AND AGRONOMICAL CHARACTERS ON 18 SELECTED GENOTYPES OF BAMBARA GROUNDNUT (*Vigna Subterranea* (L.) VERDCOURT)

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ABSTRACT

In Indonesia, bambara groundnut (*Vigna subterranea* (L.) Verdcourt) is an unpopular and minor crops, but it has an important role in the food diversification program. Bambara groundnut contains high carbohydrate and protein with relatively low fat. Recently the demand of bambara groundnut began to increase the imbalance between supply and demand is an excellent chance to develop this crop. An effort to increase crop production through plant breeding programs require genetic variability of plant populations. The purpose of this research is to determine variability of morphological and agronomical characters on 18 selected genotypes of bambara groundnut. This research was conducted at the experimental field state on Jatikerto of Agriculture Faculty, University of Brawijaya, Malang. Research began December 2013 until May 2014. The research using a Randomized Complete Block Design (RCBD) with three replications. The materials used 13 local genotypes come from Sumedang, Lamongan, Bangkalan and introduction genotypes from University of Kasetsart Thailand. The result of this research show that there were different variability of morphological character, except characters of pod shape and pigmentation on wings and banner flower. While there were different variability of agronomical characters, except characters of number of leaves. The value of genetic variability coeffisient on all characters were low, while the value of phenotip variability coefficient only in character results was quite high.

Keywords: Bambara Groundnut, Variability, Morphological, Agronomical.

INTRODUCTION

Bambara groundnut (*Vigna subterranea* (L.) Verdcourt) is an origin leguminous plants of West Africa, that developed in America, Asia and Australia. In Asia, bambara groundnut has been cultivated in India, Indonesia, Malaysia, Philippines and Thailand. In Indonesia, this plant is an unpopular. Bambara groundnut has an important role in the food diversification program because it contains high carbohydrate and protein with relatively low fat (NAS, 1979). In addition, bambara groundnut is more tolerant and easily adaptable to less fertile areas compared to other legume crops (Goli, 1995). Recently, the demand of bambara groundnut increased (Swanevelder, 1998). The imbalance between supply and demand is a good opportunity to develop this crop. An effort to increase crop production can be done with the bambara groundnut plant breeding programs requires plant populations variability. This research using 18 genotypes selected of bambara groundnut came from Indonesia and Thailand. Local genotypes were selected based on previous research, 13 selected genotypes from 50 genotypes based on the selection of seed availability (number of seeds) (Nuryati, 2014). Introduction genotypes was selected 5 genotypes based on the character of harvest age and results (Kuswanto et al., 2012). Based on the results of previous research showed that there was variability on local genotypes of bambara groundnut so it difficult to predict the outcome. It make authors to determine how the variability that occurs on introduction genotypes. The purpose of this research are to determine variability of morphological and agronomical characters on 18 selected genotypes of bambara groundnut.

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MATERIALS AND METHODS

This research was conducted at the experimental field state on Jatikerto of Agriculture Faculty, University of Brawijaya, Malang. Research began December 2013 until May 2014. The research compiled using a Randomized Complete Block Design (RCBD) with three replications. The tools used in this research include polybag, a hoe, sprayer, signs, labels, rulers, markers, RHS color charts, paper bags and digital camera. The materials used include 18 genotypes of bambara groundnut, urea 100 kg ha^{1}, SP-36 100 kg ha^{-1}, KCl 75 kg ha^{-1}, compost fertilizer and pesticide.

