

Growth and Production of Glutinous Corn Plants (*Zea mays ceratina* L.) Hybrid Kumala Variety on Planting Media Combination Compost of Cashew Nut Shell and Cow Manure

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Abstract

Glutinous corn has the potential as a source of food diversification and industrial materials so that its productivity needs to be increased. This study aims to determine the differences in growth and production of glutinous corn plants from each treatment and to obtain a dose that has a better effect on the growth and production of glutinous corn plants. This study was conducted on May-September 2021 in Jati Bali Village, Ranomeeto Barat District, South Konawe Regency. The design used was a Randomized Block Design (RBD) with treatment a combination compost of cashew nut shell and cow manure consisting of five levels, namely without compost (K0), 5 t ha⁻¹ (K1), 10 t ha⁻¹ (K2), 15 t ha⁻¹ (K3) and 20 t ha⁻¹ (K4). Each treatment was repeated three times. The variables observed were plant height, number of leaves, leaf area, stem diameter, cob weight per plant, cob length, cob diameter, dry seed weight per plant, weight of 100 seeds, and production. The results showed that the treatment had a very significant effect to all variables of growth and production of glutinous corn plants. The combination dose of cashew shell and cow dung that gave a better effect on the growth and production of hybrid glutinous corn of the Kumala variety was 20 t ha⁻¹.

Keywords: combination, Dosage, glutinous corn, growth, production

Introduction

Corn is one of the plants used as a staple food by people in various regions in Indonesia because it contains high carbohydrates. However, glutinous corn is a special type of corn because it contains starch in the form of amylopectin (almost 100%) which has the potential as a source of food diversification and materials for the textile, paper and glue industries (Maruapey, 2012). The high amylopectin can also be used for diabetes sufferers and to increase livestock weight (Fiddin *et al.*, 2018).

The production of glutinous corn is still low because the seeds planted are local varieties continuously, fertilization is not in accordance with the dosage and cultivation techniques are less than optimal (Tengah and Tumbelaka, 2016), and the decreasing nutrient content in the soil is caused by inorganic fertilizer residues. Methods that can be done to increase the growth and production of glutinous corn include planting good quality seeds such as hybrid corn varieties Kumala and the use of organic fertilizers, either a combination of various types or the right fertilizer dosage.

Organic fertilizers can come from agricultural waste (cashew nut shell waste) or manure (cow manure). Along with the development of agricultural technology, cashew nut shell waste has begun to be widely used as a material for making natural pesticides. However, the dregs have not been utilized even though they can be used as organic fertilizer because they contain macro nutrients such as N (0.84%), P (0.221%), Ca

(0.13%) and Mg (0.24%) (Sakinah, 2014). The results of the study by Rahni *et al.* (2018) showed that a dose of cashew nut shell waste compost fertilizer of 20 t ha⁻¹ provided the highest growth and production of corn plants. Manure is fertilizer that comes from livestock pens, either in the form of solid waste (feces) mixed with food waste or urine. Cow manure contains water content (%) 12.33, pH 7.12, C-Organic (%) 10.06, N-Total (%) 0.79, C/N ratio 12.73, P₂O₅ (%) 0.36, and K₂O (%) 0.61, while according to Pranata (2010), cow manure contains macro nutrients such as 0.5 N%, 0.25% P₂O₅, 0.5% K₂O.

The advantages of organic fertilizers are that they can improve soil properties, both physical, chemical, and biological properties of the soil, such as increasing the number and activity of soil microorganisms (Purba *et al.*, 2024); can improve the environmental conditions for plant growth which ultimately can increase the production of a plant (Choirul *et al.*, 2021). In addition to its advantages, organic fertilizers also have disadvantages, namely that they are needed in large quantities but are sometimes not available. Therefore, a combination of several types of organic materials is needed to meet the needs of organic fertilizers. Making fertilizers from different materials will provide different growth responses. Providing a combination of cashew nut shell compost and cow manure is a good alternative in overcoming the lack of nutrients needed by plants because it contains nutrients such as nitrogen, potassium, phosphorus and micronutrients. The combination of organic materials with a balanced dose is expected to improve the quality of the organic fertilizer so that it can improve soil fertility and increase the growth and production of glutinous corn plants.

The purpose of this study was to: (1). Determine the differences in growth and production of hybrid glutinous corn plants of the Kumala variety from each combination dose treatment of cashew nut shell compost and cow manure given and (2). Determine the dose treatment that has a better effect on the growth and production of hybrid glutinous corn plants of the Kumala variety.

