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Growth and Production of Cassavas in Intercropping System with Cowpeas

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Abstract

Cassava is one of the most important commodities worldwide, serving as a crucial food source due to its rich content of nutrients such as carbohydrates, protein, fat, calcium, and magnesium. Cassava is a perennial crop with slow growth, necessitating the selection of intercrops with shorter harvest periods. Cowpea, a legume high in protein, is widely cultivated and suitable for intercropping with cassava. Intercropping these crops involves adjusting planting distances to optimize yield. This study aims to determine the optimal planting distance in an intercropping system that yields the highest productivity for the cassava variety “Mangu” and the cowpea varieties “Albina” and “Uno”. The research was conducted from January to June 2023 at the IPB Experimental Farm in Sawahbaru, Dramaga, Bogor, on Latosol soil, at an altitude of 207 meters above sea level. The study utilized a randomized complete block design with a single factor: the intercropping system pattern. The patterns tested were 1:2 (one row of cassava with two rows of cowpea) and 1:3 (one row of cassava with three rows of cowpea), consisting of: P1: “Mangu” and “Uno” 1:2; P2: “Mangu” and “Uno” 1:3; P3: “Mangu” and “Albina” 1:2; P4: “Mangu” and “Albina” 1:3; P5: “Mangu” monoculture; P6: “Uno” monoculture; P7: “Albina” monoculture. The results indicated that the P3 planting system yielded the highest crown height at 1, 5, and 6 months after planting (MAP), the highest canopy diameter at 4 months after planting, tuber production, and 100-seed weight of cowpea. The P4 system produced the highest stem diameter, number of leaves, number of pods, pod dry weight, and seed dry weight at 9 months after planting.

Keywords: “Albina”, cropping system, “Mangu”, SDR, “Uno”

Introduction

Cassava (*Manihot esculenta* Crantz) is one of the most important commodities globally, cultivated in nearly 105 tropical and subtropical countries (Latif, 2014). It serves as a vital energy source for 7.85 billion people worldwide. Over 2 billion people in farming communities across Asia, Africa, and Latin America will continue to rely on root crops, including cassava, for food, feed, and income-generating products beyond 2020 (FAO, 2012). According to FAOSTAT (2020), Indonesia ranks as the fifth-largest producer of cassava, following Nigeria, Congo, Thailand, and Ghana. In 2020, Indonesia’s cassava production reached 18,302,000 tons, marking a 13.07% increase from 2019’s 16,350,000 tons. Cassava plays a crucial role in meeting the growing demand for food and is a potential food crop with high energy content (993 $MJ.kg^{-1}$) and efficiency (Adiele et al., 2020). Cassava tubers efficiently produce carbohydrates, yielding 250,000 calories/ha/day. They contain 30-35% carbohydrates but have low protein (1-2%), fat (<1%), calcium, magnesium, iron, and protein (Onyenwoke and Simonyan, 2014).

Cassava is a perennial crop with slow growth, which reduces resource utilization efficiency. Its low protein content affects its nutritional value. Nutritional improvement can be achieved by intercropping cassava with high-protein crops. Intercropping systems involve growing two or more plant species together and can contribute to sustainable intensification (Brooker et al., 2015).

Cropping systems aim to efficiently use resources to achieve high and stable productivity. Intercropping enhances efficiency and provides early income by selecting crops with different growth habits and shorter life cycles (Benti et al., 2020). Intercropping cassava with legumes can increase biomass by incorporating more legume rows (Thang et al., 2020). Improved soil

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physical, chemical, and biological properties through intercropping lead to better crop growth and yield (Bedoussac et al., 2015).

Cowpea (*Vigna unguiculata* L.) is a short-day legume sensitive to photoperiod (Hall and Ehlers, 2017). It adapts well to high temperatures and drought and is rich in nutrients. The cropping system significantly affects cowpea's crude protein content, with intercropping positively influencing protein content during the vegetative stage due to shading (Eskandari, 2012). Cowpea exhibits high heritability for seed protein content, with 50.8% heritable content among 173 genotypes (Weng and Eaton, 2019).