Observations based on Descriptor for Bambara Groundnut (*Vigna subterranea* (L.) Verdcourt) from IPGRI (2000). Data of morphological character was presented visually and descriptively. Data of agronomical character using analysis of variance (ANOVA) and to further test use Duncan 5%. In addition, to calculate the value of variability in selected genotypes can use the genetic and phenotype variability coefficient (Moedjiono dan Mejaya, 1994):

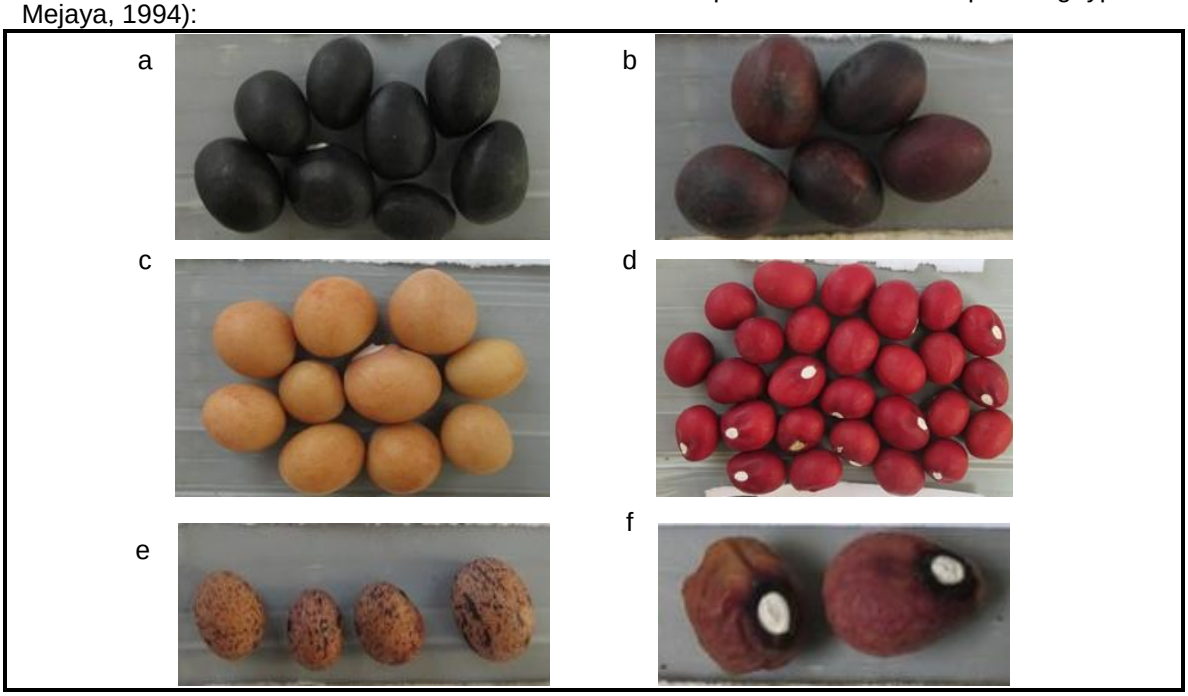
$$KKG = \frac{\sqrt{\sigma^2 g}}{\bar{x}} \times 100\% \; ; \quad \sigma^2 g = (KTg - KTe)/r$$

$$KKF = \frac{\sqrt{\sigma^2 p}}{\bar{x}} \times 100\% \; ; \quad \sigma^2 p = \sigma^2 g + \sigma^2 e$$

RESULTS AND DISCUSSION

Observation of morphological characters on 18 genotypes of bambara groundnut done in the vegetative phase, generative phase and yield. In characters of pod shape, pigmentation on the wings and flowers banner shows mostly homogen of each genotype. Pod shape on local and introduction genotypes was ending in a poin and round on the other side. The pigmentation of flower was present on wings flowers and absent on banner flowers (Picture 2).

