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Shallot cultivation on unsuitable agro-climate and marginal lowland treated with chicken manure in Bengkulu, Indonesia

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Abstract Agro-climatological condition in Bengkulu is unsuitable and most areas have marginal soil characteristics for shallot cultivation. However, all shallot varieties were adaptable and grown on the cultivation area after the soil characteristics were ameliorated. Faced with unsuitable agro-climatic conditions such as too much rainfall, farmers should construct plastic shade or should adjust planting time during the closed dry season. Futhermore, all shallot varieties responded significantly to the chicken manure applied and 7 varieties involved *Bima Brebes, Kramat, TSS Agrihort 1, Violetta 2, Violetta 3 Agrihort 1, Trisula,* and *Bauji* significantly responded to the increasing doses of the manure applied. *Bima Brebes and Violetta 3 Agrihort 1* showed the best yield performed by the shallot yields at 10 tons ha^{-1} of the chicken manure applied while *Kramat, TSS Agrohort 1, Violetta 2,* and *Trisula* showed the best yield at 20 tons ha^{-1} of the manure added. Furthermore, *Bauji* started to respond significantly at 20 tons ha^{-1} and increased significantly the yields when the increasing doses of the manure were applied. The highest yields of the shallot bulbs are grown on the irrigated marginal lowland in this area when the chicken manure was applied at 20 tons ha^{-1} which gave 20.996 tons' ha^{-1} for the dry weight of the shallot bulbs.

Keywords: Chicken manure, Climatological, Irrigated marginal lowland, Land suitability, Shallot

Introduction

Shallot is an important spice in the daily menu and processed food because of its unique taste and aroma (Yofananda *et al*., 2021). Shallot is one of the strategic food commodities and some part of the world used as traditional medicinal plant from Alliaceae family (Khorasgani and Pessarakli, 2019a). It is an imperative vegetable in Indonesia due to providing numerous health benefits.

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This crop has a high value because it is not just as spice in dishes but also as a raw material for food industry such as crispy fried shallots (Sulistyaningsih *et al*., 2020). In 2020, from the whole shallot areas in Indonesia only harvested 1,815,445 tons, and this production was much below the population demand (Al-Rosyid *et al*., 2021). With various environmental and agroclimatic circumstances, the shallot productivity in Indonesia only touched around 9.93 tons ha^{-1} (BPS Statistics Bengkulu, 2022) which was much lower as compared to the world average of 18.8 tons ha^{-1} (Tsagaye *et al*., 2021).

Shallots had need of particular edaphoclimatic circumstances, i.e., in very cold to moderate cold regions at high elevations usually more than 1000 m above sea level, and good agricultural practices to surmount bulb and seed dormancy and encourage seed stalk development and reproduce bulbs and true seeds (Khorasgani and Pessarakli, 2019b). Shallots could grow on the various climatic circumstances such as hot climates and open fields or cold climates but moderate rainfall (Sutardi *et al.,* 2022). The shallot growth was susceptible because of the large raindrops and the high rainfall intensity (Marpaung and Rosliani, 2019). Furthermore, this plant requires maximum sunlight exposure (at least 70% irradiation), air temperature 25-32 °C, and 50-70% relative humidity. The shallot plants prefer to grow in dry climates. The main challenges faced by farmers in the cultivation of shallots in the high rainfall areas was the shallot susceptible by pests and diseases attack (Wati and Despita, 2019). In short, intensive shallot cultivation could be conducted in the wide range of agroecological circumstances (Rahim, 2012) and technologically this crop could be cultivated in high production in the lowlands both on the drained wetlands and dry lands in fact most farmers favor to cultivate on the irrigated dry lands (Nadeak, 2013).