Intercropping cassava with compatible crops is an effective weed management strategy, proving more efficient than chemical methods. Using cowpea as an intercrop, coupled with selective herbicide application, effectively controls weeds in cassava fields. Integrated weed management is essential for controlling weeds in root crops, with cowpea intercropping providing variable weed control during early growth stages (Weerarathne et al., 2017).

Intercropping systems tend to have lower weed densities due to taller crops that suppress weeds. Early-stage weed suppression through soil shading results from factors like reduced light and soil nitrogen (Rinke et al., 2022). Bean crops, with their dense canopy and height, compete effectively for light, contributing to the complementary use of growth resources and reducing light and soil nitrogen available to weeds. Competition for light depends on plant height, leaf area, early growth, and canopy closure. This research aimed to study the growth and production of cassava and cowpea intercropping.

Material and Methods

The experiment was conducted at Sawahbaru experimental farm, Balungbangjaya, Bogor, West Java, at an altitude of 207 msl. The research was conducted from January to June 2023. This study used the cassava variety "Mangu" with a size of 20 cm and 2 cowpea varieties, "Albina" and "Uno". The planting system used in this study with two planting patterns, namely: 1:2 is 1 row of cassava followed by 2 cowpeas with a spacing of 1.2 m x 0.8 m, and 1:3 is 1 row of cassava followed by 3 rows of cowpeas with a spacing of 2 m x 0.5 m, 40 cm x 40 cm cowpea monoculture spacing, and 1 m x 1 m cassava monoculture spacing. The population per plot at 1:2 was 24 cassava and 96 cowpeas, at 1:3 was 30 cassava and 180 cowpeas, at monoculture was 25 cassava, and 144 cowpeas. The plot area used was 5 m x 5 m. Data was collected from five sample plants of cassava and cowpeas per plot. Materials used in this study were goat manure 2 $ton.ha^{-1}$, NPK fertilizer 300 $kg.ha^{-1}$, and herbicide (used when needed) 11 $ml.L^{-1}$.

The study used a randomized complete block design with intercropping systems as a single factor, which consists of P1 = "Mangu" and "Uno" 1.2, P2 = "Mangu" and "Uno" 1.3, P3 = "Mangu" and "Albina" 1.2, P4 = "Mangu" and "Albina" 1.3. P5 = "Mangu" monoculture. P6 = "Uno" monoculture. P7 = "Albina" monoculture. There were 7 treatments with 4 replications so there were 28 treatment units.

Growth measurements made in this study include canopy height, canopy diameter, stem diameter, number of leaves, dry weight of stalk, tuber production, cassava leaf NPK content, and cowpea production. Soil chemical analyses included soil pH, total N (Kjedahl method), available P (Bray method), and total P (NH_4OAc), which were conducted before planting, and after harvesting cassava at 6 months after planting (MAP) at a depth of 15 cm from the soil surface.

Weed vegetation analysis was conducted before land cultivation until before cowpea harvest at 1 and 2 MAP by measureing the total dry weight of weeds.

Collected data were analyzed by analysis of variance (ANOVA) followed by the Duncan Multiple Range Test (DMRT) 5% using Microsoft Excel and STAR.

Result and Discussion

Weather and Soil Conditions

According to Bureau of Meteorology (BMKG) data for Bogor City, West Java, during the study period from January to June 2023, the air temperature at the beginning of planting was 25°C, with 211.1 mm of rainfall and 21 rainy days. At the time of cowpea harvest (2 to 2.5 months after planting, MAP), the air temperature ranged from 24.7°C to 25.8°C, with rainfall between 253.8 mm and 326.1 mm, and 24-27 rainy days. During the cassava harvest, the air temperature was 26.4°C, with 320 mm of rainfall.

Soil conditions were tested at the Soil Science and Land Resources Department Laboratory and categorized according to the Bogor Soil Research Centre (1995). The soil pH was slightly acidic (6.05), N-total was moderate (0.21%), P-availability was low (18.3 ppm), and K-dd was high (0.66 cmol(+)/kg). At 6 MAP, during cassava harvest, soil pH had increased

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to 6.41, N-total was 0.22%, P-available was 54.01 ppm, and K-dd remained 0.66 cmol(+)/kg.

