

Short Communication: Morpho-agronomic characteristics of twelve accessions of white turmeric (*Curcuma zedoaria*) germplasm

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Abstract. Syahid SF, Heryanto R. 2017. Short Communication: Morpho-agronomic characteristics of twelve accessions of white turmeric (*Curcuma zedoaria*) germplasm. *Biodiversitas* 18: 269-274. White turmeric (*Curcuma zedoaria* Rosc.) is a potential medicinal plant belong to the family Zingiberaceae. This plant has a good market because of its high demand as raw material for herbal medicine, such as to cure cancer. A germplasm collection of white turmeric collected from different areas of Indonesia is available at Cicurug Research Station of Sukabumi, West Java, Indonesia. Information on characteristics of the accessions, however, are not available yet. This study aimed to determine morphological characters, growth, and yield of 12 accessions of white turmeric. The research was conducted at the Cicurug Research Station from January 2014 to March 2015. Rhizome section of each accession was grown in a 2.5 m x 3.5 m plot at 50 cm x 50 cm plant spacing. The experiment was arranged in a randomized complete block design with three replications. Parameters observed were morphological characters (type of stem, leaf tip, leaf base, leaf shape, stem color, blade color), growth (number of tillers, plant height, number of leaf/stem, leaf length, leaf width, leaf thickness) and yield (rhizome weight, rhizome length, rhizome width, and rhizome thickness) respectively. The results showed that morphological characters, growth, and yields of the 12 accessions observed were varied. All of the characters observed could be evaluated further to determine the important traits.

Keywords: *Curcuma zedoaria*, morphological characters, growth, yield, Zingiberaceae

INTRODUCTION

White turmeric or zedoary (*Curcuma zedoaria* Rosc.) is a medicinal plant belongs to the family Zingiberaceae. Zedoary has been cultivated as a spice and vegetable in South and Southeast Asia (Lobo et al. 2009). This plant has many benefits as a traditional medicine in Asia, such as for curing stomach diseases, toothache, blood stagnation, leucoderma, tuberculosis, spleen swelling, and for promoting menstruation (Saikia and Nath 2003). Rural people in India use the rhizome for its rubefacient, carminative, expectorant, demulcent, diuretic and stimulant properties while the root is used in the treatment of flatulence, dyspepsia, cold, cough and fever (Lobo et al. 2009). It is also used in some traditional eastern medicines, acts as an agent for blood purifier and used as anti venom against the bite of Indian cobra. It also has been used to treat coronary heart disease, liver cancer, anemia, chronic pelvic inflammation and helps prevent leukopenia due to cancer therapies (Dhal et al. 2012). Plant rhizome has also used as a carminative, digestive stimulant and for treatments of colds and infections (Prajapati et al. 2003). In addition, the rhizome has also been intensively used as a traditional medicine in China for the treatment of cancer (Oh et al. 2007). Curcumin and curcumenol, chemical compounds of this plant were reported to inhibit growths of S-180 sarcoma cells and mouse cervical U-14 cells (Lai et al. 2004). According to Lakhsmi et al. (2011), the chemical

compounds of white turmeric also capable of inhibiting cancer cell proliferation without causing toxicity effects on normal cells. Curcumin, demethoxycurcumin and bisdemethoxycurcumin isolated from this plant were reported for anti-oxidant and anti-inflammatory activities similar to that *Curcuma longa* L. (Syn. *Curcuma domestica* Val.) (Masuda et al. 1993). In addition, white turmeric is reported has analgesic, anti-allergic, anti-inflammatory, anti-metastatic, anti-oxidant activities, as well as protecting liver function (Ali et al. 2004; Dhal et al. 2012), and antimicrobial effect (Bugno et al. 2007). The essential oil obtained from the plant dried rhizome by steam distillation, demonstrates active antibacterial properties. The essential oil of white turmeric was moderate to good in antioxidant activities (Mau et al. 2003). Starch extracted from the plant is used as a diet for infants and convalescent person due to its cooling and demulcent properties (Syu et al. 1998).

