International Journal of Life Science and Agriculture Research
ISSN (Print): 2833-2091, ISSN (Online): 2833-2105
Volume 04 Issue 02 Febraury 2025
DOI: https://doi.org/10.55677/ijlsar/V04I02Y2025-06
Impact Factor: 7.88 , Page No : 93-98

Effect of Cover-cropping with Arachis Species on Growth and Yield of Several Upland Rice Varieties in Labulia Dryland of Central Lombok, Indonesia

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ABSTRACT: In areas with available irrigation water, rice is generally cultivated in monoculture and continuously rice after rice, which results in decreased soil quality and rice yields. This study aimed to examine the effect of cover-cropping with the legume species *Arachis* on growth and yield of several upland rice varieties. The experiment was conducted during the rainy season, on a farmer's field in Labulia Village, Central Lombok (Indonesia), from January to April 2024, arranged in a factorial randomized block design, with three blocks and two treatment factors, namely type of cover crops (T0: no cover crop, T1: *Arachis hypogaea* (peanut), T2: *Arachis pintoi*), and type of upland rice (V1: red rice, V2: black rice, V3: white rice). Those species of *Arachis* were grown between rows of the rice plants. Observation variables include growth and yield components. Data were analyzed with analysis of variance (ANOVA) and Tukey's HSD using CoStat for Windows. The results showed that cover-cropping had a significant effect on growth (plant height and number of tillers), grain yield, and yield components of the upland rice plants, with the highest average of rice grain yield (57.84 g/clump) was obtained from the plots planted with the cover crop *A. hypogaea* (peanut), while among types of upland rice, the highest average of grain yield was in the red rice (52.22 g/clump). It can be concluded that growing upland rice on raised-beds planted with cover crops from the species of *Arachis* can help increase grain yield of upland rice plants in dry land.

KEYWORDS: intercropping; upland rice; *Arachis*; cover crops; peanut

Published Online:
February 11, 2025

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1. INTRODUCTION

Rice is a semi-aquatic plant that can grow and develop in both flooded and non-flooded conditions. This plant has been widely developed throughout the world, including Indonesia, because of the use of the grains as the main source of staple food. Around 95% of Indonesians use rice as their staple food [1]. Currently, the need for rice continues to increase along with the increasing population, so land intensification must be carried out [2]. However, rice development in Indonesia has various obstacles, one of which is the conventional or monoculture planting and low soil fertility, which has an impact on decreasing grain yield and suboptimal growth of the rice plants in irrigated areas [3].

An effort to increase productivity of various food crops and restore soil fertility can be done through the use of legume plants, either as green manure, rotation crops, intercrops or cover crops. Legume plants that are used as cover crops can function as conservation crops so that they can maintain soil stability in the long term, especially in dry land [4] The use of legume cover crops from the species of *Arachis* can increase rice yields under aerobic irrigation systems [5, 6]. *Arachis hypogea* and *Arachis pintoi* which are grouped as legume crops can have a positive impact on the productivity of food crops through crop rotation and intercropping because they can provide nitrogen nutrients to increase soil fertility [7].

Legume cover crops from the species of *Arachis* have the ability to fix nitrogen from the atmosphere through establishment of symbiosis with *Rhizobium* bacteria that live in the root nodules of legume plants. In addition, the presence of *Rhizobium* bacteria can maintain soil health. A healthy soil rhizosphere will be inhabited by beneficial organisms by utilizing organic substrates from plant root exudates as a source of energy and nutrients [8, 9]. Legume plants intercropped with red rice plants can increase rice yields [10], and can reduce ground water evaporation and maintain and increase soil organic matter content due to the decomposition of cover crop litter or the use of the cover crops as living mulch or green manures [11].

This study aimed to examine the effects of planting legume cover crops from the species of *Arachis* between rows of rice plants on growth and yield of several varieties of upland rice grown on dry land in Labulia village of West Lombok, Indonesia.

