,153.00 ^b	y,152.00 ^b	w,147.00 ^a
	30 + 60 + 100	y,152.00 ^b	w,148.00 ^a	w,147.00 ^a
MLG 0311	0 + 0 + 150	y,152.00 ^b	v,145.00 ^a	v,144.00 ^a
	20 + 40 + 150	y,152.00 ^b	y,152.00 ^b	y,150.00 ^a
	30 + 60 + 100	z,155.00 ^c	y,152.00 ^b	v,145.00 ^a
ADIRA-4	0 + 0 + 150	z,154.00 ^c	y,152.00 ^b	w,146.00 ^a
	20 + 40 + 150	z,154.00 ^b	y,153.00 ^b	z,153.00 ^a
	30 + 60 + 100	z,155.00 ^c	z,154.00 ^b	x,149.00 ^a

Note: Values followed by the same letter in row (a,b,c) or column (k,l,m,n,o,p,q,u,v,w,x,y,z) are not significantly different (DMRT, P<0.05).

Duncan's α 0,05 multiple range test result in Table 5, show the interaction between the clone of MAL-6 and Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age 9 month resulted the highest conversion of fresh peeled tubers become ethanol (155.00 ml.kg⁻¹) or has average of conversion was 6.45 kg fresh peeled tubers to produce 1

litre of ethanol, do not differ significantly with interaction between clone of MLG 0311 and Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age 9 month (155.00 ml.kg⁻¹), interaction between clone of MLG 0311 and Hormax 30 mL.L⁻¹ water + Organox 60 mL.L⁻¹ water + NPK 100 kg.ha⁻¹ and harvest age 9 month (154.00 ml.kg⁻¹), interaction between clone of Adira-4 and Hormax 30 mL.L⁻¹ water + Organox 60 mL.L⁻¹ water + NPK 100 kg.ha⁻¹ and harvest age 9 month (155.00 ml.kg⁻¹). Interaction between clone of local mix and Hormax 0 mL.L⁻¹ water + Organox 0 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age 7 months resulted the lowest of conversion of fresh peeled tubers become ethanol (141.00 ml.kg⁻¹) significantly different with other treatments. Study result shows that an average value of conversion needed 6.45 kg of fresh peeled tubers to produce 1 litre of ethanol. According to Rikana and Adam, (2009)[11], the smaller of conversion number, the more efficient for raw materials due to amount or the weight of the raw material needed less and less. The conversion rate which has been used is 6.1 kg per one litre of 96% ethanol.

4. CONCLUSION

Interaction of clone MLG 0311 and Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and the age of 9 month when cassava is harvested produced the highest of weight tuber per tree (4.870 kg), the highest of total sugar content of wet weight (0.65 %), the highest of conversion of fresh peeled tuber into ethanol (155.00 ml.kg⁻¹). Clone ADIRA-4 and Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age 9 months resulted the highest of harvest index (94.261 %). Clone of MAL-6 and Hormax 20 mL.L⁻¹ water + Organox 40 mL.L⁻¹ water + NPK 150 kg.ha⁻¹ and harvest age 9 months resulted the highest of dry weight of the starch content (70.24 %).

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