Research Method

Place and Time. This research was conducted in Jati Bali Village, Ranomeeto Barat District, South Konawe Regency, Southeast Sulawesi Province and in the Agronomy and Soil Science Unit Laboratory, Faculty of Agriculture, Halu Oleo University, from May to September 2021.

Materials and Tools. The materials used were hybrid glutinous corn seeds of Kumala variety, cashew nut shell compost, cow manure, EM4, granulated sugar, water, seed mixture insecticide (Carbosulfan 25%) and pest control insecticide (Dimehypo 500 g/L + Emamectin benzoate 50 g/L). The tools used in this study were machetes, hammers, nails, hoes, diggers, cloth meters, scales, rulers, roll meters, scoops, scissors, buckets, stakes, label boards, cameras, wood, sacks, shovels, plastic bags, sprayers, tractors, raffia ropes, tarpaulins, bowls and stationery.

Research Design. This study used a Randomized Block Design (RBD) with a combination of cashew nut shell compost and cow manure consisting of five levels, namely: without compost (K0), 5 t ha⁻¹ equivalent to 3.75 kg per plot (K1), 10 t ha⁻¹ equivalent to 7.5 kg per plot (K2), 15 t ha⁻¹ equivalent to 11.25 kg per plot (K3), 20 t ha⁻¹ equivalent to 15 kg per plot (K4). Each treatment was repeated three times so that there were fifteen experimental units.

Observation Variables. Observation variables of production were carried out at the age of 14, 28, and 42 days after planting (DAP) on: plant height (cm), number of leaves (strands), stem diameter (cm), and leaf area (cm²), while production variables were carried out after harvest, namely cob weight (g) per plant, cob length (cm), cob diameter (cm), number of rows per cob, dry seed weight per cob (g), weight of 100 seeds per plot, and production per hectare.

Statistical analysis. The observation data were analyzed using variance analysis. If the variance analysis shows a real and very real effect, it is continued with Duncan's Multiple Range Test (DMRT) at a 95% confidence level.

Results and Discussion

Results

Corn Plant Growth

Plant Height (cm). The combination compost of cashew nut shell and cow manure had a significant effect on the height of hybrid glutinous corn plants of the Kumala variety at the ages of 28 and 42 DAP.

Table 1. Effect of combination compost cashew nut shell and cow manure to the height of glutinous corn plants at the ages of 28 and 42 DAP.

Compost	Plant Height (cm)			
	28 DAP	DMRT α 0.05	42 DAP	DMRT α 0.05
K0 (control)	68,89 ^c		85,14 ^b	
K1 (5 t ha ⁻¹)	72,56 ^{bc}	2=14,59	84,67 ^b	2=26,84
K2 (10 t ha ⁻¹)	84,22 ^{ab}	3=15,21	104,79 ^{ab}	3=27,97
K3 (15 t ha ⁻¹)	89,56 ^a	4=15,55	119,48 ^a	4=28,60
K4 (20 t ha ⁻¹)	89,56 ^a	5=15,76	117,94 ^a	5=28,98

Numbers followed by unequal letters differ significantly with Duncan's multiple range test (DMRT) at 95% confidence level

Table 1 shows that at the age of 28 DAP, the highest corn plants were obtained in the compost treatment with a dose of 15 t ha⁻¹ (K3) which was very significantly with treatment without compost (K0) and a dose of 5 t ha⁻¹ (K1) but not significantly with treatment the doses of 20 t ha⁻¹ (K4) and 10 t ha⁻¹ (K2). At the age of 42 DAP, the highest corn plants were obtained in the compost treatment with a dose of 20 t ha⁻¹ (K4) which was significantly with treatment without compost (K0) and a dose of 5 t ha⁻¹ (K1) but not significantly with treatment the doses of 15 t ha⁻¹ (K3) and 10 t ha⁻¹ (K2). The lowest corn plants were obtained in the control treatment (K0).

Stem Diameter (cm). The combination compost of cashew nut shell and cow manure had a significant effect on the stem diameter of hybrid glutinous corn plants of the Kumala variety at the ages of 28 and 42 DAP.

Table 2. Effect of combination compost cashew nut shell and cow manure to the stem diameter of glutinous corn plants at the ages of 28 and 42 DAP.