II. MATERIALS AND METHODS

The field experiment in this study was conducted during the rainy season, on a farmer's land in Labulia Village, Jonggat District, Central Lombok Regency, West Nusa Tenggara Province, Indonesia, which started in January and harvested in April 2024. The experiment was arranged based on a factorial Randomized Block Design with two treatment factors, namely the type of legume cover crops (T0 = without application of cover crops; T1: *Arachis hypogaea* (Bison variety of peanut); T2 = *Arachis pintoi*) and upland rice varieties (V1 = red rice variety of "Inpago Unram-1"; V2 = black rice variety of "Baas Selem"; V3 = white rice variety of "Situ Patenggang"). From the two treatment factors, nine treatment combinations were obtained, each of which was made in three blocks (as replications), so that there were 27 experimental units.

Planting of the cover crops was carried out 14 days before seeding the pre-germinated rice seeds. Preparation of cover crops began with planting *A. pintoi* cuttings in small polybags before using them as cover crops in this experiment. Cover crops were planted by dibbling peanut seeds and *A. pintoi* seedlings planted at a planting distance of 25 x 20 cm on the treatment plot. Rice planting was carried out by dibbling pre-germinated rice seeds at a distance of 25 cm x 20 cm, between rows of cover crops. The first fertilization was carried out after the rice plants were 7 days after seeding (DAS) with Phonska fertilizer (NPK 15-15-15) 1.2 g/clump, while the second fertilization was carried out when the rice plants were 35 DAS old with Urea fertilizer (0.5 g/clump), by dibbling the fertilizer 7 cm next to the base of the rice plants. Thinning and replanting of rice plants were carried out at the age of 14 DAS, by allowing only 3 seedlings to grow per planting hole. The cover crops were not fertilized.

The observation variables include growth variables (plant height, number of tillers per clump, and number of leaves per clump at the age of 56 DAS, straw dry weight, and average growth rate (AGR) by calculating the average increase in growth per day from the difference between measurements at the ages of 56 and 14 DAS), and yield components (number of panicles per clump, panicle length, number of filled grains per panicle, percentage of unfilled grain number, weight of 100 grains, grain yield per clump, and harvest index). Data were analyzed with ANOVA (analysis of variance) and Tukey's HSD using the statistical program "Costat for Windows ver. 6.303".

III. RESULTS

Based on the summary of ANOVA results (Table 1), the cover crop factor (T) significantly affected the height of the rice plant at 56 DAS, AGR of plant height, number of panicles, panicle length, number of filled grains per panicle, weight of 100 filled grains, grain yield per clump, percentage of unfilled grain number, and harvest index, while the rice variety factor (V) significantly affected the number of tillers at 56 DAS, number of leaves at 56 DAS, panicle length, number of filled grains per panicle, and weight of 100 filled grains. In terms of growth parameters, however, there was an interaction effect between the types of cover crops and the varieties of upland rice grown with or without cover crops, but it was significant only on the number of rice tillers at 56 DAS, and the patterns of the interaction effect are shown in Table 3.

In terms of the main effects, among the growth parameters of the upland rice (Table 2), the average values of plant height of rice at the age of 56 DAS and the AGR of plant height were highest in rice plants grown without cover crops (T0). The high growth rate of plant height of various rice varieties that were grown without cover crops is thought to be due to the fact that during the vegetative growth phase the rice plants did not experience competition from cover crops so that their growth was more optimal without cover crops. On the other hand, the number of leaves and the number of tillers at the age of 56 DAS were highest on rice plants grown on the raised-beds planted with the cover crop *A. pintoi* (T3). However, among the rice varieties tested, the significant differences among them were only in the number of tillers and the number of leaves at the age of 56 DAS, in which the highest average was on the red rice (V1).