White turmeric is a herbaceous and rhizomatous perennial plant composed of an upright pseudostem, a corm and underground cylindrical branches or rhizome and fleshy roots (Lobo et al. 2009). White turmeric is a seasonal crop, which is propagated from rhizomes. Its rhizome has a yellowish white flesh color with a very bitter taste and a unique aroma. White turmeric grows and spread out at various places in Indonesia. The plant grows wildly in open moist lands where at an altitude from 0-1000 m asl. (de Padua et al. 1999). White turmeric accessions shows an

interesting variation as a result of the adaptation to locations or its agroecological origin.

Indonesian Spices and Medicinal Crops Research Institute (ISMCRI) that has the mandate to conduct research on spices and medicinal crops has collected 12 accessions of white turmeric germplasm from various regions in Indonesia. Information on white turmeric characteristics are not available yet, hence cultivation technology development, utilization, and breeding program of this crop has not been done yet. Differences in phenotypic characters of the plant, including morpho-agronomic characters and chemical contents, can be used as indicators to determine the superior characters of each accessions. By knowing these characters plant breeders can create a superior crop variety.

A study is, therefore, necessary to determine the white turmeric properties including morphological characteristics, growth, and yield components. This study aims to characterize 12 accessions of white turmeric potential as breeding materials for the development of superior varieties.

MATERIALS AND METHODS

Materials

The plant materials used in the study were healthy rhizomes of 12 white turmeric accessions collected from 7 different areas in Indonesia. The collected accessions are maintained and conserved in Cicurug Research Station of Indonesian Spice and Medicinal Crops Research Institute, at Cicurug, Sukabumi, West Java, Indonesia (550 m asl.). The complete list of the accessions is presented in Table 1.

Methods

Rhizomes of each accession were prepared and cut into pieces of 30-50 grams with at least 2-3 buds. The rhizome sections were soaked in a fungicide solution at the rate of 2.0 g/L water for 30 minutes, then drained and stored at room temperature for one month to form buds. The

rhizomes that had formed sprouts were ready to be planted in the field.

The accessions were grown in a 2.5 m x 3.5 m plot at a 50 cm x 50 cm plant spacing, as 20 plants/plot. The trial was arranged in a randomized block design with three replications. The plants were fertilized with manure at the rate of 10 tons/ha, as well as urea, SP36, and KCl at the rate of 100 kg/ha. The manure was applied one week before planting. The Urea was applied in three equal split doses, i.e. the first dose was applied 30 days after sowing, the second dose was applied 60 days after sowing and the third dose was applied 90 days after sowing, while all the SP36 and KCl were given at sowing. The manure and fertilizer applications were in accordance with the technical guidelines. Plant maintenance such as weeding was done at least once a month or depending on the condition of the plant. At the time weeding, land mounding was also done in order that roots of the plants that have started to form rhizomes covered with soil to improve quality of the rhizome. Pests and diseases control was done the by adopting the Standard Operational Procedure for Zingiberaceae Family (Wahyuni et al. 2013).

The parameters observed were morphological characters, growth and yield component. Yield component represented in weight, length, width, and rhizome thickness. Length and width of the rhizome was measured in cm with help of venire caliper, after the harvesting and average was calculated. The thickness of the rhizome was measured using venire caliper. The average weight of the rhizome per plant was taken using the electric balance (Table 2).

The observations were conducted at five months when the plant growth and its morphological characters were optimal. Harvest was done at plant ages 10-12 months. Observations of the morphological characters referred to Tjitrosoepomo (1988).

Data analysis

Data were analyzed using analysis of variance (Anova). The differences of mean values were analyzed using Duncan Multiple Range Test (DMRT) at 5 % level.