Shallot cultivation produced in low harvest comparing to its potential genetic in Indonesia which could achieve 20 tons ha^{-1} (Sumarni *et al*., 2016). The shallot productivity in low harvest because of some constraints such as used unselected local seed and cultivation practices not accordance with optimum requirement for shallot growth (Marlina *et al.,* 2020). Agricultural productivities quite related to determinant production factors such as agricultural inputs, crop varieties, cultivation infrastructures mainly irrigation facilities (Nurjannah and Hasan, 2021). The shallot productivities have not achieved optimum following its potential genetic quite related to various cultivation practices by local farmers just simply following their previous cultivation practices (Kilmanun *et al.,* 2020). Developing cultivation practices based on agricultural knowledge and technologies could promote improving crop productivities as well as the farmers income and revenue (Novianti *et al.,* 2020).

Shallot planting methods usually used vegetative seed bulbs (Maintang *et al.,* 2019). In fact, the crucial problem of the intensive shallot cultivation was a limited available the high qualities of shallot seed in quantity and time when farmers need (Putrasamedja, 2010). Shallot could be grown on the various agroecological zone from lowlands to highlands between 0-900 m above sea level (Azwir and Edi, 2014). However, shallot cultivation in the lowlands faced with a limited available adapted shallot varieties with high quality seeds (Edi, 2019). The highquality seeds of the shallot varieties which adapted in the lowlands agroecological zone were limited (Saidah *et al*., 2019) therefore to fulfill the seeds demand, the farmers often planted shallot varieties for daily consumption which adapted in highlands (Kusuma *et al.,* 2013). As a consequence, shallot productivity and production growing on the lowlands was much lower than that of growing on the highland areas. In order to increase shallot production in Indonesia, shallot cultivation should expand on the high potential areas in the lowlands and at the same time the high productivity of the shallot varieties adapted in the lowland agroecological zones should be developed based on local superior varieties (Febryna *et al.,* 2019). Prior to introduce to the local farmers however the high quality of the shallot seeds should be conducted screening test for the adaptable shallot varieties which have showing fabalous growth and yield in the site-specific location (Asaad, 2016).

Shallot productivities and farmer income advantages from the shallot cultivation were determined by some combination of the production factors implemented (Adetya and Suprapti, 2021). Efforts should be applied to improve shallot production were implementation of good agricultural practices, high productive seed shallot varieties, and organic and an-organic fertilizers in balancing applied (Nur'aeni *et al.,* 2020). Simple practices for increasing shallot production were through improving cultivation practices and implementing organic fertilizers (Anisyah *et al.,* 2014). Furthermore, doses and organic fertilizer requirement for shallot cultivation depended on soil types and the characteristics of the lands. Previous studies showed that the shallot harvested in the high yields when the shallot cultivation beds were mixed with farmyard manures of 5 tons ha^{-1} (Fadillah *et al.,* 2021), 10 tons ha^{-1} (Budianto *et al.,* 2015), 30 tons ha^{-1} (Handajaningsih *et al.,* 2021), and even 40 tons ha^{-1} on Ultisols (Susikawati *et al*., 2018).

Research and development of the shallot cultivation in Bengkulu Province is very limited, especially in Kaur District therefore this study is very important for future development of the shallot cultivation development center. Cawang Kidau irrigation area in Kaur District Bengkulu Province is one of the potential areabecause of available water in continuous supply for agricultural development. The Cawang Kidau irrigation area is potential not only for rice field, but also for horticulture especially for shallot cultivation center. This study is focused on the dose of chicken manure applied and to find the adapted shallot varieties planted on the marginal lowland soil.

Materials and methods

Cawang Kidau irrigation area, Kaur District, Bengkulu Province, comprises around 1,325.25 acres and is located between $103^0$13' – $103^0$16' E and $4^0$24' – $4^0$29' S at an elevation of 287 m above sea level. The experiment was carried out on a portion of the territory from August 2022 to January 2023.