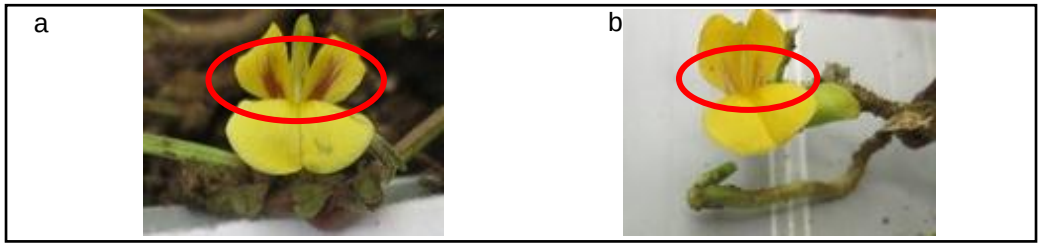
In the character of seed color among 18 genotypes of bambara groundnut was observed tends to heterogen (Table 1, Picture 1). The variability of seed color due to the cross-pollination by ants. Molosiwa (2012), self polination in bambara groundnut was mainly found in bunched plants while cross pollination occurs in spreading types.



Picture 1 Seed color of bambara groundnut: a. Black; b. Dark purple; c. Cream; d. Dark red; e. Black small dotted spots on brown background without eye; f. Cream testa with dark red butterfly-like eye

Table 1 Morphological Characters of Bambara Groundnut

Genotypes	Morphological Characters									
	Growth habit	Darkness pigmentation on wings flower	Terminal leaflet shape	Seed shape	Pod texture	Flower color	Hypocotyl color	Pod color	Seed color	Seed size
SS 2.3.2	Semibunch (7.98)	Strong dark	Elips	Oval	Much grooved	Dark yellow	Purple	Brown	Dark purple	Big
SS 3.2.2	Semibunch (7.71)	Strong dark	Oval	Oval	Much grooved	Dark yellow	Purple	Brown	Cream	Big
SS 3.3.2	Semibunch (8.38)	Strong dark	Elips	Oval	Much grooved	Dark yellow	Green	Brown	Dark purple	Medium
SS 4.3.2	Semibunch (8.00)	Strong dark	Oval	Oval	Much grooved	Dark yellow	Green	Brown	Dark purple	Medium
SS 6.3.2	Semibunch (8.27)	Strong dark	Elips	Oval	Much grooved	Dark yellow	Green	Brown	Dark purple	Medium
BBL 5.3.2	Semibunch (7.75)	Strong dark	Elips	Round	Smooth	Dark yellow	Green	Yellowish brown	Dark purple	Medium
BBL 6.1.1	Semibunch (8.10)	Strong dark	Lanset	Round	Smooth	Dark yellow	Green	Yellowish brown	Dark purple	Medium
BBL 6.2.1	Semibunch (8.70)	Strong dark	Lanset	Round	Smooth	Dark yellow	Green	Yellowish brown	Dark purple	Medium
BBL 10.1	Semibunch (8.17)	Strong dark	Elips	Round	Smooth	Dark yellow	Green	Yellowish brown	Dark purple	Medium
JLB 1	Semibunch (8.06)	Little dark	Oval	Oval	Smooth	Dark yellow	Green	Yellowish brown	Dark purple	Medium
TKB 1	Semibunch (7.67)	Strong dark	Elips	Oval	Smooth	Dark yellow	Green	Yellowish brown	Dark purple	Medium
CKB 1	Semibunch (7.84)	Strong dark	Oval	Oval	Smooth	Dark yellow	Green	Yellowish brown	Dark purple	Medium
GTKB 1	Spreading (6.50)	Little dark	Elips	Oval	Smooth	Dark yellow	Green	Yellowish brown	Dark purple	Small
Thailand local 1	Bunch (18.00)	Strong dark	Oval	Round	Little grooves	Dark yellow	Green	Yellowish brown	Dark red	Medium
TVsu 86	Bunch (16.85)	Strong dark	Lanset	Round	Little grooves	Light yellow	Green	Yellowish brown	Testa with purple spot	Small
TVsu 89	Bunch (21.00)	Strong dark	Lanset	Round	Little grooves	Light yellow	Green	Yellowish brown	Dark brown	Medium
TVsu 138	Spreading (3.57)	Strong dark	Oval	Round	Much grooved	Dark yellow	Purple	Brown	Light red	Small
TVsu 1483	Bunch (13.56)	Strong dark	Oval	Round	Much grooved	Dark yellow	Green	Brown	Cream	Medium



