Effect of Jengkol Husk Bokashi and NPK Fertilizer on the Growth and Yield of Red Okra (*Abelmoschus esculentus* L.)

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Abstract. Red okra cultivation in Indonesia remains relatively limited, accompanied by limited public awareness of its health benefits and potential food-processing applications. This condition presents opportunities for the further development and commercialization of red okra, particularly in Riau Province. Therefore, optimizing production requires the application of appropriate cultivation practices, including the combined use of organic and inorganic fertilizers such as jengkol husk bokashi and NPK fertilizer. The aim of this research was to determine the interaction of jengkol husk bokashi and NPK 15:15:15 fertilizer on the growth and yield of red okra. This study used a Factorial Completely Randomized Design consisting of two factors. The first factor was the dose of jengkol husk bokashi with four levels: 0, 1, 2, and 3 kg/plot. The second factor was NPK 15:15:15 fertilizer with four levels: 0, 5, 10, and 15 g/plant. The parameters observed included plant height, flowering day, harvesting day, number of fruits per plant, fruit weight per plant, fruit weight per fruit, and number of remaining fruits. The observation data was analysed using analysis of variance and Honestly Significant Difference test at a 5% level. The results showed that the interaction between jengkol husk bokashi and NPK 15:15:15 fertilizer showed a significant effect on plant height, days to flowering, days to harvest, fruit weight per plant, fruit weight per fruit, and the number of remaining fruits. The best treatment combination was obtained with the application of 3 kg/plot of jengkol husk bokashi and 15 g/plant of NPK 15:15:15.

Keywords: *Red okra; jengkol husk bokashi; NPK fertilizer; growth; yield; organic fertilizer; inorganic fertilize*

1. Introduction

Red okra (*Abelmoschus esculentus* L. Moench) is a widely adapted fruit vegetable in tropical and subtropical environments. This plant is characterized by red-colored stems and fruits, with the immature fruit being the main edible part. The red pigmentation of okra fruit is associated with a high anthocyanin content, which contributes to its antioxidant properties. In addition, okra fruits contain various bioactive compounds, including flavonoids, alkaloids, saponins, tannins, and polyphenols. Due to its flavonoid content, okra has potential as a complementary dietary therapy for diabetes mellitus through the inhibition of α-glucosidase activity, improvement of pancreatic β-cell function, and antioxidant action [1]. Okra fruits also contains carbohydrates and vitamins. The nutritional composition of okra fruit per 100 g consists of 88.6 g water, 144.0 kJ energy, 2.1 g protein, 8.2 g carbohydrates, 0.2 g fat, and 1.7 g fiber. In addition, it contains 84.0 mg calcium (Ca), 90.0 mg phosphorus (P), 1.2 mg iron (Fe), 185.0 µg β-carotene, 0.08 mg riboflavin, 0.04 mg thiamine, 0.60 mg niacin, and 47.0 mg ascorbic acid. All parts of the okra plant are edible and can be utilized in various food products [2]. However, okra cultivation in Indonesia remains relatively limited due to the lack of public awareness of its health benefits and processing methods. Consequently, okra production data is not yet available from the Badan Pusat Statistik (BPS) in Indonesia or Riau Province. This situation presents considerable opportunities for the development of okra cultivation in Riau Province. Therefore, appropriate cultivation techniques are required to achieve optimal production. One approach to increasing productivity is through fertilization. Fertilization involves the application of organic and inorganic fertilizers. Organic fertilizers are derived from living organisms, including decomposed plant residues, animal wastes, and other organic materials. These fertilizers may be applied in solid or liquid form and function to improve the physical, chemical, and biological properties of soil [3].

