Exploration of Mycorrhiza from Lombok soils in media sterilized by gamma irradiation and their effect on Sorghum plants

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Abstract. Mycorrhiza which plays a role in increasing P uptake of plants and also as a soil amendment to rehabilitate degraded lands. This research was conducted with the aim of isolating, characterizing, and purifying mycorrhiza from two different soil types. The results showed that the mycorrhiza species found were Glomus etunicatum, Gigaspora margarita, Sclerocytis rubiformis. A completely randomized design (CRD) consisted of 6 treatments were applied into two types of soil, was Lombok soil and Parung soil. Each treatment was repeated 3 times, so that there were 36 experimental units. Treatments given were as follow: (1) Without mycorrhiza and without P source (Control); (2) fertilizer SP-36; (3) Mycofer mycorrhiza; (4) Mycofer Mycorrhiza + SP 36 fertilizer; (5) Mikorbi mycorrhiza from Lombok; (6) Mikorbi mycorrhiza from Lombok + SP 36 fertilizer. The results showed that combination mikorbi mycorrhiza and fertilizer SP 36 on Parung soil can increase stover production by 57.35% compared to control, by 9.73% compared to the mycofer mycorrhiza and fertilizer SP 36. The results showed that mycorrhiza is suitable to use in soils with low P content, so that they could help increase the availability of P in the soil and be easily absorbed by plants.

1. Introduction

Mycorrhiza produce phosphatase enzymes which can function for the mineralization of organic P compounds in the soil [1] and according to Klugh et al. [2], Plassard and Fransson [3] reported that mycorrhiza also produce organic acids so they can reduce metal toxicity and increase the availability of P in the soil. Mycorrhiza is a symbiotic mutualism between fungi and plant roots. Mycorrhiza are obligate symbionts that cannot preserve the body and its reproduction when separated from the host plant [4,5]. Mycorrhiza play a role in increasing the absorption of P nutrients, increasing water absorption in dry areas, increasing plant resistance to disease, improving soil structure, protecting plants from heavy metal poisoning [6].

Arbuscular mycorrhiza fungi are obligate, so they always use host plants to live and reproduce. One technique for multiplying mycorrhiza is using a culture pot. Mycorrhiza are allowed to grow and develop in the root system of their hosts which are grown in pots containing certain media. Carrier is the most important component in the multiplication of mycorrhiza inoculants. The carrier materials used for the propagation of mycorrhiza inoculants are husk charcoal, straw, soil, sand, zeolite, vermiculite, and biochar [7-9]. The spores to be used as inoculants can be produced in pot culture.
using various host plants on sterile medium. Various plants that can be used as host plants are sorghum [10, 11], maize [12], kudzu [13], Guinea grass (Panicum maximum)[14].

The aim of the study was to isolate, characterize, and purify mycorrhiza from the sorghum host plant, coming from Lombok soil, to test the effect of mycorrhiza on plant growth.

2. Methodology
The research was carried out at the Laboratory of Fertilization and Plant Nutrition, the Center for Isotope and Radiation Application, the Jakarta National Nuclear Energy Agency Lebak Bulus South Jakarta. Research time was carried out on January 2018 - July 2019. The results of soil analysis, carried out at the laboratory land resources management, IPB University Bogor. This study consisted of six activities, namely: 1) soil and root sampling, 2) initial spore observation, 3) mycorrhiza trapping, 4) identification of mycorrhiza spores, 5) single culture creation, 6) multiplication of mycorrhiza cultures, 7) test viability mycorrhiza spore, 8) application mycorrhiza to sorghum plants.

