



Yield Performance of Three Sulawesi Local Aromatic Upland Rice Varieties at Various Planting Spacing Distance with Alley Cropping System

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Authors' contributions

This work was carried out in collaboration among all authors. Author MK designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors RA and SC managed the analyses of the study. Author SC managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was carried out to examine the production performance of 3 local Sulawesi aromatic upland rice varieties planted with the alley cropping system at various planting distances pattern in Sampano Village, South Larompong District, Luwu Regency, South Sulawesi from February to June 2022. Plant spacing and selection of more adaptive varieties was one aspect for testing. The plants were laid out in a Split Plots Design in a factorial Randomized Completely Block Design. The main plots were 3 local varieties of Ngapa, Sassa, and Latimojong. Subplots were planting spacing consisting of random spacing (spread), 25 cm x 25 cm, 20 cm x 20 cm, and 15 cm x 15 cm. The results showed that 15 cm x 15 cm was the best spacing for planting local aromatic

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upland rice varieties in the alley cropping system which produced 1,433.24 kg dry grain weight per hectare, while Ngappa variety outperformed Sassa and Latimojong by registering 1,350 kg/ha.

Keywords: Upland rice; aromatic; planting distance; local varieties.

1. INTRODUCTION

Upland rice is a rice variety that can grow and develop well on land that has limited water, sloping, or other environmental conditions that do not support rice/paddy farming. By developing upland rice, farmers can utilize previously unproductive lands for rice cultivation, in the sense that the utilization of sub-optimal land can be done without disturbing the cultivation of paddy rice. Upland rice is also a source of hope to support the sustainability of rice production to maintain food security, especially in areas experiencing low rainfall because one of the characteristics of upland rice is its resistance to drought stress. Indonesia is rich in various local upland rice varieties in several regions including in the South Sulawesi region, in Luwu district where farmers cultivate several aromatic upland rice varieties including Ngappa, Sassa and Latimojong [1]. Local aromatic upland rice generally has a strong root system and is able to withstand water shortages for a longer period of time compared to rice paddy varieties. This allows farmers to continue producing rice despite the long dry season. The weakness of local aromatic upland rice is that it is generally long-lived and less responsive to fertilization, and has lower productivity compared to other rice varieties so that appropriate cultivation technology needs to be applied in the process of plant growth and yield, especially if planting in an alley cropping system.

The cultivation of aromatic upland rice of local Sulawesi varieties carried out with Alley Cropping system still needs to be studied, especially on aspects of appropriate cultivation techniques such as the selection of varieties and proper plant spacing arrangements so that the resulting production becomes more optimal. Alley cropping is a type of sustainable agriculture that aims to find substitutes for monoculture rice farming, which is a significant problem in contemporary agriculture because it is thought to be endangering the sustainability of agricultural production due to its high reliance on chemical inputs.

Planting distances is one of the factors that determine the high yield in rice production.

Planting distance is influenced by the morphologymorfology of rice varieties and soil fertility. Rice varieties that have the ability to produce high tillers require a wider planting distance when compared to varieties with lower tillering potential. Yield data on overall upland rice production in Indonesia is still low, which averages only 3.091 tons/ha for monoculture plantings, much lower than the productivity of paddy rice which reaches 5,179 tons/ha [2].

The importance of evaluating local aromatic rice varieties will encourage rice production on sub-optimal lands in the future. The spacing aspect of local aromatic upland rice in the alley cultivation system is expected to increase the efficiency of absorption of solar intensity for the photosynthesis process so that plant production can be optimized [3]. Cahyani AR, Suryanto A [3] has suggested that to reduce competition and maximize yields in plants grown under tree stands (*Alley Cropping*) can be done several ways including setting the number of populations (spacing). In addition, the relationship between cultivation aspects and the genetic characteristics of plant varieties has a close relationship. One variety with certain genetic traits can adapt to certain planting distances in different cropping systems. This study aimed to examine the production performance of 3 local Sulawesi aromatic upland rice varieties planted with the alley cropping system at various planting distances pattern.

2. MATERIALS AND METHODS

The research was conducted in Sampano Village, South Larompong Sub-district, Luwu District, South Sulawesi for 5 months (February to June 2022) using seeds from 3 local brown upland rice varieties from Luwu district, South Sulawesi namely; Ngappa, Sassa and Latimojong. The research was laid out in a Split Plots Design (SPD) arranged in a Factorial Completely Randomized Block Design (RCBD) of 2 factors each as the Main Plot (PU) Local varieties of aromatic upland rice. As Subsidiary Plots (AP) was the planting distance (J) consisting of random spacing (Spread). The number of seeds spread was adjusted to a

spacing of 25 cm x 25 cm, 20 cm x 20 cm and 15 cm x 15 cm. Agronomic data of the generative phase related to crop production was carried out destructively, namely calculating by taking 3 sample plants from each treatment. The parameters observed were number of panicles per clump, number of grains per panicle, grain weight per clump (g), percentage of hulled grain per clump (%) and grain weight per hectare (kg/ha). Data collected were subjected to statistical analysis (ANOVA), using Statistical Tools for Agricultural Research (STAR) by IRRI software version 2.0.1). Significant means were separated using LSD test.