One potential source of organic fertilizer is jengkol husk waste. Jengkol fruits are widely consumed as food, generating substantial quantities of husk waste. If discarded without proper management, jengkol peels can contribute to environmental pollution due to their unpleasant odor. However, jengkol husk can be utilized as a raw material for bokashi fertilizer, which has the potential to improve soil physical, chemical, and biological properties. This is attributable to the nutrient content of jengkol husk, which includes 1.82% N, 0.03% P, 2.10% K, 0.27% Ca, and 0.25% Mg [4]. Bokashi is an organic composting method that utilizes effective microorganisms (EM4), consisting of lactic acid bacteria, photosynthetic bacteria, Actinomycetes, yeasts, and fungi [5]. In addition to organic fertilizers, the application of inorganic fertilizers can also support the growth and development of okra plants. One commonly used inorganic fertilizer is NPK Phonska 15:15:15. This compound fertilizer contains 15% nitrogen (N), 15% phosphorus (P_2O_5), 15% potassium (K_2O), and 10% sulfur (S). Because it is highly water-soluble, the nutrients contained in NPK Phonska can be readily absorbed and utilized efficiently by plants [6]. Therefore, this study was conducted to evaluate the effects of jengkol husk bokashi and NPK fertilizer on the growth and yield of red okra (*Abelmoschus esculentus* L. Moench).

2. Research Methods

The research was conducted at the Experimental Garden of the Faculty of Agriculture, Universitas Islam Riau, Pekanbaru, Indonesia, from November 2024 to February 2025. The materials used in this study were red okra seeds of the Charmine Splendor F1 Hybrid variety, jengkol husk bokashi, NPK fertilizer, Dithane M-45 fungicide, Decis 25 EC insecticide, and Furadan 3G. Meanwhile, the equipment used included hoes, machetes, stainless steel knives, thrust frames, paddles, cameras, meters, buckets, hand sprayers, drums, tarpaulins, and stationery.

The experiment was arranged in a factorial Completely Randomized Design (CRD) consisting of two factors. The first factor was the application of jengkol husk bokashi (B), which comprised four treatment levels, namely without jengkol husk bokashi (B0), 1 kg/plot (B1), 2 kg/plot (B2), and 3 kg/plot (B3). The second factor was the application of NPK fertilizer (K), which also comprised four treatment levels, namely without NPK fertilizer (K0), 5 g/plant (K1), 10 g/plant (K2), and 15 g/plant (K3). The combination of these factors resulted in 16 treatment combinations. Each treatment combination was replicated three times, resulting in a total of 48 experimental units. Each experimental unit consisted of four plants, of which two plants were designated as sample plants. Therefore, the total number of plants used in the experiment was 192.

3. Results and Discussion

3.1 Plant Height (cm)

The analysis of variance revealed that the interaction and main effect of jengkol husk bokashi and NPK fertilizer significantly affected the plant height of red okra. The average height plant of red okra tested using Tukey's Honestly Significant Difference (HSD) test at the 5% level are presented in Table 1.

Table 1. Plant height of red okra with application of jengkol husk bokashi and NPK fertilizer (cm)

Jengkol husk bokashi (kg/plot)	NPK fertilizer (g/plant)				Average
	N0 (0)	N1 (5)	N2 (10)	N3 (15)	
B0 (0)	27,67 h	29,33 gh	32,33 fgh	34,17 d-g	30,88 d
B1 (1)	32,67 fgh	33,83 efg	34,17 d-g	35,00 def	33,92 c
B2 (2)	36,17 c-f	36,33 c-f	39,00 b-e	40,50 bc	38,00 b
B3 (3)	36,50 c-f	39,17 bcd	41,83 ab	46,83 a	41,08 a
Average	33,25 c	34,67 c	36,83 b	39,13 a	
KK = 4,82 %	HSD BN = 5,27		HSD B&N = 1,92		

The numbers in the columns and rows followed by the same lowercase letter are not significantly different according to the HSD test at the 5% level

Based on the HSD test at 5% level (Tabel 1), the interaction between 3 kg/plot of jengkol husk bokashi and 15 g/plant of NPK fertilizer (B3N3) resulted in the highest average plant height of 46.83 cm. The B3N3 treatment was not significantly different from B3N2 but was significantly different from the other treatments. These results indicate that the application of 3 kg/plot of jengkol husk bokashi has improved the physical, chemical, and biological properties of the soil, so that the application of 10 g/plant and 15 g/plant of NPK 15:15:15 fertilizer can be optimally absorbed by the plants and produce maximum okra plant height. Based on the analysis of nutrient content in jengkol husk bokashi presented in Table 2, it indicates that the jengkol husk bokashi contains high levels of N. According to Ref. [7], nitrogen plays a role in protein synthesis, enzymes, and chlorophyll formation, which is very important in the process of photosynthesis.