Picture 2 Darkness pigmentation on wings flowers: a. Strong dark; b. Little dark

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Agronomical characters on bambara groundnut influenced by a number of genes, which of each has contributed small on phenotypic performance. Bahar and Zein (1993) said that the genes that role in the performance of a quantitative character is strongly influenced by the environment. Although some environmental factors can be controlled such as temperature, water, nutrients and sunlight. There were other things such as the interaction of genes and environment are difficult to explain because it involves factors in cells that were not easily measured. The results of observations on the agronomical characters showed that in local and introduction genotypes was significant difference result, except number of leaves.

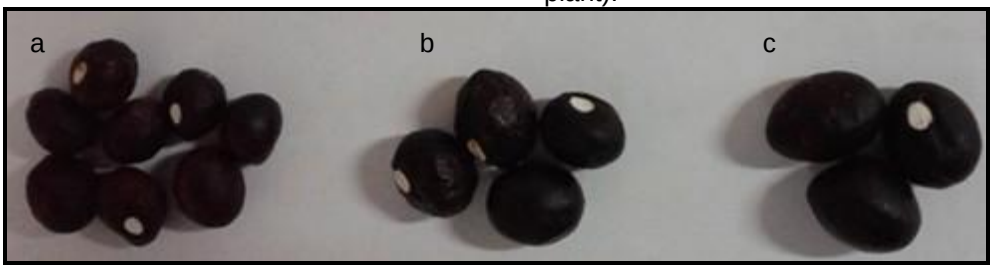
One of the important agronomical characters was the number of seeds per pod. High yields were also due to the relative size of the seeds. In general, the large seed came from grooved pod texture, while the small seed came from smooth pod texture (Heller et al., 1995). However, based on observations, showed that not all grooved pod textured have large seeds, such as Thailand introduction genotype despite having a grooved pod texture, but the size of seed was small. It because include the weight per seed less than 6 g (Picture 3).

Spread type usually has large seed, but the maturity of seed more slowly (Heller et al., 1995). Febriani (2011), bunch type has short internode length so that at harvest, the pods will be easily taken because the distance between the pods close and the pods not spread far in the soil. This can reduce the risk of pods left in the ground. Semibunch and spreading type require wider spacing than the bunch type so that harvest to be thorough because the location of the pods spread.

In 18 genotypes of bambara groundnut that observed showed the average value of fruit set less than 40% (Table 2). It due the planting done in the green house, which has a high temperature different from the conditions in the field. High temperature conditions in the green house make the process of evaporation faster so it thus affecting the adequacy of water in plants. Adequacy of water was an importat role in the process of forming pods. Redjeki (2007), bambara groundnut including drought-tolerant plants, but these plants still require sufficient water during pod filling. Lack of water can lead to pod into a little, because ginofor dry before process of forming pods. In addition, water shortage in post-flowering in bambara groundnut can reduce growth, decrease the number of pods per plant but not on seed weight.

Characters of harvest age associated with growth habit. Spread type have a longer harvest age than buch type (Redjeki, 2007). Thailand introduction genotypes have bunch type so it have faster harvest age, eespecially genotype TVsu 89 (94.81 days of harvest age). While GTKB 1 has a longer harvest age (119.55 days), it because these genotypes has spread type.

The average value of each character of the genotype can be used to determine the genotype that has the potential to be developed. In Sumedang local genotypes, there was significant only in the weight per seed and the other characters no significant (Table 2). Among Sumedang local genotype which has the potential to be developed was SS 3.3.2 because it has large weight per seed than the other genotype so that will affect the results (weight of seeds per plant).