Compost	Stem Diameter (cm)			
	28 DAP	DMRT α 0.05	42 DAP	DMRT α 0.05
K0 (control)	1,10 ^b		1,16 ^b	
K1 (5 t ha ⁻¹)	1,10 ^b	2=0,1495	1,20 ^b	2=0,2419
K2 (10 t ha ⁻¹)	1,15 ^b	3=0,1558	1,29 ^{ab}	3=0,2521
K3 (15 t ha ⁻¹)	1,23 ^{ab}	4=0,1593	1,45 ^a	4=0,2578
K4 (20 t ha ⁻¹)	1,38 ^a	5=0,1614	1,50 ^a	5=0,2612

Numbers followed by unequal letters differ significantly with Duncan's multiple range test (DMRT) at 95% confidence level

Table 2 shows that the largest corn stem diameter at the age of 28 DAP was obtained in the compost with a dose of 20 t ha⁻¹ (K4) which was not significantly with a dose of 15 t ha⁻¹ (K3) but significantly different from other treatments. At the age of 42 DAP, the largest corn stem diameter was obtained in the compost with a dose of 20 t ha⁻¹ (K4) which was not significantly with doses of 15 t ha⁻¹ (K3) and 10 t ha⁻¹ (K2) but significantly with the other treatments. The smallest stem diameter both at the age of 28 and at 42 DAP was obtained in the treatment without compost (K0).

Number of Leaves (Shells). The combination compost of cashew nut shell and cow manure had a significant effect on the number of leaves of hybrid glutinous corn plants of the Kumala variety at the ages of 28 and 42 DAP.

Table 3. Effect of combination compost cashew nut shell and cow manure to the number of leaves of glutinous corn plants at the ages of 28 and 42 DAP.

Compost	Number of Leaves (Shells)			
	28 DAP	DMRT α 0.05	42 DAP	DMRT α 0.05
K0 (control)	6,00 ^c		8,78 ^b	
K1 (5 t ha ⁻¹)	6,22 ^c	2=0,4090	9,00 ^b	2=0,8343
K2 (10 t ha ⁻¹)	6,78 ^b	3=0,4262	9,89 ^a	3=0,8694
K3 (15 t ha ⁻¹)	7,22 ^a	4=0,4359	10,33 ^a	4=0,8890
K4 (20 t ha ⁻¹)	7,00 ^{ab}	5=0,4416	10,33 ^a	5=0,9008

Numbers followed by unequal letters differ significantly with Duncan's multiple range test (DMRT) at 95% confidence level

Table 3 shows that when the plants were 28 DAP old, the highest number of corn leaves was obtained in the compost with a dose of 15 t ha⁻¹ (K3) which was not significantly with a dose of 20 t ha⁻¹ (K4) but very significantly with the other treatments. The lowest number of leaves was obtained in the without a compost (K0). At the age of 42 DAP, the highest number of corn leaves was obtained in the compost with a dose of 20 t ha⁻¹ (K4) and a dose of 15 t ha⁻¹ (K3) which was not significantly with a dose of 10 t ha⁻¹ (K2) but very significantly with other treatments. The lowest number of leaves was obtained in the treatment without a compost (K0).

Leaf Area (cm²). The combination compost of cashew nut shell and cow manure had a significant effect on the leaf area of hybrid glutinous corn plants of the Kumala variety at the ages of 42 DAP.

Table 4. Effect of combination compost cashew nut shell and cow manure to the leaf area of glutinous corn plants at the ages of 28 and 42 DAP.

Compost	Leaf Area (cm ²)			
	28 DAP	DMRT α 0,05	42 DAP	DMRT α 0,05
K0 (control)	162,16		218,29 ^c	
K1 (5 t ha ⁻¹)	172,79	ns	249,90 ^{bc}	2=60,87
K2 (10 t ha ⁻¹)	219,62	ns	298,82 ^{ab}	3=63,43
K3 (15 t ha ⁻¹)	261,74	ns	337,41 ^a	4=64,86
K4 (20 t ha ⁻¹)	278,49	ns	356,91 ^a	5=65,72

Numbers followed by unequal letters differ significantly with Duncan's multiple range test (DMRT) at 95% confidence level; ns = not significant

Table 4 shows that at the age of 28 DAP, the compost treatment had no significant effect on leaf area. At the age of 42 DAP, the widest corn plant leaves were obtained in the compost with a dose of 20 t ha⁻¹ (K4) which was not significantly with doses of 15 t ha⁻¹ (K3) and 10 t ha⁻¹ (K2) but very significantly with the other treatments. The narrowest leaf area was obtained in the treatment without compost (K0).

Corn Plant Production

Cob Length and Diameter (cm). The combination compost of cashew nut shell and cow manure had a significant effect to cob length and diameter of hybrid glutinous corn plants of the Kumala variety.

Table 5. Effect of combination compost cashew nut shell and cow manure to the cob length and cob diameter of glutinous corn plants.