3. RESULTS AND DISCUSSION

3.1 Growth and Yield Parameters

The results in Table 1 showed significant differences in the number of panicles per clump,

grains per panicle, and the percentage of empty grains against the varieties planted and the spacing also significantly affected the number of grains per panicle, grain weight per clump, and the percentage of empty grains (Table 2). The LSD (0.05) test results showed that the Sassa variety had the highest average number of panicles per clump (6.44) significantly different from the Ngappa and Latimojong varieties, but the Sassa variety had fewer grains per panicle (83.31) significantly different from the Ngappa and Latimojong varieties. The percentage of empty grains of the Ngappa and Sassa.

Based on the planting distance and its effect on plants, it showed that spacing of 15 cm x 15 cm has a large number of grains per panicle and grain weight per clump compared to the spacing of 25 cm x 25 cm and 20 x 20 cm which recorded a lower percentage of empty grain (2.22 and 2.65%) respectively (Table 2).

Table 1. Number of panicles, grain, grain weight per clump, and percentage of empty-grain in 3 local aromatic upland rice varieties in Alley Cropping system

Rice variety	Number of panicles per clump	Number of grain per panicle	Grain weight per clump	Percentage of empty-grain
Ngappa	4.72 ^b	94.24 ^a	14.66 ^a	3.57 ^b
Sassa	6.44 ^a	83.31 ^b	14.49 ^a	3.23 ^b
Latimojong	4.48 ^b	95.57 ^a	13.82 ^a	4.34 ^a

Notes: Mean numbers followed by different letters mean significantly different in the LSD (0.05) test

Table 2. Number of panicles per clump, grains per panicle, grain weight per clump, and percentage of empty grains in local aromatic upland rice at various spacing pattern in alley cropping system

Planting Distance Pattern	Number of panicles per clump	Number of grain per panicle	Grain weight per clump	Percentage of empty-grain
Random (Spread Out)	5.17 ^a	74.66 ^b	9.4 ^b	5.56 ^a
25 cm x 25 cm	5.44 ^a	82.59 ^b	12.55 ^b	4.42 ^b
20 cm x 20 cm	5.28 ^a	99.14 ^a	16.65 ^a	2.65 ^c
15 cm x 15 cm	4.97 ^a	107.77 ^a	18.7 ^a	2.22 ^c

Notes: Mean numbers followed by different letters mean significantly different in the LSD (0.05) test

3.2 Variety and Spacing Differences

Differences in varieties and spacing have a significant effect on rice production (dry grain per hectare), but there was no interaction effect of both on production. Figs. 1 and 2 shows the rice yield or weight of dry grain per hectare based on rice varieties and based on planting distance pattern where Ngappa and Latimojong varieties have better average yield while the best planting distance that gives the highest yield is 15 cm x 15 cm spacing.

Differences in spacing and rice varieties can have a significant effect on yield and plant growth in monoculture cropping systems as well as in intercropping or alley cropping systems in between annual crops. The ideal plant distances pattern is when the plant's need for environmental conditions (light, humidity, air aeration and rooting) can be fulfilled so as to affect the rate of photosynthesis and the rate of net assimilation of plants. Plant distances affect root development which could affect plant growth and production. Plant spacing that is too tight could inhibit plant growth due to competition for

resources such as water, nutrients and sunlight. Fischer et al. [4]. Kadir M et al. [1] reported that through proper plant distances, the level of competition between and among plants can be minimized as much as possible. The findings are similar to Dejen [5] who reported that planting distance and population density play an important role, so that plants can utilize solar radiation more effectively and efficiently. Too wide a spacing can make the plants too spread out thus affecting the use of resources and overall plant growth. The results in the random spacing (spread out) were not appropriate while the 15 cm x 15 cm spacing outperformed the others while in terms of variety selection for alley cropping, Ngappa and Latimojong varieties were more responsive. The results are in conformity with the findings of Anwari et al. [6] who reported that the planting distance had a significant effect on the number of tillers, the number of filled grains per panicle, and the number of grains per panicle. Different rice varieties have different yield potentials and can produce more grain per hectare compared to others under different cropping conditions [7-13].

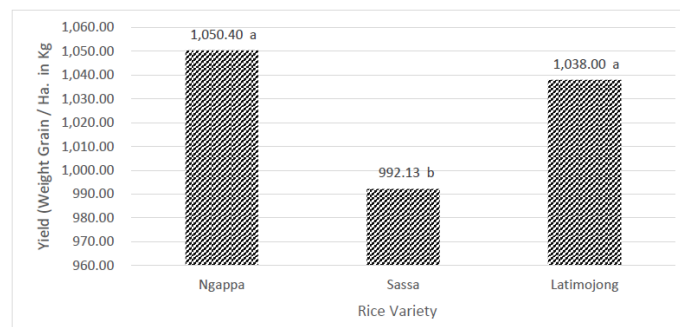


Fig. 1. Dry weight-grain of local aromatic rice planted in Alley Cropping system by different variety