Picture 3 Seed size of bambara groundnut: a. Small (< 3 g); b. Medium (3-6 g); c. Big (> 6 g)

Table 2 Agronomical Characters of Bambara Groundnut

Genotypes	Karakter Agronomi										
	TT	ABg	Bg50%	PMBg	UP	JBg	JPg/plant	FS	JBj/plant	B/Bj	BBj/plant
SS 2.3.2	30.67 def	43.37 bc	42.00 bcd	56.27 de	112.73 bcd	69.07 abcde	11.50 abc	0.16 ab	10.47 ab	6.27 de	62.87 abcd
SS 3.3.2	31.58 f	43.90 bc	43.00 bcd	57.53 de	112.87 bcde	61.97 abcde	6.30 a	0.10 a	6.10 a	13.11 f	82.71 abcd
SS 3.2.2	32.02 f	41.07 ab	41.00 bc	57.87 de	114.67 def	78.47 bcde	12.30 abc	0.16 ab	12.23 ab	3.70 bcd	42.43 abc
SS 4.3.2	32.05 f	43.47 bc	42.67 bcd	59.83 e	116.18 def	63.33 abcde	10.76 abc	0.20 abcd	9.86 ab	7.31 e	73.70 abcd
SS 6.3.2	31.23 ef	43.67 bc	43.00 bcd	57.97 de	115.03 def	76.67 bcde	10.93 abc	0.15 ab	10.00 ab	5.74 cde	57.10 abc
BBL 5.3.2	27.28 cd	47.13 cde	45.00 cde	53.17 bcde	114.07 cdef	73.77 abcde	21.67 abcd	0.28 abcd	20.33 abc	4.88 cde	98.04 bcd
BBL 6.1.1	27.55 cde	44.83 bcd	43.67 bcde	53.47 bcde	112.03 bcd	62.63 abcde	17.27 abcd	0.27 abcd	16.40 abc	4.30 bcd	72.89 abcd
BBL 6.2.1	28.18 cdef	45.53 bcd	45.00 cde	53.99 cde	115.07 def	98.07 e	32.40 d	0.32 bcd	32.23 c	4.38 bcd	142.84 d
BBL 10.1	27.15 cd	47.61 cde	46.33 def	51.20 abcde	114.30 cdef	83.70 cde	28.83 cd	0.36 cd	25.73 bc	4.38 bcd	109.51 cd
JLB 1	26.87 cd	49.57 de	48.00 efg	52.50 bcde	115.33 def	87.13 de	22.63 abcd	0.28 abcd	25.27 bc	3.86 bcd	99.13 bcd
TKB 1	25.95 bc	52.21 e	49.67 fg	48.49 abcd	115.63 def	70.48 abcde	27.42 bcd	0.39 d	26.08 bc	3.71 bcd	102.61 bcd
CKB 1	28.27 cdef	51.87 e	50.67 gh	52.37 bcde	116.90 def	92.93 de	26.53 bcd	0.31 bcd	23.47 abc	4.45 bcd	101.30 bcd
GTKB 1	25.12 bc	59.46 f	54.04 h	48.14 abcd	119.55 f	101.59 e	25.98 bcd	0.28 abcd	23.26 abc	0.61 a	12.72 a
Thailand Local 1	25.13 bc	45.11 bcd	42.67 bcd	45.59 abc	113.43 cde	47.55 abcd	15.45 abcd	0.30 bcd	14.41 abc	3.92 bcd	65.71 abcd
TVsu 86	18.74 a	41.30 ab	42.67 bcd	41.95 a	109.08 bc	35.03 ab	6.21 a	0.19 abc	4.96 a	1.79 ab	8.00 a
TVsu 89	19.13 a	37.56 a	36.33 a	44.07 ab	94.81 a	38.31 abc	5.83 a	0.15 ab	5.83 a	3.46 bc	21.19 ab
TVsu 138	22.70 b	42.77 bc	44.59 cde	60.00 e	118.40 ef	69.06 abcde	29.00 cd	0.37 cd	32.00 c	0.50 a	19.97 ab
TVsu 1483	25.19 bc	40.32 ab	39.33 ab	44.77 abc	107.88 b	29.32 a	8.39 ab	0.27 abcd	8.41 ab	3.78 bcd	39.63 abc