However, the number of tillers per hill at the age of 56 DAS showed an interaction effect between the type of ground cover plant and rice varieties (Table 3), which showed different responses between rice varieties to the type of cover crop planted. When planted without cover crop (T0), the highest average number of tillers was in red rice variety Inpago Unram-1 (V1), but in beds with the cover crop *A. pintoi* (T3), the highest average number of tillers was in black rice variety Baas Selem (V2), while in beds planted with peanut cover crop, there was no difference in the number of tillers between upland rice varieties (Table 3).

Table 1. Summary of ANOVA results for all measurement variables

Observation Variables	Sumber Keragaman		
	Cover crop (T)	**Varieties (V)**	**T*V**
Plant height at 56 DAS	S	NS	NS
Tiller number at 56 DAS	NS	S	S
Leaf number at 56 DAS	NS	S	NS
Average growth rate (AGR) of plant height	S	NS	NS
AGR of tiller number	NS	NS	NS
AGR of leaf number	NS	NS	NS
Dry straw weight	NS	NS	NS
Panicle number per clump	S	NS	NS
Panicle length	S	S	NS
Filled grain number per panicle	S	S	NS
Weight of 100 filled grains	S	S	NS
Percentage of unfilled grain number	S	NS	NS
Grain yield per clump	S	S	NS
Harvest index	S	NS	NS

Table 2. The effects of cover cropping and upland rice varieties on growth related variables of the upland rice plants

Treatments	Plant height at 56 DAS (cm)		Tiller number at 56 DAS		Leaf number at 56 DAS		AGR plant height (cm/day)		AGR tiller number per day		AGR leaf number per day		Weight of dry straw (g)	
T0: no cover crop	113.43	a	39.83	b	127.47	a	1.77	a	0.58	a	2.11	a	34.14	a
T1: *A. hypogaea*	97.64	b	37.63	b	118.38	a	1.40	b	0.68	a	2.27	a	35.37	a
T2: *A. pintoi*	108.28	ab	48.67	a	135.50	a	1.66	ab	0.73	a	2.27	a	34.97	a
Tukey's HSD	14.73		6.47		-		0.34		-		-		-	
V1: red rice	105.87	a	46.52	a	145.07	a	1.58	a	0.70	a	2.48	a	35.52	a
V2: black rice	106.39	a	41.58	ab	121.50	ab	1.62	a	0.68	a	2.11	a	35.19	a
V3: white rice	107.10	a	38.03	b	114.78	b	1.64	a	0.61	a	2.06	a	33.77	a
Tukey's HSD	-		6.47		25.03		-		-		-		-	

[1)] Mean values followed by the same letter are not significantly different between treatments of each factor

Table 3. The patterns of interaction effects between the types of cover crops and varieties of the upland rice on their tiller number per clump at 56 DAS

Treatments of crover cropping	V1: Red rice		V2: Black rice		V3: white rice	
T0: no cover crop	47,66	a	35,75	b	36,08	b
T1: Arachis hypogaea	40,64	ab	31,41	b	40,83	b
T2: Arachis pintoi	51,25	a	57,58	a	37,16	b
Tukey's HSD 5%			11,22			

[1)] Mean values followed by the same letters in each row or each column are not significantly different between types of cover crops or varieties of the upland rice

In relation to the yield components of the upland rice, there was no interaction effect between the treatment factors (Table 1). Based on the main effects, between the two treatment factors, the types of cover crops show significant effects on all yield components measured, with the highest mean values are on upland rice grown with peanut cover crops, which include panicle number per clump, panicle length, filled grain number per clump, grain yield per clump and harvest index, but the weight of 100 grains is highest on the rice plants grown with the cover crop *A. pintoi*, while the highest percentage of unfilled grain number is on the rice plants without cover crops (Table 4), which means that without cover crops, the percentage of unfilled grain number will be higher compared with growing upland rice with cover crops of legume types. These all indicate the positive effects of growing upland rice together with cover crops of legume species, which in this study include peanut (*A. hypogaea*) and *A. pintoi*. These are contrast with growth parameters, especially those related to plant height of the upland rice, in which plant height during the peak of vegetative growth (56 DAS) and the AGR of plant height were highest on the upland rice plants that were grown without any cover crops. In relation to the different varieties of upland rice, the highest average of grain yield per clump was on the red rice variety Inpago Unram-1 (V1), which seems to be supported by the tendency of the highest values of panicle number per clump and harvest index (Table 4) as well as dry straw weight (Table 2). Harvest index was calculated as the percentage of grain weight per clump over the total weight of the grains and the straw.