Weed Vegetation Analysis

Weed vegetation analysis was conducted before land cultivation until before cowpea harvest at 1 and 2 MAP. Initially, seven types of weeds were identified: four broadleaf weeds, two grass weeds, and one sedge. Broadleaf weeds, including *Amaranthus spinosus, Mimosa invisa mart, and Emilia sonchifolia*, dominated before planting cassava. Broadleaf weeds are adaptable and tolerant to environmental stress and are difficult to suppress. According to Hardiman et al. (2014), dominant weeds in the intercropping system of peanuts and cassava are broadleaf weeds and *Cyperus rotundus* L., which can reproduce vegetatively through stem tubers and generatively through seeds, leading to rapid spread.

Effect of Cropping System on Weed Dry Weight

The cropping system significantly affected the total dry weight of weeds (Figure 1). At 1 MAP, treatments P2 and P4 resulted in the highest total dry weight of weeds (49.1 and 48.1 g, respectively). The high dry weight of weeds is attributed to limited space for weed growth and sunlight access for photosynthesis (Hardiman et al., 2014). The expanding cassava canopy provides shade, reducing sunlight reaching weeds and covering the soil surface.

Intercropping of cassava and cowpea at 1 MAP was not effective in suppressing weeds, resulting in high weed dry weight. However, at 2 MAP, the intercropping system could suppress weed growth and reduce dry weight by 0.2-0.70 ton per ha. Intercropping with cowpea can reduce weed seed numbers and suppress germination and growth. It helps suppress secondary weed growth after intercrops cover the soil surface.

The results of the study in (Figure 2) show that the highest weed summed dominant ratio (SDR) is obtained in broadleaf weeds, namely *Ageratum conyzoides*, and *Cleome gynandra* in the 1: 3 Manggu + “Uno” and “Mangu” + “Albina” planting system treatments at 1 MAP, namely (5.9), and (5.8). and grass weeds, namely *Echinochloa colanum* (4.3). The treatment at 2 MAP of grassy weeds, namely *Paspalum conjugatum* and tackle weed, namely, *Cyperus rotundus* in monoculture cropping systems had the highest yields (2.1 and 2.0). The SDR of weeds at 2 MAP was lower than at 1 MAP, because the cowpea population as intercrops at 2 MAP was higher and lush, thus covering the soil surface and reducing weed population density and weed dry weight. After all, the sunlight received by weeds was reduced due to the cowpea canopy covering the soil surface at 2 MAP.

The lower SDR value of grass weeds, while broadleaf weeds still appear because broadleaf weeds are resistant to shade. Weeds are not resistant to shade and result in suppressed weed growth when cowpea plants cover the soil surface, and the wider cassava canopy.