Table 2. Nutrient content of jengkol husk bokashi

Nutrient Content	Jengkol Husk Bokashi	Minimum standards	Category
N total	1,38 %	≥ 0,40%	High
P_2O_5	0,06 %	≥ 0,10%	Low
K_2O	0,24 %	≥ 0,20%	Medium–High

* Laboratory of Central Plantation Services, Pekanbaru (2024)

Conversely, the lowest okra plant height was found in the treatment without jengkol husk bokashi and NPK fertilizer of 15:15:15 (B0N0), at 27.67 cm. This is because there was no additional nutrient addition from organic or inorganic fertilizers, and the plants obtained only natural nutrients from the soil. According to Ref. [8], the amount of N absorbed by plants is influenced by the availability of organic matter in the soil.

3.2 Flowering Days (day)

The analysis of variance showed that the interaction and main effect of jengkol husk bokashi and NPK fertilizer significantly affected the flowering days of red okra. The average flowering days of red okra tested using Tukey's Honestly Significant Difference (HSD) test at the 5% level are presented in Table 3.

Based on the HSD test at 5% level (Tabel 3), the interaction between 3 kg/plot of jengkol husk bokashi with 15 g/plant of NPK fertilizer (B3N3) resulted in the earliest flowering days, namely 39.67 days. The B3N3 treatment was not significantly different from the B3N2, B3N1, and B3N0 treatments, but significantly different from the other treatments. This proves that application of 3 kg/plot of jengkol husk bokashi can improve soil fertility by enhancing the physical, chemical, and biological properties.

Table 3. Flowering days of red okra with application of jengkol husk bokashi and NPK fertilizer (day)

Jengkol husk bokashi (kg/plot)	NPK fertilizer (g/plant)				Average
	N0 (0)	Average	N2 (10)	N3 (15)	
B0 (0)	55,17 e	51,50 de	51,67 de	50,83 de	51,46 c
B1 (1)	50,00 d	50,83 d	50,50 d	48,83 cd	50,04 c
B2 (2)	51,83 de	47,83 cd	45,67 bc	45,00 bc	48,42 b
B3 (3)	43,00 ab	42,33 ab	41,67 ab	39,67 a	41,67 a
Average	50,00 e	48,12 d	47,38 a-d	46,08 a	
	KK = 2,89%	HSD BN = 4,20		HSD B&N = 1,53	

The numbers in the columns and rows followed by the same lowercase letter are not significantly different according to the HSD test at the 5% level

Therefore, the addition of nutrient from NPK fertilizer 15:15:15 at 5 g/plant and 10 g/plant can be optimally observed by plants, although the flowering days are not optimal with 15 g/plant. Ref. [9] emphasized that proper fertilizer management is essential for improving nutrient use efficiency, minimizing nutrient losses, and ensuring that plants receive nutrients according to their requirements.

3.3 Harvesting Days (day)

The analysis of variance showed that the interaction and main effect of jengkol husk bokashi and NPK fertilizer significantly affected the harvesting days of red okra. The average harvesting days of red okra tested using Tukey's Honestly Significant Difference (HSD) test at the 5% level are showed in Table 4.

Table 4. Harvesting days of red okra with application of jengkol husk bokashi and NPK fertilizer (day)

Jengkol husk bokashi (kg/plot)	NPK fertilizer (g/plant)				Average
	N0 (0)	N1 (5)	N2 (10)	N3 (15)	
B0 (0)	57.83 e	57.00 de	56.17 de	57.00 de	57.00 d
B1 (1)	55.50 b-e	56.33 de	55.67 de	52.83 de	55.08 c
B2 (2)	57.00 de	52.50 cd	50.17 bc	49.50 bc	52.29 b
B3 (3)	47.50 ab	46.67 ab	46.17 ab	44.33 a	46.17 a
Average	54.46 c	53.13 bc	52.05 ab	50.92 a	
	KK = 2,90%	HSD BN = 4,62		HSD B&N = 1,62	

The numbers in the columns and rows followed by the same lowercase letter are not significantly different according to the HSD test at the 5% level

Based on the HSD test at 5% level (Tabel 4), the interaction of 3 kg/plot of jengkol husk bokashi with 15 g/plant of NPK fertilizer (B3N3) resulted in the earliest harvest time, with a mean of 44.33 days. The B3N3 treatment was not significantly different from the B3N2, B3N1, and B3N0 treatments, but significantly different from the other treatments. Earlier flowering promotes earlier fruit formation, which consequently leads to earlier harvest [10]. Adequate nutrient availability in the soil is one of the key factors in determining plant growth and yield [7;9]. Therefore, the application of appropriate fertilizer can enhance plant growth and accelerate crop maturity.