Note: TT = plant height (cm), ABg = days to first flowering (days), Bg50% = days to 50% flowering (days), PMBg = period of flowering (days), JBg = number of flowers, UP = harvest age (days), JPg/plant = number of pods per plant, FS= fruit set, JBj/plant= number of seed per plant, B/Bj = the weight per seed (g), BBj/plant = number of seeds per plants, Figures followed by the same letters are not significantly different at test of Duncan 5%.

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Table 3 The Value of Genetic and Phenotype Variability Coefficient

Variable	Average	KKG (%)	KKF (%)
Height plant (cm)	26.93	13.95	16.09
Number of leaves	39.94	11.54	23.58
Number of flowers	68.84	22.47	42.00
Days to fisrt flowering (days)	45.60	10.72	12.46
Days to 50% flowering (days)	44.42	8.89	10.45
Period of flowering (days)	52.15	9.03	13.43
Harvest age (days)	113.22	4.53	5.22
Number of pods per plant	17.77	39.70	68.94
Fruit set	0.25	24.88	46.68
Number of seeds per plant	17.03	41.34	71.29
The weight of seed per plant(g)	67.35	41.64	77.94
The weight per seed (g)	4.45	58.87	67.35

In Lamongan local genotypes showed all characters no significant (Table 2). Among Lamongan local genotypes, BBL 6.2.1 has potential to be developed because it has advantage on all agronomical characters especially in yield (weight of seeds per plant) and it has good performance to answer the market demand.

In Bangkalan local genotypes, days to first flowering, days to 50% flowering, the weight per seed and the weight of seed per plant showed significant result (Table 2). JLB 1 has potential to be developed in days to fosrt flowering and TKB 1 has potential to be developed in seed weight.

In Thailand introduction genotypes, only in number of flower and the weight of seed per plant showed no significant (Table 2). Among Thailand introduction genotypes, TVsu 138 has potential to be developed because it has the average value high yield.

In addition the variability can be seen from the genetic variability coefficient (KKG) and phenotype variability coefficient (KKF). Based on observations in 18 genotypes of bambara groundnut, it was known that plant height, number of leaves, days to fisrt flowering, days to 50% flowering, period of flowering and harvest age difference between the value of harvest has KKG and KKF low (Table 3). This suggests that the environment provides little effect. But the character of the number of flower, fruit set, number of pods per plant, number of seeds per plant, weight of seed per plant and weight per seed has a difference of value KKG and KKF high enough so that the environment provides quite large effect.

Characters with KKG relatively low and rather low classified as narrow variability, while KKF with relatively high and high classed as a wide variability (Austi, 2013). Selection can be done on the characters that have a narrow genetic variability because genetic component without environmental modifications that can lead to blurring of the influence of genes. The material used in this research came from a mix of local and introduction genotypes with different genetic backgrounds so that the value of observed agronomical characters diverse.

CONCLUSION AND RECOMMENDATION

The variability of morphological characters on 18 selected genotypes of bambara groundnut mostly heterogen, except pod shape, pigmentation on wings and banner flowers. While the variability of agronomic characters on 18 selected genotypes of bambara groundnut showed significantly different results, except number of leaves. The value of KKG and KKF on characters of plant height, number of leaves, days to fisrt flowering, days to 50% flowering, period of flowering and harvest age include low. While the value of KKG and KKF on character of the number of flower, fruit set, number of pods per plant, number of seeds per plant, weight of seed per plant and weight per seed include quite high.

BBL 6.2.1, BBL 10.1, JLB 1, TKB 1 and TVsu 138 have the potential to be developed, especially from the important characters such as yield characters (number of seeds per plant and the weight of seed per plant).

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