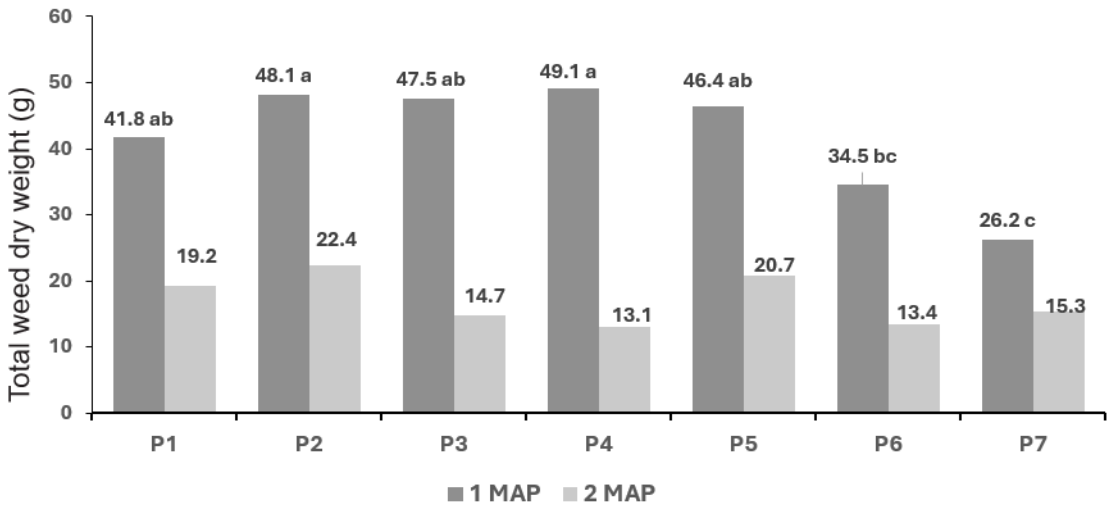

Figure 1. Total dry weight of weeds per treatment at 1 and 2 months after planting in cowpea and cassava intercropping. Values followed by different letters mean significantly different according to DMRT (α = 0.05). Cropping system 1:2 is 1 row of cassava followed by 2 rows of cowpeas; 1:3 is 1 row of cassava followed by 3 rows of cowpeas. P1 = “Mangu” and “Uno” 1:2, P2 = “Mangu” and “Uno” 1:3, P3 = “Mangu” and “Albina” 1:2, P4 = “Mangu” and “Albina” 1:3. P5 = “Mangu” monoculture. P6 = “Uno” monoculture. P7 = “Albina” monoculture. MAP= months after planting.

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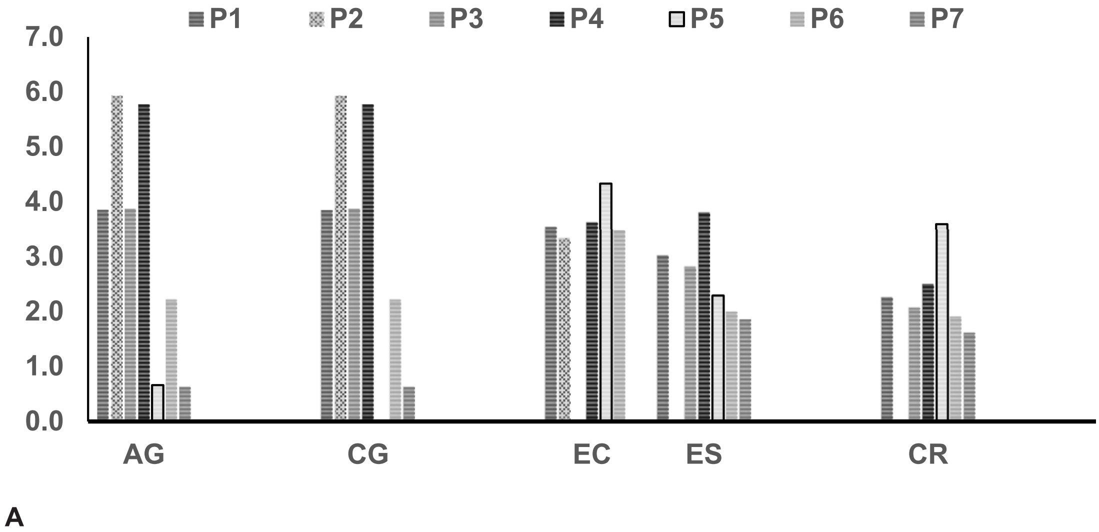