Data for climatic conditions such as mean annual temperature were taken from BPS Statistics-Bengkulu (2022) and mean annual rainfall from Paski *et al*. (2017). The soil properties and soil qualities analyzed in the Soil Science Laboratory, Faculty of Agriculture, University of Bengkulu involving soil pH H_2O (1:5 soil: H_2O), pH KCl (1:5 soil: 1 M KCl) (Reeuwijk, 2002), total-N (semimicro Kjeldahl) (Lee *et al*., 2017), available P (P-Bray I, 0,03 M NH_4F + 0.025 M HCl) (Bray and Kurtz, 1945), and K (K_{exch}) (1 M NH_4OAc pH 7) (Hajek *et al.,* 1972).

The field experiment was factorial in a randomized complete block design (RCBD) with two factors replicated three times. The first factor was shallot variety consisting of 10 (ten) varieties, namely V1 = *Bima Brebes,* V2 = *Kuning,* V3 = *Kramat,* V4 = *TSS Agrihort 1,* V5 = *Violetta 2,* V6 = *Violetta 3 Agrihort,* V7 = *Trisula,* V8 = *Sembrani,* V9 = *Mja Cipanas, dan* V10 = *Mauji*. The second factor was doses of chicken manure involving of 5 (five) levels; M_0 = 0 ton ha^{-1}, M_1 = 10 tons ha^{-1}, M_2 = 20 tons ha^{-1}, M_3 = 30 tons ha^{-1}, and M_4 = 40 tons ha^{-1}. With 10 shallot varieties, 5 doses of the chicken manure, and 3 replications gave 150 experimental plots with each plot of 3 m^2 (1.5 m x 2 m) planted area. The spacing was 20 cm x 20 cm ensuring that each plot contained 75 shallot clumps. The distance between each plot was 50 cm and each block was 100 cm designed for drainage ditches. To avoid the border effect, the outermost plant row of each plot was excluded from sample selection, and 5 samples were gathered from each plot 10 days after planting.

Basal fertilizer was applied one day before planting with half of the recommended dose of 190 kg N ha^{-1}, 92 P_2O_5 ha^{-1}, 120 kg K ha^{-1} (Sumarni *et al*. 2012) and dolomite was applied 2 weeks before planting with a dose of 2 tons ha^{-1} (Figure 1). The field was watered continuously through water channel between the experiment blocks (Figure 2).

Figure 1. Soil liming with dolomite

Figure 2. Land preparation and watering

The planting media was mechanically protected from weed proliferation, pests, and diseases control using Curacron (2 cc l^{-1}), Dithane (2 g l^{-1}), and Score (2 cc l^{-1}) beginning 7 days after planting and ending 7 days before harvesting time with an interval of 1-2 times a week (Figure 3). The shallots were harvested based on physiological maturity criteria such as the leaves began to wilt, 70 – 80% of the leaves showing yellowish color, stem base hardens, some bulbs emerging from the ground media, and a layer of the bulbs emerging showing red color (Susilo, 2016).

Figure 3. The shallot growth performance

The shallot yield metrics are based on the performance of the bulbs, such as the diameter of the largest bulbs, the number of bulbs clump^{-1}, the fresh weight of the biggest bulbs, the fresh weight off bulbs clump^{-1}, the dry weight of bulbs clump^{-1}, and the dry weight of bulbs plot^{-1}. Projection of shallot yield in ton ha^{-1} followed the next equation:

Shallot bulbs (tons ha^{-1}) = (10,000 m^2 / m^2 of plot area) x bulbs harvested plot^{-1} (kg) x 80%

Statistical analysis

The data were analyzed using ANOVA at a 5% significance level, and treatment averages were compared using the Duncan Multiple Range Test (DMRT) (Gomez and Gomez, 1984) using CropStat 7.2 statistical software program.

Results

The maximum temperature in this area was 34.80 °C and the minimum temperature was 22.00 °C, with the mean temperature being around 28.7 ^{0}C, so this climatic condition was classified as medium suitable for shallot cultivation, whereas the average annual rainfall of 2,871 mm classified as unsuitable for the shallot cultivation. Because of some essential nutrients contained in this soil such as N-total 0.24%, 8.95 mg 100g^{-1} P_20_5, 0.74 cmol kg^{-1} K_2O classified as low available for shallot growth and soil pH (H_2O) 4.5 classified as acid condition, the soil characteristics in this area were classified as marginal suitable for shallot cultivation.