Table 1. The provenance of 12 accessions of white turmeric from Cicurug Research Station, Sukabumi, West Java, Indonesia

Accessions	District	Province	Collector	Date of collection
Cuze 1	Sukabumi	West Java	N.I	2001
Cuze 2	Cianjur	West java	Exploration from researcher	June 2, 2008
Cuze 3	Cianjur	West Java	Exploration from researcher	June 2,2008
Cuze 4	Gunungkidul	Yogyakarta	Exploration from researcher	June 2,2008
Cuze 5	Bunaken	North Sulawesi	Exploration from researcher (N. Bermawie)	June 2, 2008
Cuze 6	N.I.	North Sulawesi	Exploration from researcher (N.Bermawie)	June 2, 2008
Cuze 7	Ciwidey	West Java	Exploration from researcher (N.Bermawie)	June 2, 2008
Cuze 8	N.I.	Bali	Exploration from researcher (E. Hadipoetyanti)	June 2, 2008
Cuze 9	N.I.	East Nusa Tenggara	Exploration from researcher (W. Lukman)	July, 2009
Cuze 10	GunungKidul	Central Java	N.I.	2009
Cuze 11	Purwakarta	West Java	Exploration from researcher (S. Wahyuni)	2009
Cuze 12	N.I.	East Java	Exploration from researcher (W.Lukman)	2011

Note: N.I. = No information

Table 2. The parameter observed of white turmeric

Morphological characteristics	
Type of stem	
Leaf tip	
Leaf base	
Leaf shape	
Stem color	
Blade color	
Leaf pubescence	
Rhizome color	
Growth characteristics	
Number of tillers	
Plant height	
Number of leaf/stem	
Leaf length	
Leaves width	
Leaf thickness	
Stem diameter	
Characteristics of yield	
Rhizome weight	
Rhizome length	
Rhizome width	
Rhizome thickness	

leaf morphology was particularly shown in the presence or absence of purplish red color along the main vein of the leaf (Figure 2). Most of the accessions had a green leaf color with purplish red color along the main vein. Only Cuze 9 and Cuze 10 had a slight purplish red leaf. All the white turmeric accessions showed a white crown flower with a thin red stripe edge, lanceolate leaf with acuminate tip and base, and green leaf vein. The upper surface of the leaf was rough and lower leaf surface was smooth (Table 3). Growth characters of 12 white turmeric accessions showed variations mainly on number of tillers, number of leaf, plant height, stem diameter, leaf length, width and thickness (Table 4). Yield characters of 12 white turmeric accessions are varied (Table 5).



Figure 1. White turmeric plants (*Curcuma zedoaria* Rosc.)

RESULTS AND DISCUSSIONS

Results

A white turmeric plants had an erect stem, had many fibrous roots aerial shoots (pseudostem) with leaf, and underground stems (rhizome) (Figure 1). Morphological characters of the 12 white turmeric accessions showed variations in colors of leaf and rhizome. Variations on the