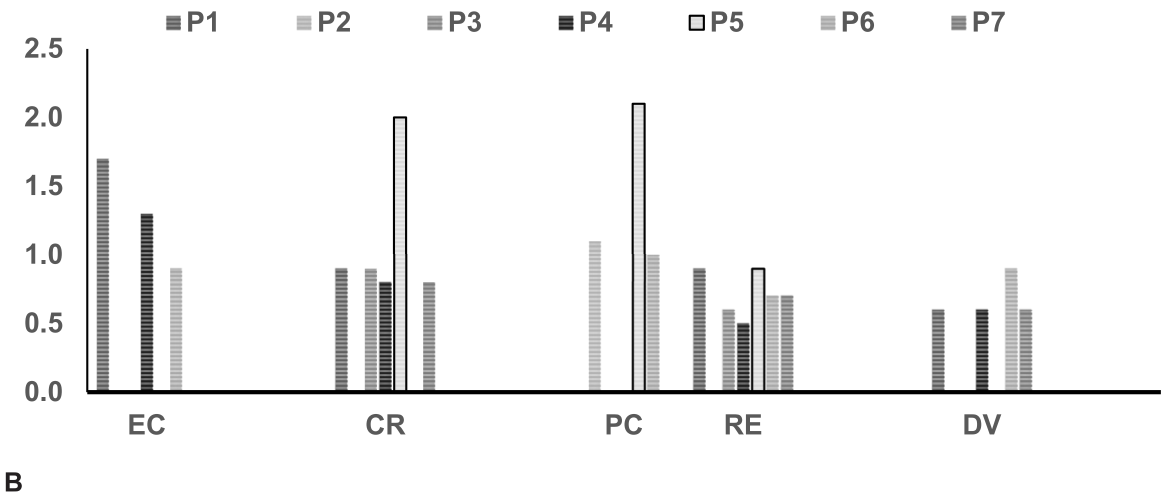

Figure 2. Weed summed dominant ratio at 1 MAP (A) and 2 MAP (B). AG: Agearatum conyzoides CG: *Cleome gynandra EC: Echinochloa colanum ES: Emilia sonchifolia CR: Cyperus rotundus PC: Paspalum conjugatum RE: Rottboellia exaltata DV: Drymaria vilosa Cham.* Cropping system 1:2 is 1 row of cassava followed by 2 rows of cowpeas; 1:3 is 1 row of cassava followed by 3 rows of cowpeas. P1 = “Mangu” and “Uno” 1:2, P2 = “Mangu” and “Uno” 1:3, P3 = “Mangu” and “Albina” 1:2, P4 = “Mangu” and “Albina” 1:3. P5 = “Mangu” monoculture. P6 = “Uno” monoculture. P7 = “Albina” monoculture. MAP= months after planting.

Cassava Morphology

The results showed that the planting system significantly affected canopy height at 1, 2, 3, 5, and 6 months after planting (MAP) (Table 1). Canopy height increased with plant age (Table 4). At 6 MAP, cassava in the intercropping system P3 reached a canopy height of 246.1 cm, which was taller than in the monoculture system, where the canopy height was 224.2 cm. A study by Amoako et al. (2022) found that canopy height increased significantly with cowpea population density (p<0.05). Similarly, research by Sherif (2011) indicated that reduced plant spacing decreases competition for light, leading to increased internode length and consequently taller plants. Narrow spacing thus produces taller plants compared to wide spacing.

These findings highlight the potential benefits of intercropping systems in enhancing the growth characteristics of cassava, particularly in terms of canopy height, which can be attributed to optimized resource utilization and reduced competition.

The planting system significantly affected the canopy diameter at 1, 2, and 4 MAP. The highest canopy diameter at 1 and 2 MAP was found in P4 (“Mangu” + “Albina” 1.3) (27.9, and 59.1 cm), and at 4 BST the highest canopy diameter was in P3 (“Mangu” + “Albina” 1.2) (143 cm). The intercropping system gave the highest diameter compared to the monoculture system, similar to the research of Amoako et al.

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Table 1. Effect of planting system on canopy height of cassava plants at 1 to 6 months after planting (MAP).

Cropping systems	Canopy height (cm)					
	1 MAP	2 MAP	3 MAP	4 MAP	5 MAP	6 MAP
"Mangu" - "Uno" 1:2	34.4 ab	73.1 a	99.7 b	147.9	183.8 b	215.2 b
"Mangu" - "Uno" 1:3	36.9 a	73.7 a	114.7 a	146.4	190.9 ab	225.1 b
"Mangu" - "Albina" 1:2	35.8 ab	64.1 b	98.6 b	150.8	201.5 a	246.1 a
"Mangu" - "Albina" 1:3	32.9 b	70.7 a	94.1 b	151.0	185.4 b	220.0 b
"Mangu" monoculture	37.2 a	67.9 ab	112.3 a	150.5	194.4 ab	224.2 b

Notes: Values followed by different letters in the same column mean significantly different according to DMRT (α = 0.05). MAP = month after planting. Cropping system 1:2 is 1 row of cassava followed by 2 rows of cowpeas; 1:3 is 1 row of cassava followed by 3 rows of cowpeas.