Compost	Cob Length (cm)	DMRT α 0,05	Cob Diameter (cm)	DMRT α 0,05
K0 (control)	8,61 ^e		3,64 ^b	
K1 (5 t ha ⁻¹)	9,44 ^d	2=0,52	3,69 ^b	2=0,31
K2 (10 t ha ⁻¹)	10,33 ^c	3=0,54	3,94 ^{ab}	3=0,32
K3 (15 t ha ⁻¹)	11,11 ^b	4=0,56	4,08 ^a	4=0,33
K4 (20 t ha ⁻¹)	12,28 ^a	5=0,56	4,16 ^a	5=0,33

Numbers followed by unequal letters differ significantly with Duncan's multiple range test (DMRT) at 95% confidence level

Table 5 shows that the longest cob was obtained in the compost with a dose of 20 t ha⁻¹ (K4) which was very significantly with other treatments. The shortest cob length was obtained in the control (K0). The largest corn cob diameter was obtained in the compost with a dose of 20 t ha⁻¹ (K4) which was not significantly with a dose of 15 t ha⁻¹ (K3) and a dose of 10 t ha⁻¹ (K2) but significantly to other treatments. The smallest cob diameter was obtained in the without compost (K0).

Cob Weight per Plant and Dry Seeds Weight per Plant (g). The combination compost of cashew nut shell and cow manure had a significant effect to cob weight per plant and dry seeds per plant of hybrid glutinous corn plants of the Kumala variety.

Table 6. Effect of combination compost cashew nut shell and cow manure to cob weight per plant and dry seed weight per plant of glutinous corn plants.

Compost	Cob Weight per Plant (g)	DMRT α 0,05	Dry Seed Weight per Plant (g)	DMRT α 0,05
K0 (control)	32,00 ^e		25,89 ^e	
K1 (5 t ha ⁻¹)	39,56 ^d	2=6,55	33,33 ^d	2=5,07
K2 (10 t ha ⁻¹)	49,56 ^c	3=6,83	43,67 ^c	3=5,28
K3 (15 t ha ⁻¹)	61,00 ^b	4=6,98	50,67 ^b	4=5,40
K4 (20 t ha ⁻¹)	83,89 ^a	5=7,08	66,22 ^a	5=5,47

Numbers followed by unequal letters differ significantly with Duncan's multiple range test (DMRT) at 95% confidence level

Table 6 shows that the heaviest corn cobs per plant were obtained in the compost with a dose of 20 t ha⁻¹ (K4) which was very significantly to the other treatments. The lightest cobs were obtained in the treatment without compost (K0). The heaviest dry seed weight per plant was obtained in the compost with a dose of 20 t ha⁻¹ (K4) which was very significantly to other treatments. The lightest dry seed weight per plant was obtained in the treatment without compost (K0).

Weight of 100 Seeds (g) and Seed Production (t ha⁻¹). The combination compost of cashew nut shell and cow manure had a significant effect to weight of 100 seeds and seed production of hybrid glutinous corn plants of the Kumala variety.

Table 7. Effect of combination compost cashew nut shell and cow manure to weight of 100 seeds and seed production of glutinous corn plants.

Compost	Weight of 100 Seeds (g)	DMRT α 0,05	Seed Production (t ha ⁻¹)	DMRT α 0,05
K0 (control)	29,00 ^c		1,39 ^e	
K1 (5 t ha ⁻¹)	29,67 ^c	2=3,87	1,78 ^d	2=0,28
K2 (10 t ha ⁻¹)	39,00 ^b	3=4,04	2,33 ^c	3=0,29
K3 (15 t ha ⁻¹)	40,67 ^{ab}	4=4,13	2,70 ^b	4=0,29
K4 (20 t ha ⁻¹)	43,33 ^a	5=4,18	3,53 ^a	5=0,30

Numbers followed by unequal letters differ significantly with Duncan's multiple range test (DMRT) at 95% confidence level

Table 7 shows that the weight of 100 seeds heaviest obtained in the compost with a dose of 20 t ha⁻¹ (K4) was not significantly with a dose of 15 t ha⁻¹ (K3) but very significantly with the other treatments. The weight of 100 seeds lightest was obtained in the treatment without compost (K0). The highest seed production was obtained in the compost with a dose of 20 t ha⁻¹ (K4) which was significantly from other treatments. The lowest seed production was obtained in the treatment without compost (K0).