In contrast, the longest harvest time was found in the treatment without application of jengkol husk bokashi or NPK fertilizer (B0N0), with a mean harvest time of 57.83 days. This result indicates that red okra plants were unable to achieve optimal growth without adequate nutrient inputs. According to Ref. [12], nutrient availability in the soil significantly influences plant growth and productivity. Essential nutrients must be supplied continuously and in balanced proportions to support optimal plant development and yield.

3.4 Number of Fruit per Plant (fruit)

The analysis of variance showed that the interaction between jengkol husk bokashi and NPK fertilizer had no significant effect on the number of fruit per plant of red okra. However, the main effects of jengkol husk bokashi and NPK fertilizer significantly affected the number of fruits per plant. The average number of fruit tested using Tukey's Honestly Significant Difference (HSD) test at the 5% level are showed in Table 5.

Table 5. Number of fruit per red okra plant with application of jengkol husk bokashi and NPK fertilizer (fruit)

Jengkol husk bokashi (kg/plot)	NPK fertilizer (g/plant)				Average
	N0 (0)	N1 (5)	N2 (10)	N3 (15)	
B0 (0)	6,50	7,17	7,50	8,67	7,46 b
B1 (1)	7,50	8,33	8,00	8,50	8,08 ab
B2 (2)	8,50	8,67	8,50	10,00	8,92 ab
B3 (3)	8,83	8,83	9,17	10,67	9,38 a
Average	7,83 b	8,25 ab	8,29 ab	8,46 a	
	KK = 7,49%		HSD B&N = 1,99		

The numbers in the columns and rows followed by the same lowercase letter are not significantly different according to the HSD test at the 5% level

Based on the HSD test at 5% level (Tabel 5), the application of jengkol husk bokashi at a dose of 3 kg/plot (B3) resulted in the highest number of fruits per plant, with an average of 9.38 fruits. This B3 treatment was significantly different from B0, B1, and B2. The increase in fruit number may be attributed to the nutrient content of jengkol husk bokashi, which contains 1.38% N, 0.06% P_2O_5, and 0.24% K_2O. The application of a higher bokashi dose increases nutrient availability, thereby supporting fruit development and increasing fruit production in red okra. In addition, jengkol peel bokashi can also improve soil structure by increasing organic matter, enhancing the soil's water-holding capacity and improving the activity of beneficial soil microorganisms [13]. Increased microbial activity can improve nutrient mineralization and enhances nutrient availability and uptake by plants, which contributes to improved vegetative growth and reproductive development.

Based on the HSD 5% test, the main effect of NPK 15:15:15 fertilizer at a dose of 15 g/plant (N3) resulted in the highest number of fruits per plant, with a mean of 8.46 fruits. However, this treatment was not significantly different from N2 (10 g/plant NPK fertilizer) but was significantly different from the other treatments. These results indicate that the application of NPK fertilizer at an optimum dose enhanced fruit production in red okra by providing sufficient nutrients to support flowering, fruit set, and fruit development.

3.5 Weight of Fruit per Plant (g)

The analysis of variance showed that the interaction and main effect of jengkol husk bokashi and NPK fertilizer significantly affected the fruit weight per red okra plant. The average fruit weight per red okra plant tested using Tukey's Honestly Significant Difference (HSD) test at the 5% level are showed in Table 6.