The variance analysis revealed there were interactions between the shallot varieties and the chicken manure applied on the number of bulbs clumps^{-1} and fresh weight of the biggest bulbs while both treatments; the shallot varieties and the chicken manure individually influenced significantly all attributes of the shallot yields (Table 1).

Table 1. Summary of F-calc. treatment of chicken manure on 10 shallot varieties on shallot yield

Attributes	F-calc.			CV (%)
	Varieties	Chicken Manure	Interaction	
Diameter of the biggest bulbs	13.43*	5.75*	1.35 ^{ns}	11.18
Number of bulbs clump^{-1}	29.36*	2.51*	2.09*	19.04
Fresh weight of the biggest bulbs	21.02*	5.33*	1.90*	16.37
Fresh weight of bulbs clump-1	6.13*	4.34*	0.99 ^{ns}	18.87
The dry weight of bulbs clump-1	4.28*	4.01*	The dry	20.63
The dry weight of bulbs plot-1	4.31*	4.05*	0.74 ^{ns}	20.51

Note: * = significantly different. ^{ns} = no significantly different. CV = coefficient of variance

The number of bulbs from 4 shallot varieties, namely, *Kramat, Violetta 2, Violetta 3 Agrihort 1*, and *Sembrani* were not significantly different when increasing doses of the chicken manure applied. *Bima Brebes* and *Crok Kuning* showed a significant decrease in bulb number as an increasing dose of the chicken manure at 40 tons ha^{-1} was added. In contrast, increasing the doses of manure applied up to 30 tons ha^{-1} on Trisula and Bauji planting media significantly increased the number of shallot bulbs (Table 2).

Table 2. Interaction between shallot varieties and chicken manure on the number of bulbs

Varieties	**Dose of chicken manure (tons ha^{-1})**				
	0	10	20	30	40
Bima Brebes	6.33 c AB	6.90 d A	6.69 de A	6.83 c A	5.14 f C
Crok Kuning	9.57 abc A	9.19 cd AB	9.24 cd AB	7.71 c AB	7.43 def B
Kramat	6.00 c A	6.52 d A	6.86 de A	5.76 c A	5.81 ef A
TSS Agrihort 1	11.33 ab B	14.67 a AB	11.67 abc B	16.00 a AB	17.67 a A
Violetta 2	13.67 a A	13.67 ab A	12.00 abc A	13.00 b A	10.00 cde A
Violetta 3 Agrihort 1	12.14 ab A	11.76 abc A	12.24 abc A	13.48 ab A	11.71 bcd A
Trisula	11.00 ab ABC	8.67 cd C	10.00 bc BC	14.33 ab AB	15.67 ab A
Sembrani	13.33 a A	10.81 bc A	13.67 a A	12.33 b A	13.76 abc A
Maja Cipanas	13.86 a AB	11.95 abc B	12.52 ab B	12.67 b B	15.33 ab A
Bauji	7.90 bc B	11.86 abc AB	9.60 bcd B	11.50 b AB	14.62 abc A

Note: No substantial change is indicated by a number followed by the same capital/small letter in the same line/column.

The fresh weights of the biggest bulbs from 3 shallot varieties, namely; *Sembrani, Maja Cipanas,* and *Crok Kuning* were not significantly different when increasing doses of the chicken manure applied. Fortunately, there were 7 varieties involved *Bima Brebes, Kramat, TSS Agrihort 1, Violetta 2, Violetta 3 Agrihort 1, Trisula,* and *Bauji* significantly increased in the fresh weights of the biggest bulbs when the increasing doses of the manure applied. *Bima Brebes and Violetta 3 Agrihort 1* showed the best yield performed by the fresh weights of the biggest bulbs at 10 tons' ha^{-1} of the chicken manure applied. Furthermore, *Bauji* started to respond significantly at 20 tons' ha^{-1} and increased significantly in the fresh weights of the biggest bulbs when the increasing doses of the manure were applied (Table 3).