Table 2. Effect of planting system on canopy diameter of cassava plants at 1 to 6 months after planting (MAP)

Cropping system	Canopy diameter (cm)					
	1 MAP	2 MAP	3 MAP	4 MAP	5 MAP	6 MAP
"Mangu" - "Uno" 1:2	19.8 bc	45.8 b	82.4	121 bc	148	177
"Mangu" - "Uno" 1:3	21 bc	60.9 a	77.5	112 c	150	214
"Mangu" - "Albina" 1:2	18.8 c	46.3 b	78.8	143 a	173	204
"Mangu" - "Albina" 1:3	27.9 a	59.1 a	77.5	116 bc	154	220
"Mangu" monoculture	22.8 b	39 b	89.8	138 ab	158	207

Notes: values followed by different letters in the same column are significantly different according to DMRT (α = 0.05). MAP = month after planting. Cropping system 1:2 is 1 row of cassava followed by 2 rows of cowpeas; 1:3 is 1 row of cassava followed by 3 rows of cowpeas.

Table 3. Effect of planting system on stem diameter of cassava plants at 1-6 months after planting (MAP).

Cropping system	Stem diameter (mm)					
	1 MAP	2 MAP	3 MAP	4 MAP	5 MAP	6 MAP
"Mangu" - "Uno" 1:2	5.82 bc	11.15	15.17	20.17	26.50	29.90
"Mangu" - "Uno" 1:3	6.04 b	11.38	15.82	20.05	24.63	28.09
"Mangu" - "Albina" 1:2	5.46 bc	11.26	16.12	21.52	27.56	30.13
"Mangu" - "Albina" 1:3	7.05 a	13.08	18.04	21.47	25.84	29.49
"Mangu" monoculture	5.12 c	11.82	16.62	20.52	26.37	28.22

Notes: Values followed by different letters in the same column are significantly different according to DMRT (α = 0.05). MAP = month after planting. Cropping system 1:2 is 1 row of cassava followed by 2 rows of cowpeas; 1:3 is 1 row of cassava followed by 3 rows of cowpeas.

Table 4. Effect of planting system on the number of leaves of cassava plants at the age of 1-6 MAP

Cropping system	Leaf number					
	1 MAP	2 MAP	3 MAP	4 MAP	5 MAP	6 MAP
"Mangu" - "Uno" 1:2	15.7 bc	37.2	50.7	65.5	82.7	84.7 c
"Mangu" - "Uno" 1:3	17.5 b	38.5	53.7	74.7	84.7	86.0 bc
"Mangu" - "Albina" 1:2	15.0 c	38.7	54.5	66.2	84.5	86.7 bc
"Mangu" - "Albina" 1:3	20.0 a	41.5	61.0	78.7	88.5	94.2 ab
"Mangu" monoculture	14.0 c	41.2	60.0	73.0	94.0	96.5 a

Notes: Values followed by different letters in the same column are significantly different according to DMRT (α = 0.05). MAP = month after planting. Cropping system 1:2 is 1 row of cassava followed by 2 rows of cowpeas; 1:3 is 1 row of cassava followed by 3 rows of cowpeas.

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(2022), cassava planted with intercropping has a wider crown compared to monoculture cassava, and analysis of variance at the $p < 0.05$ level showed no significant differences.

The results of the research in Table 3 show the effect of the 1:3 planting system on the diameter of cassava stems with “Albina” cowpea varieties giving the effect of higher stem diameter at 1 MAP. Plant density affects competition for growing space, nutrients, water, and sunlight, and allows cassava plants to grow better with a larger stem diameter (Hidayat et al., 2018).

The results showed in Table 4, that the planting system affects the number of fresh leaves at 1, and 6 MAP. The number of leaves at 1 MAP with a spacing of 1:3 cassava and cowpea varieties “Albina” (P3) gave the highest results, while at 6 MAP, the monoculture planting system had the highest number of leaves, but there was no difference with the planting system with a spacing of 1:3 cowpea with “Albina” variety (P3). “Mangu” variety of cowpea has a branching type that is not branched (erect), so it has a higher average number of leaves, due to the proportion of longer leafy stems (Suwarto and Abrori, 2018).