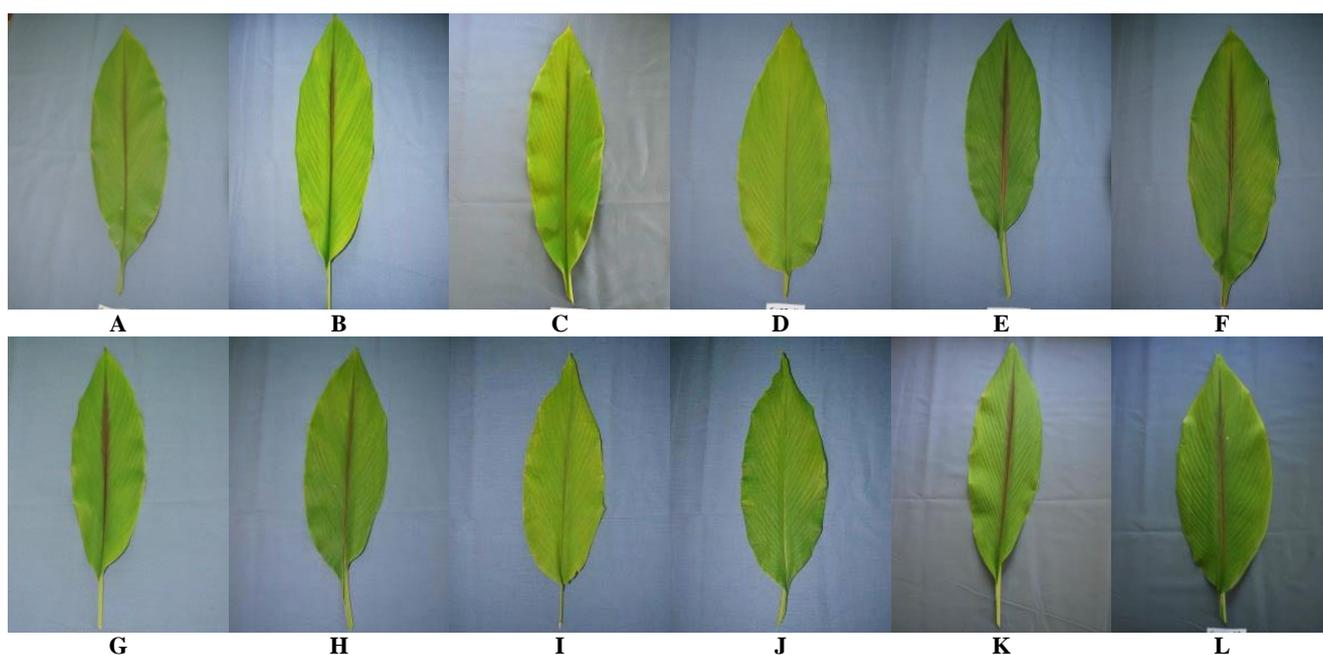


Figure 2. Leaf shapes of white turmeric from Cicurug Research Station, Sukabumi, West Java, Indonesia. A. Cuze 1 , B. Cuze 2 , C. Cuze 3 , D. Cuze 4 , E. Cuze 5 , F. Cuze 6 , G. Cuze 7 , H. Cuze 8 , I. Cuze 9 , J. Cuze 10 , K. Cuze 11 , L. Cuze 12

Table 3. Morphological characteristics of 12 white turmeric accessions from Cicurug Research Station, Sukabumi, West Java, Indonesia

Accession No.							Leaf pubescence		Rhizome	
	Stem type	Leaf Tip	Leaf base	Leaf shape	Stem color	Blade color	Upper	Lower	Peel color	Flesh color
Cuze 1	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with purplish red color along the main vein	Rough	Smooth	White brownish	White
Cuze 2	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with purplish red color along the main vein	Rough	Smooth	White brownish	White
Cuze 3	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with purplish red color along the main vein	Rough	Smooth	White brownish	White
Cuze 4	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with purplish red color along the main vein	Rough	Smooth	White brownish	White
Cuze 5	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with purplish red color along the main vein	Rough	Smooth	White brownish	White
Cuze 6	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with purplish red color along the main vein	Rough	Smooth	White brownish	White
Cuze 7	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with purplish red color along the main vein	Rough	Smooth	White brownish	White
Cuze 8	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with purplish red color along the main vein	Rough	Smooth	White brownish	White
Cuze 9	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with a slight purplish red color along the main vein	Rough	Smooth	White brownish	White
Cuze 10	Flat	Acuminate	Acuminate	Lanceolate	Green	Green without purplish red color along the main vein	Rough	Smooth	White brownish	Yellow
Cuze 11	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with purplish red color along the main leaf vein	Rough	Smooth	White brownish	White
Cuze 12	Flat	Acuminate	Acuminate	Lanceolate	Green	Green with purplish red color along the main leaf vein	Rough	Smooth	White brownish	White

Table 4. Growth characters of 12 white turmeric accessions grown at from Cicurug Research Station, Sukabumi, West Java, Indonesia