Table 3. Interaction between shallot varieties and chicken manure on fresh weight of the biggest bulbs

Varieties	Dose of chicken manure (tons ha^{-1})				
	0	10	20	30	40
Bima Brebes	26.81 a B	28.19 bc A	28.19 cde A	28.57 bc A	28.19 bcd A
Crok Kuning	25.81 a A	25.19 cd A	27.19 de A	31.14 bc A	23.52 d A
Kramat	30.00 a B	38.57 a AB	52.86 a A	47.86 a A	44.05 a AB
TSS Agrihort 1	29.90 a B	30.67 b AB	31.43 bcd A	31.67 bc A	31.48 bc A
Violetta 2	29.71 a C	31.14 b BC	33.05 b AB	33.52 abc A	32.43 bc AB
Violetta 3 Agrihort 1	17.48 b C	21.71 d ABC	18.86 f BC	25.43 c AB	26.19 cd A
Trisula	30.71 a B	31.14 b AB	32.10 bc A	26.38 c C	32.43 bc A
Sembrani	23.67 ab A	27.10 bc A	27.62 cde A	42.48 ab A	27.05 bcd A
Maja Cipanas	24.52 a A	23.14 cd A	25.19 e A	20.19 c A	21.48 d A
Bauji	27.67 a D	28.57 bc CD	29.95 bcd C	31.95 bc B	34.00 b A

Note: No substantial change is indicated by a number followed by the same capital/small letter in the same line/volumn.

The two highest knol from all varieties planted were *Violetta 2* and *Kramat* however all varieties had good adaptability and growth well in the lowland area. The smallest bulbs were found of Maja Cipanas, 2.90 cm, and the lowest weight was given by *Violetta Agrihort 1*, 21.93 g but all were classified as a big knol (Table 4).

The shallot varieties grown on the irrigated marginal lowland in Bengkulu showed all varieties could be adapted to the lowland and the bulb yields from all varieties closed and some were much higher than the varieties description. The dry weights of shallot bulbs harvested were in the ranges of 16.183 – 23.228 tons ha^{-1} (Table 5).

Table 4. Dyent yields from various shallot varieties

Varieties	Diameter of biggest bulbs (cm)	Number of bulbs clumps^{-1}	Fresh weight of the biggest bulbs (g)	Fresh weight of bulb clump^{-1}	The dry weight of bulbs clump^{-1}
Bima Brebes	3.56 b	6.14 e	27.99 bc	141.10 b	98.48 cde
Crok Kuning	3.20 cd	8.63 d	26.57 c	127.97 b	86.10 e
Kramat	3.72 ab	6.19 e	32.67 a	142.00 b	93.62 de
TSS Agrihort 1	3.61 b	14.27 a	31.03 b	135.71 b	106.67 abcd
Violetta 2	3.95 a	12.47 bc	31.97 b	137.67 b	110.76 abcd
Violetta 3 Agrihort 1	2.86 e	12.27 bc	21.93 d	168.24 a	112.95 abc
Trisula	3.58 b	11.93 bc	30.55 b	134.69 b	103.22 bcde
Sembrani	3.14 de	12.78 ab	29.58 bc	164.66 a	120.38 ab
Maja Cipanas	2.90 e	13.27 a	22.90 d	180.86 a	123.62 a
Bauji	3.48 bc	11.10 bc	30.43 b	135.62 b	101.62 cde

Note: No substantial change is indicated by a number followed by the same small letter in the same column.