Tuber Production

At 9 and 10 weeks after planting (WAP), cowpea plants were harvested. After harvesting, the cowpea plants were uprooted, and fertilization was carried out next to the cassava plants to replenish nutrients, aimed at enhancing cassava yield at 6 MAP.

The results in Table 5 showed that the planting system had no significant effect on tuber production at the 6 MAP harvest. The highest tuber weight was recorded in the monoculture planting system (4,350 g) and the “Mangu” + “Albina” 1:2 (P3) intercropping system (4,250 g). Research by Garreto et al. (2023) indicated that planting cassava during the dry season results in lower biomass accumulation compared to the rainy season due to better water and temperature conditions during early cassava development, which leads to higher yields. Rainfall at the beginning of planting in January was 211.1 mm, while at harvest in June (6 MAP), it was 320.6 mm, favoring soil conservation and early cassava growth.

Cassava Leaf NPK Content

Leaf nutrient levels of N, P, and K in cassava showed no significant effect from the planting system at 6 MAP. The average nutrient levels were N (4.35%) categorized as high, P (0.30%) as medium, and K (1%) as low. The K content in cassava leaves tends to increase with the soil’s K availability (Umeh et al. 2015). Research by Suwarto et al. (2023) indicated that the biomass weight of plant organs determines the amount of nutrients transported at harvest, with

Table 5. Effect of planting systems on the cassava tuber production.

Cropping System	Tuber production per plant			
	Weight (g)	Number of bulbs	Tuber length (cm)	Tuber circumference (mm)
“Mangu” - “Uno” 1:2	2,949	10.25	30.69	129.1
“Mangu” - “Uno” 1:3	2,449	9.50	28.67	111.7
“Mangu” - “Albina” 1:2	4,250	12.50	29.07	127.4
“Mangu” - “Albina” 1:3	2,924	9.25	31.54	123.3
“Mangu” monoculture	4,350	14.00	27.85	120.5

Notes: Values followed by different letters in the same column mean significantly different according to DMRT ($\alpha = 0.05$). Cropping system 1:2 is 1 row of cassava followed by 2 rows of cowpeas; 1:3 is 1 row of cassava followed by 3 rows of cowpeas.

Table 6. Effect of planting systems on cassava leaf NPK content.

Cropping System	Cassava leaf		
	N-Total (%)	P (%)	K (%)
“Mangu” - “Uno” 1:2	4.27	0.302	0.91
“Mangu” - “Uno” 1:3	4.19	0.302	0.94
“Mangu” - “Albina” 1:2	4.43	0.310	1.07
“Mangu” - “Albina” 1:3	4.43	0.295	0.95
“Mangu” monoculture	4.43	0.302	1.13

Notes: Testing results of the Laboratory of Agronomy and Horticulture Department of IPB University. Cropping system 1:2 is 1 row of cassava followed by 2 rows of cowpeas; 1:3 is 1 row of cassava followed by 3 rows of cowpeas.

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the highest NPK content in cassava leaves and the highest K content in the tubers.

Cowpea Yield

The planting system significantly affected the number of pods, pod dry weight at first harvest, seed dry weight, and 100-seed weight. This study found a positive correlation between the number of pods and pod dry weight, seed dry weight, and 100-seed weight. The "Albina" cowpea variety showed the highest yield compared to the "Uno" variety. According to Wahyudi et al. (2022), genetic differences can cause variations in plant traits, with different varieties showing significantly different responses even when grown in the same environment. Both genetic and environmental factors are crucial in influencing crop yields.

In the 1:2 cropping system and cowpea monoculture, the "Albina" variety produced the highest 100-seed weights of 15.44 g and 15.36 g, respectively. Genotypes respond differently to cropping patterns, with some better able to handle stress. Reduced light intensity due to shading can inhibit metabolism and decrease photosynthesis, affecting yield

Land Equivalence Ratio (LER)

The land equivalence ratio (LER) quantifies the land required for monoculture planting to achieve yields equivalent to those obtained from intercropping systems. It serves as a measure of land-use efficiency in intercropping with additive series patterns; a higher LER value indicates greater land-use efficiency. An LER greater than 1 signifies that the complementary effects of the intercropped plants lead to more efficient use of land resources.