Accession	Numberof tillers	Plantheight (cm)	Numberof leaf/stem	Leaf length (cm)	Leaves width (cm)	Leafthickness (mm)	Stem diameter (mm)
Cuze 1	5.45 c	78.35 d	9.22 b	39.4 5 ab	13.56 bcd	0.30 b	15.70 d
Cuze 2	3.33 a	65.55 abcd	9.50 b	34.37 ab	12.24 bcd	0.30 b	14.20 cd
Cuze 3	4.28 abc	66.13 abcd	9.55 b	40.83 b	12.39 bcd	0.30 b	13.71 cd
Cuze 4	3.33 a	48.83 a	6.94 a	26.44 ab	10.79 ab	0.29 b	9.66 ab
Cuze 5	3.08 a	52.18 a	8.06 a	23.65 a	8.84 a	0.27 a	9.12 a
Cuze 6	3.33 a	56.71 abc	9.55 b	30.91 ab	11.35 abc	0.30 b	12.44 abcd
Cuze 7	3.39 a	67.33 abcd	9.33 b	35.53 ab	12.36 bcd	0.30 b	14.53 cd
Cuze 8	4.06 ab	67.92 abcd	8.67 b	36.01 ab	13.58 bcd	0.30 b	13.31 bcd
Cuze 9	4.00 ab	75.87 cd	8.50 a	38.89 ab	14.45 d	0.30 b	14.30 cd
Cuze 10	4.16 ab	57.37 abc	6.94 a	31.59 ab	11.93 bcd	0.30 b	11.09 abc
Cuze 11	4.89 bc	72.47 bcd	9.17 b	37.67 ab	14.06 cd	0.30 b	15.51 d
Cuze 12	3.28 a	55.42 ab	8.34 ab	43.16 b	11.58 bcd	0.29 b	12.01 abcd
CV (%)	17.15	16.00	9.04	24.82	12.18	5.86	16.02

Note: Numbers in each column followed with the same letters is not significantly different at 5% level by DMRT.

Table 5. Yield characters of 12 white turmeric accessions from Cicurug Research Station, Sukabumi, West Java, Indonesia

Accession	Rhizome weight (g)	Rhizome length (cm)	Rhizome width (cm)	Rhizome thickness (mm)
Cuze 1	833.33 c	24.16 abc	11.83 bc	14.49 ab
Cuze 2	642.78 abc	22.43 abc	10.56 abc	14.89 ab
Cuze 3	527.78 abc	20.94 abc	8.90 abc	13.81 ab
Cuze 4	364.67 a	20.24 abc	9.08 abc	12.21 a
Cuze 5	344.44 a	17. 69 a	7.33 a	12.53 ab
Cuze 6	737.22 bc	26.55 c	12.04 c	15.06 ab
Cuze 7	762.78 bc	23.97 abc	10.6 abc	14.94 ab
Cuze 8	686.11 abc	24.24 abc	10.24 abc	14.47 ab
Cuze 9	758.89 bc	25.49 bc	10.77 abc	15.20 b
Cuze 10	491.11 abc	22.16 abc	9.79 abc	14.86 ab
Cuze 11	671.67 abc	22.44 abc	10.87 bc	14.24 ab
Cuze 12	428.33 ab	19.12 ab	8.33 ab	13.17 ab
KK (CV)%	33.00	15.94	18.04	10.67

Note: Numbers in each column followed by the same letters is not significantly different at 5% level by DMRT.

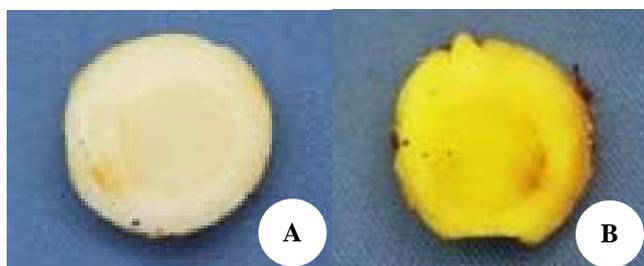


Figure 3. Rhizome flesh color of white turmeric from Cicurug Research Station, Sukabumi, West Java, Indonesia. A. White (Cuze 1, Cuze 2, Cuze 3, Cuze 4, Cuze 5, Cuze 6, Cuze 7, Cuze 8, Cuze 9, Cuze 11 and Cuze 12), B. Yellow (Cuze 10)