Table 4. The effects of cover cropping and upland rice varieties on grain yield and yield components of the upland rice plants

Treatments	Panicle number per clump		Panicle length (cm)		Filled grain number per panicle		Weight of 100 filled grains (g)		Percentage of unfilled grain number (%)		Grain yield (g/clump)		Harvest index (%)	
T0: no cover crop	18.78	b	23.59	b	97.07	c	2.68	b	28.92	a	40.90	c	54.51	b
T1: A. hypogaea	23.19	a	25.25	a	118.69	a	2.78	ab	21.20	b	57.84	a	62.13	a
T2: A. pintoi	21.69	a	24.31	ab	107.21	b	2.82	a	21.14	b	52.96	b	60.31	a
Tukey's HSD	2.61		1.37		9.13		0.13		4.96		2.52		2.27	
V1: red rice	22.00	a	23.76	b	99.68	b	2.65	b	25.22	a	52.22	a	59.28	a
V2: black rice	21.81	a	23.85	b	108.13	ab	2.77	ab	22.99	a	50.97	ab	58.90	a
V3: white rice	19.86	a	25.54	a	115.15	a	2.87	a	23.07	a	48.51	b	58.77	a
Tukey's HSD	2.61		1.37		9.13		0.13		4.96		2.52		2.27	

1) Mean values followed by the same letter are not significantly different between treatments of each factor

IV. DISCUSSION

Based on the interaction effect between the treatment factors on the number of tillers per clump during the vegetative growth phase of rice plants, there appears to be a difference in response between the upland rice varieties to the application of cover crops (Table 3), but this interaction effect does not continue to the generative phase, as seen from the absence of a significant interaction effect on yield components of the upland rice plants (Table 4). However, the average values of yield components of the rice plants appear higher on the rice plants grown together with the legume cover crops. This positive effect of legume cover cropping is thought to be due to the influence of the *Arachis* species of the cover crops which can play a role in providing available nutrients, especially N, needed by the rice plants in the seed filling phase due to the high need for photosynthate for seed filling, so that maintaining a high number of green leaves with this N supply is very important in the seed filling phase. The treatment with cover crops from legumes such as *Arachis* species, which were grown between rows of cereal plants can fix atmospheric nitrogen so that it can increase the availability of N for the rice plants, when compared to the monocrop planting or without cover crops [12].

In addition, legume plants can facilitate cereal plants such as rice in absorbing nutrients needed by the plants because legume plants can increase the availability of nitrogen, Fe and Zn which are very beneficial for cereal plants so that the effect of cover crops from *Arachis* species can have a positive impact on the yield components of cereal crops [13]. In addition, the dense growth of cover crop leaves is also thought to inhibit weed growth, and the Bison variety of peanut plants used as cover crops in this study have denser leaves than other peanut varieties such as Hypoma-1 [14].

In its application in the field, the effect of cover crop treatment using peanut plants showed the highest rice yield which was significantly higher than under the cover crop treatment with *A. pintoi* and without cover crops. This is because the formation of peanut root nodules is generally very abundant and peanuts are capable of establishing symbiosis with *Rhizobium* bacteria so that this legume plant can contribute N to the rice plants growing next to it through the transfer of N from the peanut rhizosphere to the rice plants [15], and intercropping with peanut plants can also increase the land equivalency ratio [16]. This allows for high yields from several upland rice varieties in the cover crop treatment with *Arachis* species. In addition to the ability to fix nitrogen from legume plants of the *Arachis* species or peanuts, peanut plants can increase the amount of grain in red rice plants compared to without legume plants as companion plants in red rice cultivation [17].