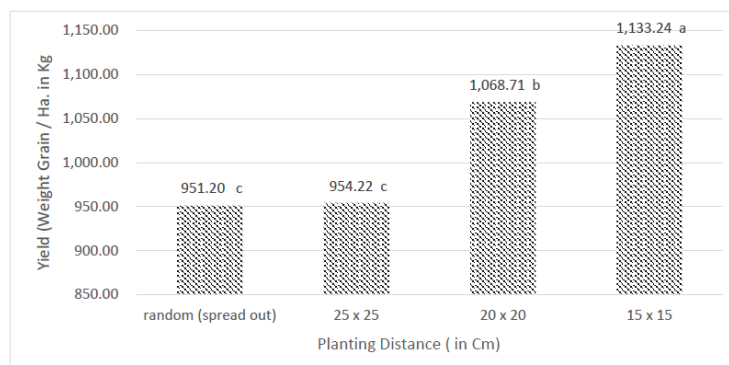


Fig. 2. Dry weight-grain of local aromatic rice planted in Alley Cropping system by different planting distance pattern

4. CONCLUSION

The best spacing for planting local aromatic upland rice varieties in the alley cropping system was 15 cm x 15 cm which produced the highest dry grain weight per hectare with an average of 1,433.24 Kg/Ha, while Ngappa variety outperformed the others in production with an average of 1,350 Kg/ha.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kadir M, Aty R, Syamsia. Growth and production analysis of local aromatic upland rice with rice straw compost application in alley cropping system and monoculture. *Journal of Agros Agriculture (Indonesia)*. 2023;25(2):1751-1759.
2. Santoso AB, Supriana T, Girsang MA. Effect of Rainfall on Upland Rice Production in Indonesia. *Indonesian Journal of Agricultural Sciences (Indonesia)*. 2022;27(4):606-613.
3. Cahyani AR, Suryanto A. Pengaturan Waktu Tanam dan Jumlah Bibit Tanaman Padi Gogo (*Oryza sativa* L.) Pada Pola Tanam Tumpangsari Dengan Tanaman Ubi Kayu (*Manihot esculenta*). *Jurnal Produksi Tanaman*. 2018;6(7): 1219-26..
4. Fischer RA, Ramos OM, Monasterio IO, Sayre KD. Yield response to plant density, row spacing and raised beds in low latitude spring wheat with ample soil resources: an update. *Field crops research*. 2019;232: 95-105.
5. Dejen T. Effect of Plant Spacing and Number of Seedlings per Hill to Transplanted Rice (*Oryza Sativa* X *Oryza Glaberrima*) under Irrigation in Middle Awash, Ethiopia. *Journal of Applied Life Sciences International*. 2018;17(4): 1-9.
6. Anwari G, Moussa AA, Wahidi AB, Mandozai A, Nasar J, Abd El-Rahim MGM. Effects Of Planting Distance On Yield And Agro-Morphological Characteristics Of Local Rice (Bara Variety) In Northeast Afghanistan. *Current Agriculture Research Journal*. 2019;7(3):350.
7. Garba AA, Mahmoud BA, Adamu Y, Ibrahim U. Effect of Variety, Seed Rate And Row Spacing On The Growth And Yield Of Rice In Bauchi, Nigeria. *African Journal of Food, Agriculture, Nutrition and Development*. 2013;13(4):8155-8166.
8. Suryanto RA. Planting Time and Number of Seedlings of Upland Rice (*Oryza Sativa* L.) in Intercropping Pattern with Cassava (*Manihot esculenta*). *Journal of Crop Production (Indonesia)*. Effect of Plant Spacing and Number of Seedlings Per Hill Totransplanted Rice (*Oryza Sativa* X *Oryza glaberrima*) Under Irrigation In Middle Awash, Ethiopia. *Journal of Applied Life Sciences International*. 2018: 1- 9.
9. Sayre KD. Yield Response To Plant Density, Row Spacing And Raised Beds In Low Latitude Spring Wheat With Ample Soil Resources: An Update. *Field Crops Research*; 2019.
10. Mousavi SR, Eskandari H. A General Overview On Intercropping And Its Advantages In Sustainable Agriculture, *J. Appl. Environ. Biol. Sci.* 2011;1(11): 482–486.
11. Moro B, Nuhu I, Martin E. Effect Of Spacing On Grain Yield And Yield Attributes Of Three Rice (*Oryza Sativa* L.) Varieties Grown In Rain-Fed Lowland Ecosystem In Ghana. *Int. J. Plant Soil Sci.* 2016;9(3):1-10.
12. Uddin M, Hasan M, Ahmed S, Hasan M. Effect of Spacing on Morpho-Physiological Response of Different T. Aman Rice Cultivars Under Coastal High Land Ecosystem. *Indian Journal of Agricultural Research*. 2010;44(4).

13. Haque M, Razzaque A, Haque A, Ullah M. Effect of Plant Spacing and Nitrogen On Yield of Transplant Aman Rice Var. Brrri Dhan 52. *Journal of Bioscience and Agriculture Research*. 2012;4(02):52-59.

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