2.1. Materials and Tools
The tools used in the study were: microscopes (Olympus CX 21 and XT 2 A), multilevel measuring sieves 710 μm and 45 μm, spectrophotometer (Optima SP 300), Gamma Chamber 4000 A irradiator, Co-60 radiation source. The materials used in this study consisted of: sorghum seeds of Samurai 2 BATAN variety. Zeolites 1 to 2 mm in size, mycorrhiza isolates (Glomus etunicatum, Gigaspora margarita, Sclerocytis rubiformis) from Lombok soil, Mycofer mycorrhiza isolates consisting of Gigaspora margarita, Glomus manihotis, Glomus etunicatum and Acaulospora tuberculata from the Central Forestry Biotechnology Laboratory collection. IPB University, Red Hypoxen (25-5-20), urea fertilizer (45.18% N), SP 36 fertilizer (36.38% P₂O₅), KCl fertilizer (61.09% K₂O), and trypan blue 0.05%, HCl 2%, and KOH 10%.

2.2. Research methods
The research consisted of six activity stages, namely: 1) soil and root sampling, 2) initial spore observation, 3) mycorrhiza trapping, 4) identification of mycorrhiza spores, 5) single culture creation, 6) multiplication of mycorrhiza cultures, 7) test viability mycorrhiza spore, 8) application mycorrhiza to sorghum plants.

2.3. Experimental design
This research was conducted at the the Laboratory of Fertilization and Plant Nutrition, the Center for Isotope and Radiation Application, the Jakarta National Nuclear Energy Agency. This study used completely randomized design (CRD) consisted of 6 treatments were applied into two types of soil, was Lombok soil and Parung soil. Each treatment was repeated 3 times, so that there were 36 experimental units. Treatments given were as follow: (1) Without mycorrhiza and without P source (Control); (2) fertilizer SP-36; (3) Mycofer mycorrhiza; (4) Mycofer mycorrhiza + SP 36 fertilizer; (5) Mikorbi mycorrhiza from Lombok; (6) Mikorbi mycorrhiza from Lombok + SP 36 fertilizer.

2.4. Procedures of isolation and application mycorrhiza
Isolation of mycorrhiza includes: Soil samples were collected from the Desa Akar-akar of North Lombok, West Nusa Tenggara with the coordinate point S 08°13.682’E 116°21. 365’. The soil is taken from the if the layer is at a depth of 0 to 20 cm. soil samples put in a plastic bag and labeled. The soil sample is a composite of ten points of extraction of 500 g each.

Spore selection used trapping techniques with the method of [15] using culture pots. The planting medium used was ± 150 g of soil samples. Sorghum seeds are inserted into the planting hole. Furthermore, the plants are stored in a greenhouse.

Watering as 30 ml pot⁻¹ can be done in a petri dish or watered slowly in zeolite media every day. Sorghum plants infected with mycorrhiza ± 2 weeks after being transferred to the pot were given red
Hyponex fertilizer (25-5-20) with a concentration of 1 g in to 2 liters of water. Watering the fertilizer is given as much as 30 ml pot⁻¹. Fertilizer is given twice a week.

Plants at the age of 1-3 months are checked for roots under a microscope. If there is a lot of mycelium in the roots at the age of 3 months, the watering and fertilizer are stopped. If there are not many mycorrhiza spores, just keep watering the water without applying fertilizer until the number of mycelia in the pot is high. Then do the drying (stressing) for two weeks to stimulate sporulation of mycorrhiza fungi.

Zeo 1-2 mm size that has been washed with water, soaked in hyponex solution, then the zeolite is dried in the sun. Then put the zeolite into the cardboard, to do the 50 kGy dose of Gamma irradiation sterilization.

Mycorrhiza spores found from trapping were attached to the roots of 5-day old soybean plants. Sorghum plants that have been affixed with spores are then planted in zeolite media with a plastic bottle container. The roots of sorghum after 1 week of age are examined under the microscope, if there is already an infection in the roots, the plants in the plastic bottle are moved and planted in plastic pots with a volume of 150 ml. Furthermore, the plants are stored in a greenhouse.