Based on the HSD test at 5% level (Tabel 6), the interaction between of jengkol husk bokashi at a dose of 3 kg/plot and NPK 15:15:15 at a dose of 15 g/plant (B3N3) had the highest average fruit weight per plant of 100.20 g. The B3N3 treatment was not significantly different from the B2N3 treatment, but it was significantly different from the other treatment combinations. These results indicate that the combined application of jengkol husk bokashi at a dose of 3 kg/plot and NPK 15:15:15 at a dose of 15 g/plant provided an optimum nutrient supply for plant growth and fruit development, resulting in greater fruit weight per plant in red okra.

Table 6. Weight of fruit per red okra plant with application of jengkol husk bokashi and NPK fertilizer (g)

Jengkol husk bokashi (kg/plot)	NPK fertilizer (g/plant)				Average
	N0 (0)	N1 (5)	N2 (10)	N3 (15)	
B0 (0)	45,17 f	51,80 ef	55,85 def	73,22 bcd	56,51 d
B1 (1)	55,66 def	68,70 b-e	64,40 cde	68,95 b-e	64,43 c
B2 (2)	64,39 cde	72,07 bcd	73,17 bcd	83,42 ab	73,26 b
B3 (3)	73,73 bc	74,02 bc	73,92 bc	100,20 a	80,47 a
Average	59,74 c	66,65 b	66,83 b	81,45 a	
KK = 8,60 %	HSD BN = 17,96	HSD B&N = 6,54			

The numbers in the columns and rows followed by the same lowercase letter are not significantly different according to the HSD test at the 5% level

According to Ref [14], the application of fertilizer at a dose appropriate to plant nutrient requirements can improve plant growth and development. Fertilizers provide essential nutrients that support the formation and development of plant tissues, thereby enhancing physiological activities associated with growth and fruit production. Consequently, adequate nutrient availability contributes to increased fruit weight and overall yield in red okra.

Meanwhile, the lowest fruit weight per plant was found in the B0N0 treatment, at mean value of 45.17 grams. This indicates that inadequate nutrient availability limits plant growth and fruit development, resulting in lower fruit production. According to Ref [15], one of the factors supporting optimal plant growth is the availability of sufficient nutrients and organic matter in the soil.

3.6 Weight of Fruit per Fruit (g)

The analysis of variance showed that the interaction and main effect of jengkol husk bokashi and NPK fertilizer significantly affected the weight of fruit per fruit. The average weight of fruit per fruit tested using Tukey's Honestly Significant Difference (HSD) test at the 5% level are showed in Table 7.

Table 7. Weight of fruit per fruit with application of jengkol husk bokashi and NPK fertilizer (g)

Jengkol husk bokashi (kg/plot)	NPK fertilizer (g/plant)				Average
	N0 (0)	N1 (5)	N2 (10)	N3 (15)	
B0 (0)	6,941 f	7,229 f	7,447 def	8,437 b	7,514 c
B1 (1)	7,421 ef	8,238 bcd	8,055 b-e	8,090 b-e	7,951 b
B2 (2)	7,611 c-f	8,311 bc	8,608 ab	8,340 bc	8,218 b
B3 (3)	8,340 bc	8,376 bc	8,061 b-e	9,393 a	8,542 a
Average	7,578 c	8,039 b	8,043 b	8,565 a	
KK = 3,28 %	HSD BN = 0,80	HSD B&N = 0,29			

The numbers in the columns and rows followed by the same lowercase letter are not significantly different according to the HSD test at the 5% level

Based on the results of the HSD test at 5% level (Table 7), the interaction between 3 kg/plot of jengkol husk bokashi and 15 g/plant of NPK fertilizer (B3N3) produced the highest average fruit weight per fruit of 9.39 g, and the B3N3 treatment was not significantly different from the B2N2 treatment, but significantly different from the other treatments. Meanwhile, the lowest fruit weight per fruit was found in the B0N0 treatment, at 6.94 g. This indicates that inadequate nutrient availability limited plant growth and fruit development, resulting in lower fruit weight. According to Ref [16], fertilizers containing adequate nutrients are essential for supporting plant growth and development. Therefore, nutrient deficiencies can restrict plant growth and development, ultimately reducing crop productivity and yield.

4. Conclusions

The interaction between jengkol husk bokashi and NPK 15:15:15 fertilizer significantly affected plant height, flowering day, harvesting day, fruit weight per plant, and fruit weight per fruit of red okra. The combination of 3 kg/plot of jengkol husk bokashi and 15 g/plant of NPK 15:15:15 fertilizer produced the most favorable growth and yield responses.