Table 5. The dry weight of bulbs in the plot, dry weight converted, and yield comparison to variety description

Varieties	The dry weight of bulbs (kgs plot^{-1})	Converted The dry weight of bulbs (tons ha^{-1})	Comparison to Variety Description (tons ha^{-1})
Bima Brebes	6.93580 cde	18.495	9,9
Crok Kuning	6.068.47 e	16.183	24.9 – 26.6
Kramat	6.601.73 de	17.605	9 – 20
TSS Agrihort 1	7.495.67 abcd	19.989	20.04
Violetta 2	7.780.20 abcd	20.747	13.56 – 19.09
Violetta 3 Agrihort 1	7.961.87 abc	21.232	13.59 – 17.30
Trisula	7.256.80 bcde	19.351	6.50 – 23.21
Sembrani	8.470.93 ab	22,589	9.0 – 24.4
Maja Cipanas	8.710.67 a	23.228	10.9
Bauji	7.147.27 cde	19.059	13 – 14

The numbers of a column followed by the same lowercase letter are not significantly different in the 5% F level test

The optimum dose of the chicken manure applied was 20 tons ha^{-1} for almost attributes of the shallot yields, and the increase of the manure applied above the 20 tons' ha^{-1} was not significantly followed by the yield of shallot bulbs anymore (Table 6). The 20 tons ha of the chicken manure added gave 20.996 tons ha for the dry weight of the shallot bulbs.

Table 6. Effect of chicken manure on shallot yield

Dose of chicken manure (ton ha^{-1})	Diameter of bulbs (cm)	Number of bulbs clump^{-1}	Fresh weight of the biggest bulbs (g)	Fresh weight of bulbs clump^{-1}	The dry weight of bulbs clump^{-1}	The dry weight of bulbs plot^{-1}
0	3.22 b	10.51 b	26.63 c	133.16 b	94.90 c	6.681.57 c
10	3.24 b	10.60 ab	28.54 bc	137.91 b	99.86 bc	7.028.03bc
20	3.61 a	10.33 b	30.64 ab	155.28 a	111.86 a	7.873.40 a
30	3.48 a	11.36 ab	31.92 a	152.37 a	108.95 ab	7.670.10 ab
40	3.46 a	11.71 a	30.08 ab	155.53 a	113.13 a	7.961.60 a

The optimum dose of the chicken manure applied was 20 tons' ha^{-1} for almost attributes of the shallot yields, and the increase of the manure applied above the 20 tons' ha^{-1} was not significantly followed by the yield of shallot bulbs anymore (Table 6). The 20 tons ha of the chicken manure added gave 20.996 tons ha for the dry weight of the shallot bulbs.

Discussion

The research area is categorized as unsuitable for shallot cultivation due to the annual rainfall is too high. The shallot would grow optimal at mean annual rainfall 1,000 – 1,400 mm yr-1 while the mean annual rainfall >2,500 mm yr^{-1} is permanently unsuitable for shallot cultivation (Wahyunto *et al.,* 2016). The obstacle of planting shallots in the high rainfall area especially in the rainy season was the risk of diseases. Shallot cultivations in South Kalimantan were attacked by diseases with symptoms of Moler caused by *Fusarium oxysporum* fungi and Anthracnose caused by *Colletotrichum* sp., fungi (Safitri *et al.,* 2019). In this experiment, improvement efforts to overcome high rainfall for suitable shallot cultivation was using plastic shade. Also, overcoming the high water available in the planting media because of too high rainfall, between blocks of the experiment was made drainage ditches to discharge the water holding capacities. The use of shade and making drainage ditch could maintain soil temperature and humidity for preventing the occurrence of soil-borne diseases (Rahayu *et al.,* 2018).