Discussions

White turmeric has an erect stem, has many fibrous aerial shoots (pseudostem) with leaf and underground

stems (rhizome). There were no differences in the form of the stem in all the accessions. Stem color of all the accessions was green. The leaf shape was lanceolate. Most accessions have green color of the blade, with purplish red color along the main vein. However, Cuze 9 showed slight purplish red color along the midrib and no purplish red color in Cuze 10. Another difference was found on flesh color of the rhizomes. All accessions had a white color of rhizome except Cuze 10 that had a yellow color.

The occurrence of different characters on several accessions could be due to various factors, including the origin of accessions, growth environment, and genetic factors. All the characterized accessions derived from a various environmental condition with differences in agro-climatic conditions that can affect plant morphological characters. Current information on specific morphological characteristics of white turmeric is not available yet, and the use of plant material in today's society was based on rhizomes production. Wahyuni et al., (2013) reported morphological variations (plant height, the number of tillers, the number of leaves, leaf length, leaf width and stem diameter) in nine accessions of *Zingiber aromaticum* Val. On *Curcuma longa*, the genetic differences were reflected in morphology, consumer preferences, and usage (Jan et al. 2012). The morphological differences were due to the interaction between environmental and genetic one.

The number of tillers of white turmeric was varied. Accession Cuze 1 has the largest number of tillers and the highest average of plant height. The number of tillers was associated with the yield of rhizomes. The highest number of leaves were found on accession Cuze 3 and Cuze 6. The longest leaf was found on by accession Cuze 12, the widest leaf size was found on accession Cuze 9. Leaf thickness varied (0.27- 0.30 mm). Accession with the largest stem diameter was Cuze 11. There were variation in growth components of the accessions, which was likely due to the plant genotype. On germplasm of *Zingiber aromaticum*, variations in the growth components had been reported (Wahyuni et al. 2013). It was also reported on turmeric

(*Curcuma longa*) that genotype effects plant growth such as plant height, the number of leaves, leaf width and maximum finger per plant (Jilani et al. 2012).

The highest rhizome yield was produced by accession Cuze 1. The rhizome yield was influenced by the genotype. On *Zingiber aromaticum* and *Zingiber officinale* Rosc., differences in genotype produce various rhizome yields (Aragaw et al. 2011; Wahyuni et al. 2013). In addition to the genotype, the environmental condition also affected yield of ginger (Bermawie et al. 2012). The rhizome production was correlated with the number of tillers. In this research, accession Cuze 1 has the largest number of tillers so it also has the highest weight of rhizome. There were positive correlations between plant height, leaf number, leaf length, and rhizome thickness; and rhizome yield (Abraham and Latha 2003).

The longest and widest rhizome were found on accession Cuze 6 and the thickest rhizome was found on accession Cuze 9. The accession that has the longest rhizome also has the widest rhizome size. The rhizome shape of white turmeric has typically irregular-rounded.

Variation in rhizome was also found on their flesh color. Most of the accessions had white flesh, i.e. Cuze 1, Cuze 2, Cuze 3, Cuze 4, Cuze 5, Cuze 6, Cuze 7, Cuze 8, Cuze 9, Cuze 11 and Cuze 12 (Figure 3.A). Only one accession, Cuze 10, has a yellow flesh color (Figure 3.B).

The study concluded that morpho-agronomic characteristics of 12 accessions of white turmeric were varied. Most accessions have green color of the blade, with purplish red color along the main vein. However, Cuze 9 showed slight purplish red color along the midrib and no purplish red color in Cuze 10. Another difference was found on flesh color of the rhizomes. All accessions had a white color of rhizome except Cuze 10 that had a yellow color. The highest rhizome yield was produced by accession Cuze 1. Accession Cuze 6 had the longest and widest rhizome and Cuze 9 was performed the thickest rhizome.

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