References

[1] Pasaribu, A. A., Amalia. A., Tampubolon, V. A. A., & Pasaribu, S. F. (2022). Potency of Okra (*Abelmoschus esculentus* L. Moench) as Antidiabetic. Jurnal Gizi Dan Kesehatan, 14(2), 238–244.

[2] Gemede, H. F., Ratta, N., Haki, G. D., & Woldegiorgis, A. Z., (2015). Nutritional quality and health benefits of Okra (*Abelmoschus esculentus*). International Journal of Nutrition and Food Sciences, 4(2), 208–215.

[3] Widowati, L. R., Hartatik, W.., Setyorini, D., & Trisnawati, Y. (2022). Pupuk Organik Dibuatnya Mudah, Hasil Tanam Melimpah. Pusat Perpustakaan dan Penyebaran Teknologi Pertanian, Kementerian Pertanian Republik Indonesia.

[4] Ajie, D., Wardhani, G. K., Phungghalawati, E., Wananto, A. Y., & Osiana, R. (2014). Tukul Jengkol (Tumbukan Kulit Jengkol) untuk Tingkatkan Produktivitas Padi Organik. Institut Pertanian Bogor.

[5] Maulana, R., & Yett, H. S. Y. (2015). Pengaruh Pemberian Pupuk Bokashi Dan Npk Terhadap Pertumbuhan Dan Produksi Tanaman Jagung Manis (*Zea mays* Var saccharata Sturt) Application. Jurnal Untuk Mu Negeri, 2(2), 1–14.

[6] Kaya, E. (2013). Pengaruh Kompos Jerami dan Pupuk NPK terhadap N-tersedia Tanah, Serapan-N, Pertumbuhan, dan Hasil Padi Sawah (*Oryza sativa* L). Jurnal Agrologia, 2(1), 43–50.

[7] Marschner, P. (2012). Mineral Nutrition of Higher Plants. 3rd Edition. Academic Pres

[8] Hartatik, W., Husnain, & Widowati, L. R. (2015). Peranan Pupuk Organik dalam Peningkatan Produktivitas Tanah dan Tanaman. Jurnal Sumberdaya Lahan, 9(2), 107–120.

[9] Weil, R. R., & Brady, N. C. (2017). The Nature and Properties of Soil. Fifteenth edition. Macmillan Publishing.

[10] Nurdiansah, R. (2019). Pengaruh Pemberian Bokashi Kulit Jengkol Dan Mulsa Jerami Padi Terhadap Pertumbuhan Dan Hasil Tanaman Melon (*Cucumis melo* L.). [Skripsi]. Universitas Muhammadiyah Sumatera Utara. Medan.

[11] Triadiawarman, D., Aryanto, D. & Krisbiyantoro, J. (2022). Peran Unsur Hara Makro Terhadap Pertumbuhan Dan Hasil Bawang Merah (*Allium cepa* L.). Jurnal Agrifor, 21, 27–32.

[12] Hamzah, A., & Siswanto, B. (2023). Pupuk Organik Tinjauan Teori dan Praktek. Forind.

[13] Anam, C., D. E, Kusumawati, & Apriliya, Y. A. (2023). Upaya Peningkatan Produksi Tanaman Tomat (*Solanum lycopersicum* M.) Dengan Aplikasi Pupuk Daun Dan Pupuk KCl. Agroradix, 7(1), 1-10.

[14] Rupa, C. J. (2022). Analisis Ketersediaan Unsur Hara Nitrogen Dan Bahan Organik Di Bawah Tegakan Uru *(Elmerrillia ovalis)* Dan Kebun Kopi *(Coffea sp)* Di Kelurahan Tagari, Kecamatan Balusu, Kabupaten Toraja Utara. [Skripsi]. Universitas Hasanuddin.

[15] Gani, A., S. Widiyanti, & Sulastri. (2021). Analisis Kandungan Unsur Hara Makro Dan Mikro Pada Kompos Campuran Kulit Pisang Dan Cangkang Telur Ayam. Jurnal Kimia Riset, 6(1), 8–19.