Canopy height is a critical factor in determining a plant's ability to capture sunlight. In this study, cassava, with its higher canopy, overshadowed cowpea, allowing cassava to capture more light and reducing weed growth. Fewer weeds were observed at 2 MAP compared to 1 MAP.

The results showed that the LER for the intercropping systems ranged from 1.27 to 1.78. The intercropping system of P2 (1 row of cassava and 3 rows of "Uno" cowpea) had the highest LER of 1.78, followed by the 1:2 system with an LER of 1.73, and P3 (1 row of cassava and 2 rows of "Albina" cowpea) with an LER of 1.72. These findings suggest that the 1:2 and 1:3

Table 7. Effect of planting system on number of pods, dry weight of pods, dry weight of seeds, dry weight of 100-seeds, and dry weight conversion yield per hectare.

Cropping system	Number of pods (WAP)		Pod dry weight (g) (WAP)		Seed dry weight (WAP) (g)		100-seed weight (g)	Dry weight conversion yield per hectare [tr]
	9	10	9	10	9	10		
"Mangu" - "Uno" 1:2	63.5 b	60.5	114.9 b	109.4	86.2 b	81.9	14.3 b	1038
"Mangu"- "Uno" 1:3	76.2 b	56.7	112.2 b	95.2	81.1 b	74.1	13.9 b	1202
"Mangu"-"Albina" 1:2	65.5 b	53.7	129.0 b	102.2	96.9 ab	81.2	15.4 a	1104
"Mangu"-"Albina" 1:3	96.7 a	66.2	152.6 a	113.3	116.6 a	84.9	14.8 b	893.50
"Uno" monoculture.	54.0 c	58.5	93.2 c	111.7	75.0 b	93.1	14.3 b	983.75
"Albina" monoculture	65.5 b	52.7	131.7 b	103.1	103.3 a	84.3	15.3 a	1476.75

Notes: Values followed by different letters in the same column mean significantly different according to DMRT (α = 0.05). [tr] = transformation $\sqrt{(x + 0.5)}$ WAP = Week after planting. Cropping system 1:2 is 1 row of cassava followed by 2 rows of cowpeas; 1:3 is 1 row of cassava followed by 3 rows of cowpeas.

Table 8. Land equation ratio of different cassava intercropping systems

Cropping system	LER
"Mangu" - "Uno" 1:2	1.73
"Mangu" - "Uno" 1:3	1.78
"Mangu" - "Albina" 1:2	1.72
"Mangu" - "Albina" 1:3	1.27

Notes: Cropping system 1:2 is 1 row of cassava followed by 2 rows of cowpeas; 1:3 is 1 row of cassava followed by 3 rows of cowpeas.

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intercropping patterns are highly efficient in terms of land use.

The 1:2 cropping system, which produced the highest LERs (1.73 and 1.72), aligns with the research by Salsabila et al. (2022), which stated that a two-row intercropping pattern can increase land-use efficiency by 56% compared to monoculture. The selection of compatible crop combinations in intercropping is crucial, as they can exhibit a mutualistic symbiotic relationship. For example, the nitrogen needs of the main crop (cassava) can be met by the intercrop (cowpea) through its nitrogen-fixation capabilities (Sari et al., 2020).

Conclusion

The intercropping of cassava and cowpea significantly influenced cassava morphology during the cowpea growth phase, affecting canopy height, canopy diameter, stem diameter, and the number of leaves. However, intercropping did not affect the morphology of cassava plants after the cowpeas were harvested. Despite the lower cassava population in intercropping compared to monoculture, tuber yields were similar between the two systems. Cowpea yield at 9 WAP was not significantly different between intercropping and monoculture systems in terms of the number of pods, pod dry weight, seed dry weight, and 100-seed weight. The intercropping system resulted in an increased land equivalence ratio (LER), with the highest LER observed in the intercropping of cassava “Mangu” and cowpea “Uno” at both 1:2 and 1:3.

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