Discussion

The results showed that the combination of cashew nut shell compost and cow manure significantly affected all observation variables, both on the growth and production of glutinous corn plants. Cashew nut shell compost contains several nutrients such as: 0.84% N, 0.21% P, 0.70% K, 0.13% Ca, 0.24% Mg and cow manure contains nutrients such as: N 2.33%; P₂O₅ 0.61%; K₂O 1.58%; Ca 1.04%; Mg 0.33%; Mn 179 ppm and Zn 70.5 ppm so that when combined, the nutrients in the soil increase, are balanced and available to plants so that they produce good plant growth. The

increase in plant height is due to increased cell division and elongation as a result of the addition of nutrients to the soil and plant.

The highest number of leaves is obtained in the tallest corn plants. This is because the higher the corn plant, the more segments are formed and leaves grow in each segment of the plant stem, so the higher the plant, the more leaves it has. This is in line with the opinion of Sugito (2009), who stated that high chlorophyll content and a wider leaf surface contain more chlorophyll due to increased auxin production contained in cow manure, then the distribution of auxin that occurs in the plant causes faster cell elongation and produces plant growth where the higher the plant, the more leaves will occupy the segments on the corn stem.

The results of the study on the components of stem diameter growth Table 2 shows that the best treatment was the 20 t ha⁻¹ (K4) treatment of cashew nut shell compost combined with cow manure. This is in line with the research of Rahni et al. (2018) that corn plants give different responses to each dose level of cashew nut shell compost application. This is related to the ability of plants to efficiently photosynthesize so that the photosynthate produced can increase the formation and development of vegetative organs. Sudartiningsih and Prasetya (2010) stated that cow manure contains NPK nutrients which are very much needed to stimulate the enlargement of stem diameter and root formation that will support the establishment of plants accompanied by the formation of plant height during aging or harvest time. Nyakpa *et al.* (2008) stated that nitrogen is a very important element for the development of stem diameter. Nitrogen is part of protein, an important part of protoplasm, enzymes, biological catalyst agents that accelerate life processes. Phosphorus is one of the essential macronutrients for plant growth and yield, which plays an important role in stimulating the formation of carbohydrates where sufficient carbohydrates will affect cell enlargement where the results of cell enlargement activity will result in an increase in the diameter of the stem. For plants, fertilizer is used to live, grow and develop so that the provision of cashew shell waste and cow manure is thought to function to support the growth of stem diameter along with other elements in the soil. Fertilizer is very much needed by plants, therefore the availability of balanced fertilizer in the soil is very necessary.

The results of the study on the leaf area growth component Table 4 shows that the best treatment is the treatment of 20 t ha⁻¹ (K4) cashew shell compost combined with cow manure and the lowest is the Control treatment (K0). This is thought to be because the combination of cashew shell compost treatment with cow manure has a significant interaction on the leaf area parameter. Nasaruddin and Rosmawati (2011) stated that by providing fertilizer with a higher nitrogen content, it can accelerate the growth and development of plant organs so that the number of leaves and leaf area size increase more quickly.

The results of the study on the components of the length and diameter of the cob per plant Table 4.6. shows that the best treatment is the treatment of 20 t ha⁻¹ (K4) cashew shell compost combined with cow manure and the lowest is the Control treatment (K0). This is thought to be because the K content available in the soil affects the growth and yield of plants. Kasniari and Supadma (2007) explained that the K element plays an important role in increasing size such as cob length and seed weight. The available N content in the soil affects the growth and yield of plants. Sintia and Megi (2011) stated that the formation of cobs is influenced by sufficient nitrogen

nutrients to enlarge the seeds and increase the protein content in the seeds so that the diameter of the cob increases. Mayadewi (2007) explained that the provision of manure fertilizer can stimulate the formation of cob diameter which is related to the results of photosynthate and is translocated to the corn cob.

The results of the study on the components of the weight of cobs per plant and the weight of dry seeds per cob Table 7. shows that the best treatment is the treatment of 20 t ha⁻¹ (K4) cashew nut shell compost combined with cow manure and the lowest is the Control treatment (K0). This is proven that the provision of cashew nut shell compost and cow manure can improve the physical, biological and chemical conditions of the soil where the study took place, so that the treatment given can be utilized properly by plants, in addition to the release of nutrients contained in cashew nut shell waste and cow manure can contribute nutrients to plants, so that the provision of 20 t ha⁻¹ is the best treatment in increasing the weight of cobs per plant. Fertile soil and lots of organic soil material can provide optimal productivity for plant growth and development. The process of photosynthesis and the rate of photosynthate translocation run well so that it can be used to form and enlarge seeds, resulting in an increase in the weight of 100 seeds and the productivity of corn plants.

Conclusion

1. The combination compost of cashew nut shell with cow manure has an effect on the growth and production of corn hybrid Kumala variety.
2. The treatment that provides a better effect on the growth and production of corn plants is the 20 t ha⁻¹ (K4).

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