The soil qualities in this area were classified as a marginal suitable for shallot cultivation. Previous study showed this area classified as the marginal suitable for shallot growth with soil determinants involved soil erosion hazard, nutrient availability, and nutrient retention (Rahman *et al*., 2022). Therefore, the improvements in the soil fertility were needed through additions of compounded NPK fertilizer, dolomite, and farmyard manure. Shallot growth requires sufficient and balanced amounts of macronutrients such as N, P, and K to boost productivity and quality in yields or bulbs (Suwandi *et al.,* 2017). N is a vital nutrient for the formation and physiological activities of nucleic acids, proteins, bio-enzymes, and chlorophyll, and the physiological processes have a considerable impact on bulb output and quality (Barker and Pilbeam, 2015). Furthermore, P is identified in the process of root growth as a builder of nucleic acids, phosphorus-lipids, bio- enzymes, proteins, and metabolic chemicals as part of the crucial ATP in energy transmission. K is the third macroelement, and it is important for maintaining plant water balance and cell turgor pressure, controlling the closing and opening of plant stomata, and regulating the accumulation and transport of newly created carbohydrates (Sing and Verma, 2001).

Shallot yield was lower in acidic soils and amended the marginal soils with lime materials increased shallot growth and yields (Sopha *et al*., 2021). Furthermore, the harvested shallot bulbs rose because the lime supplied improved soil pH and Ca^{2+} concentration while decreasing exchangeable Al^{3+}. A dolomite treatment of 1.5 tons ha^{-1} four weeks before planting resulted in a considerably greater quantity and weight of bulbs per clump (Tanari *et al*., 2018). Liming with dolomite showed a significant effect on bulb harvested (Jayanti and Tanari, 2021).

To ameliorate the marginal soils, the chicken manure applied on soils with low soil pH could release P fixed on colloid cations in the acidic soil, therefore, P available for plant growth increase (Emshher *et al.,* 2022). Furthermore, the manure could amend the soil physical, chemical, and biological qualities of the sub-optimal soil, improved the soil nutrients availability, provided high water holding capacity, and could alleviate the toxic nature elements contained in the ultisol soils. Chemical characteristics of the chicken manure were pH (1:5 H_2O) 7.70, EC (1:5 H_2O) 8.15 dS m^{-1}, organic matter 559.30 g kg^{-1}, total N 29.30 g kg^{-1}, total P 43.20 g kg^{-1}, total K 38.80 g kg^{-1}, total Ca 47.50 g kg^{-1}, and total Mg 36.20 g kg^{-1} (Thepsilvisut *et al*., 2022). Different from inorganic fertilizers content, some organic acids such as humic acid, fulvic acid, hormones, and enzymes are very useful both for plants and the environment, and microorganisms could be obtained in the farm yard manure (Atmaja *et al.,* 2019).

Based on Table 2, the application of the manure up to 30 tons ha^{-1} on *Trisula* and *Bauji* planting media significantly increased the number of shallot bulbs. Similar research in Muna District Southeast Sulawesi showed the best treatment for the dose of farmyard manure on the growth and production of shallots with the application of 30 tons ha^{-1} giving the average yield of 20.33 tons ha^{-1} (Feriatin *et al.,* 2021). Furthermore, *Bima Brebes and Violetta 3 Agrihort 1* showed the best yield performed by the fresh weights of the biggest bulbs at 10 tons' ha^{-1} of the chicken manure applied. The best yield was obtained from the application of 10 tons ha^{-1} of chicken manure (Hartatik and Saputri, 2023) and significant effects on the number of tubers per clump, the wet weight of tubers per clump, the wet weight of tubers per plot, dry weight of the tuber per hill, and the dry weight of sunbeds per plot (Pradana and Machfudz, 2020). Generally, using 10 tons ha^{-1} of the poultry manure had a superior effect on proximate composition and most of growth parameters and yield components achieved the highest nutrient concentrations and uptake on most of the macro and micronutrients in leaves and bulbs as compared with the control (Falodun and Egharevba, 2018). While *The Kramat, TSS Agrohort 1, Violetta 2,* and *Trisula* showed the best yield at 20 tons ha^{-1} of the manure added. The best tuber yield was obtained on sub-optimal dryland in West Nusa Tenggara treated with 20 tons ha^{-1} of manure (Mulyati *et al*., 2022).