In addition to showing high yield, the cover crop treatment with *Arachis* species also showed a low percentage of unfilled grain number and a high harvest index compared to the treatment without cover crops. The high percentage of unfilled grain number in the control treatment (without cover crops) is thought to be due to the absence of companion plants of the legume type *Arachis* species so that the N needs of rice plants are less fulfilled, especially during the seed filling phase, which causes imperfect seed filling, thus increasing the percentage of unfilled grain number. Red rice plants intercropped with peanuts showed greener leaf color with a higher number of green leaves in the flowering phase when compared to without intercropping with peanuts, which ultimately resulted in higher grain yields in rice plants intercropped with peanuts than without peanuts [18]. Legume plants such as soybeans [19, 20], mungbeans [21, 22], or peanuts [15, 18] can transfer nitrogen (N) to the cereal plants growing next to them, so that cover cropping can have a positive effect on yield and yield components of the main crops.

V. CONCLUSION

It can be concluded that cover-cropping had a significant effect on growth (plant height and number of tillers), grain yield, and yield components of the upland rice plants, with the highest average of rice grain yield (57.84 g/clump) was obtained from the plots planted with the cover crop *A. hypogaea* (peanut), while among types of upland rice, the highest average of grain yield was in the red rice (52.22 g/clump). Therefore, growing upland rice on raised-beds planted with cover crops from the species of *Arachis* can help increase grain yield of upland rice plants in dry land.

VI. DISCLOSURE

We do not have any conflicts of interest in this work.

REFERENCES

1. Pratiwi, R., Rahayu, D., & Barliana, M. I. (2016). Pemanfaatan selulosa dari limbah jerami padi (Oryza sativa) sebagai bahan bioplastik. *Indonesian Journal of Pharmaceutical Science and Technology*, 3(3), 83.
2. Satria, B., & Harahap, E. M. (2017). Peningkatan Produktivitas Padi Sawah (Oryza sativa L.) Melalui Penerapan Beberapa Jarak Tanam dan Sistem Tanam: The increased productivity of paddy (Oryza sativa L.) by application some distance planting and cropping system. *Jurnal Online Agroekoteknologi*, 5(3), 629-637.
3. Santoso, Y. S., Rivai, R. R., Herwitarahman, A., Alfiah, N. A., & Susanto, R. (2013). Penentuan umur panen dengan metode akumulasi satuan panas (HEAT UNIT) untuk meningkatkan ketepatan waktu panen kacang tanah (*Arachis hypogaea*).
4. Snapp, S., & Surapur, S. (2018). Rye cover crop retains nitrogen and doesn't reduce corn yields. *Soil and Tillage Research*, 180, 107-115.
5. Dulur, N. W. D., Wangiyana, W., Farida, N., & Kusnarta, I. G. M. (2019). Improved growth and yield formation of red rice under aerobic irrigation system and intercropping with peanuts. *IOSR Journal of Agriculture and Veterinary Science*, 12(8), 12-17.
6. Wangiyana, W., Fikri, M.A., Aryana, I.G.P.M., & Mahardika, I.B.K. 2022. Additive intercropping with peanut increases growth and yield of various promising lines of red rice under aerobic irrigation system on permanent raised-beds. *IOP Conf. Ser.: Earth Environ. Sci*., 1107, 012011.
7. Prasetyo, S. E., & Pujiwati, H. (2009). Produktivitas lahan dan NKL pada tumpangsari jarak pagar dengan tanaman pangan. *Jurnal Akta Agrosia*, 12(1), 51-55.
8. Hindersah, R., & Simarmata, T. (2004). Potensi rizobakteri Azotobacter dalam meningkatkan kesehatan tanah. *Jurnal Natur Indonesia*, 5(2), 127-133.
9. Erniyani, K. (2009). Pemanfaatan Tanaman Penutup Tanah Dalam Sistem Usaha Tani. *Agrica*, 2(1), 39-42.
10. Wangiyana, W., Farida, N., & Abdurrachman, H. (2020). Relay-planting of peanuts between double or triple rows at different dates increases growth, nitrogen content, and yield of red rice under aerobic irrigation systems. *International Journal of Environment Agriculture and Biotechnology*, 5(5):1378-1382.
11. Rosliani, R., Sumarni, N., & Sulastrini, I. (2010). Pengaruh cara pengolahan tanah dan tanaman kacang-kacangan sebagai tanaman penutup tanah terhadap kesuburan tanah dan hasil kubis di dataran tinggi. *Jurnal Hortikultura*, 20(1).
12. Wangiyana, W., Aryana, I. G. P. M., Gunartha, I. G. E., & Dulur, N. W. D. (2018). Pengaruh inokulasi mikoriza terhadap komponen hasil padi sistem pengairan aerobik yang ditumpangsarikan dengan kacang hijau. *AgriTECH*, 38(3), 289-294.
13. Xue, Y., Xia, H., Christie, P., Zhang, Z., Li, L., & Tang, C. (2016). Crop acquisition of phosphorus, iron and zinc from soil in cereal/legume intercropping systems: a critical review. *Annals of Botany*, 117(3), 363-377.
14. Zainab, S., & Wangiyana, W. (2021). Pertumbuhan dan hasil dua varietas kacang tanah dalam tumpangsari replacement series dengan padi beras hitam sistem irigasi aerobik pada bedeng. *Jurnal Silva Samalas*, 4(1), 1-9.
15. Chu, G.X., Shen, Q.R., & Cao, J.L. (2004). Nitrogen fixation and N transfer from peanut to rice cultivated in aerobic soil in an intercropping system and its effect on soil N fertility. *Plant and Soil*, 263: 17–27.
16. Matusso, J. M. M., Mugwe, J. N., & Mucheru-Muna, M. (2014). Potential role of cereal-legume intercropping systems in integrated soil fertility management in smallholder farming systems of Sub-Saharan Africa. *Research Journal of Agriculture and Environmental Management*, 3(3), 162-174.
17. Iryani, E., Wangiyana, W., dan Dulur, N. W. D. (2019) 'Pertumbuhan dan Hasil Berbagai Varietas Kacang Tanah antara Penanaman secara Monokrop dan bersama Padi Beras Merah pada Sistem Irigasi Aerobik'. *Crop Agro*, 12(1): 59-68.

18. Wangiyana, W., Dulur, N. W. D., Farida, N., & Kusnarta, I. G. M. (2021). Additive intercropping with peanut relay-planted between different patterns of rice rows increases yield of red rice in aerobic irrigation system. *Emirates Journal of Food and Agriculture*, 33(3), 202-210.
19. Fujita, K., Ogata, S., Matsumoto, K., Masuda, T., Ofosu-Budu, G.K., & Kuwata, K. (1990). Nitrogen transfer and dry matter production in soybean and sorghum mixed cropping system at different population density. *Soil Science and Plant Nutrition*, 36(2): 233-241.
20. Wangiyana W., Aryana, I.G.P.M., and Dulur, N.W.D. 2021 Mycorrhiza biofertilizer and intercropping with soybean increase anthocyanin contents and yield of upland red rice under aerobic irrigation systems. *IOP Conf. Ser.: Earth Environ. Sci.*, 637, 012087.
21. Wangiyana, W., Irwinsyah, L.R., Parawinata, and Kisman (2020). Additive Intercropping with Legume Crops Increases Waxy Maize Yield on Vertisol Riceland in Lombok, Indonesia. *Russian Journal of Agricultural and Socio-Economic Sciences*, 102(6): 57-64.
22. Wangiyana, W., Aryana, I.G.P.M., and Dulur, N.W.D. 2023. Intercropping red rice genotypes with mungbean and application of mycorrhiza-biofertilizer to increase rice yield with reduced inorganic fertilizer doses. *AIP Conf. Proc.*, 2583, 020010.