All shallot varieties are classified as big knol shallot varieties. Shallot bulbs were categorized as a big bulb having diameter > 1,8 cm or weight > 10 g, medium bulbs with diameter 1,5 – 1,8 cm or weight bulbs 5-10 g, and small bulbs with diameter < 1,5 cm or weight of < 5 g) (Sumarni and Hidayat 2005). The dry weights of shallot bulbs harvested were in the ranges of 16.183 – 23.228 tons ha^{-1}**.** These yields closed to the previous research conducted on lowland Central Kalimantan for *Bima Brebes, Maja Cipanas,* and *Bauji* cultivar gave 13.31, 18.48, 22.40 tons ha^{-1}, respectively (Firmansyah and Bhermana, 2019). *Bima Brebes* was suitable and adaptive planted on dry lowland ecoregion of Pesisir Selatan District, West Sumatera (Andraini *et al.,* 2021), Karang Anyar District, Central Java (Triharyanto *et al*., 2018), and *Bima Brebes* and *Trisula* was suitable growth in Gowa, South Sulawesi (Idhan *et al*., 2015). *Bauji* well grown and yielded in Jember, East Java (Siswadi *et al.,* 2022) could produce 18 tons ha^{-1} (Kurniasari *et al*., 2021).

The highest dry bulb yield was obtained at a dosage of 15 - 25 tons ha^{-1} of manure (Atman *et al.*, 2022). Furthermore, to make farming activities more efficient, it was recommended to use 15 tons' ha^{-1} of cow manure. Application of the 15 tons' ha^{-1} chicken manure gave the best onion bulb weight *(*Buhaira *et al.*, 2022). A 15 tons ha^{-1} application of chicken manure resulted in shallot growth with a greater bulb neck diameter, bulb diameter, and higher bulb dry weight (Erkalo *et al.,* 2022). Performances of shallot dry tuber weight and dry plant weight were significantly increased with the organic fertilizer added at 15 tons ha^{-1} when the application of the organic fertilizer was at 15 tons ha^{-1} (Warman *et al*., 2022). The application of 10 tons ha^{-1} chicken manure influenced shallot development on leaf length, root-shoot ratio, relative growth rate, bulb fresh weight, and bulb dry weight in the lowland (Susilawati *et al.*, 2022). The maximum yield was obtained by applying 20 tons ha^{-1} of chicken manure to cutting onion seed bulbs (Aminah *et al.,* 2022). Using chicken manure to low-input shallot production systems may boost soil fertility and productivity.

In short, when the arable lands in high altitude areas are limited, vast areas in the lowlands distributed in all islands in Indonesia could be developed as shallot cultivation areas. Some soil characteristics determining shallot cultivation could be overcome through soil amelioration with both organic fertilizers and inorganic fertilizers. Faced with unsuitable agro-climatic conditions such as too much rainfall, farmers should construct plastic shade or should adjust planting time during the closed dry season.

All shallot varieties: *Bima Brebes, Crok Kuning, Kramat, TSS Agrihort 1, Violetta 2, Violetta 3 Agrihort 1, Trisula, Sembrani, Maja Cipanas*, and *Bauji* were adaptably grown on the Cawang Kidau irrigation area Kaur District Bengkulu Province. There were 7 varieties involved *Bima Brebes, Kramat, TSS Agrihort 1, Violetta 2, Violetta 3 Agrihort 1, Trisula,* and *Bauji* significantly responded to the increasing doses of the manure applied. *Bima Brebes and Violetta 3 Agrihort 1* showed the best yield performed by the shallot yields at 10 tons' ha^{-1} of the chicken manure applied while *Kramat, TSS Agrohort 1, Violetta 2,* and *Trisula* showed the best yield at 20 tons' ha^{-1} of the manure added. Furthermore, *Bauji* started to respond significantly at 20 tons' ha^{-1} and increased significantly the yields when the increasing doses of the manure were applied. The highest yields of the shallot bulbs grown on the irrigated marginal lowland in this area when the chicken manure was applied were 20 tons' ha^{-1} which gave 20.996 tons' ha^{-1} for the dry weight of the shallot bulbs.

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