Provision of water as much as 30 ml pot⁻¹ dose in the zeolite medium slowly every day. Sorghum plants that have been infected with mycorrhiza ± 2 weeks after being transferred to the pot are given red Hyponex fertilizer (25-5-20) with a concentration of 1 g in to 2 liters of water. Watering the fertilizer is given as much as 30 ml pot⁻¹. Fertilizer is given twice a week.

Sorghum plants at the age of 1-3 months are checked for roots under a microscope. If there is a lot of mycelium in the roots at the age of 3 months, the watering and fertilizer are stopped. If there are not many mycorrhiza spores, just keep watering the water without applying fertilizer until the number of mycelia in the pot is high. Then do the drying (stressing) for two weeks to stimulate sporulation of mycorrhiza fungi. Harvesting is done by dismantling the host plant and taking its roots. The roots are cut into small pieces (± 0.5 cm) and mixed with the planting medium and packed in plastic.

Mycorrhiza effectiveness test includes: Plants are planted in ± 150 g plastic pots. Propagated spores are separated by type (one type of spore and a combination of spores). Each spore was tested on sorghum plants. The spores are attached to the roots of 5 days old sorghum. Plants at the age of 1-3 months are checked for roots under a microscope. If there is a lot of mycelium in the roots at the age of 3 months, the watering and fertilizer are stopped. If there are not many mycorrhiza spores, just keep watering the water without applying fertilizer until the number of mycelia in the pot is high. Then do the drying (stressing) for two weeks to stimulate sporulation of mycorrhiza fungi.

The test for spore viability was carried out using the method of [15] which has been modified. Spore screening used a stratified sieve measuring 710 µm and 45 µm. The 45 µm filter was placed on a petri dish. A total of 60 spores of mycorrhiza isolates were placed on sterile filter paper, the bottom of which had been sprinkled with zeolites measuring 1 to 2 mm weighing ± 10 grams. The sample was repeated 4 times. Then wetted until damp conditions. The petri dishes are then tightly closed and stored in a dark room. At 3 days of age, spore germination can be seen in the microscope. From the number of mycorrhiza spores that germinated, the percentage of viability was calculated. The soil used in the experiment is land from Lombok and Parung. The soil is taken from the if it is at a depth of 0 to 20 cm. Soil is put into the pot as much as 1 kg absolute dry weight per pot. Soil samples for analysis of the initial soil chemical properties in a composite before the soil was used in the experiment.

Mycorrhiza inoculation is carried out by two ways of inoculation (double inoculation). Mycorrhiza inoculation is carried out in two ways aimed at ensuring that the mycorrhiza was given to plants can infect the plant roots. The first inoculation is by using a sprouts tray. Mycofer mycorrhiza propagules are fed into trays 2 - 4 cm thick. Sorghum seeds are sown into the array. At 3 days, the development of the mycelium was observed using a microscope. Sorghum seedlings that have been colonized with Mycorrhiza aged 7 days after planting (DAP) were transferred from the tray to the pot. Four seeds were inserted into the planting hole, then after the age of 14 day after sowing (DAS), 2 uniform plants were selected in each pot. The second inoculation was used mycorrhizal propagules derived from the
propagation of the newly harvested pot culture. The mycorrhiza propagules derived from the pot culture were put in a jar then stirred until they were homogeneous. 10 grams of mycorrhiza propagules were applied to the planting hole. Then the sorghum seedlings are put into the planting hole and then covered again with soil.

In this study the fertilizers used were urea fertilizer (45.18% N), KCl fertilizer (61.09% K₂O), SP 36 fertilizer (36.38% P₂O₅). The fertilization doses used in this study were 100 ppm N, 200 ppm P, and 100 ppm KCl. Urea, KCl, SP 36 are applied at planting time. Harvesting sorghum in the vegetative phase at 45 days after planting (DAP). Identification of the degree of mycorrhiza root colonization in plant root examples. Observation of mycorrhiza colonization on plant root samples was carried out through staining techniques at the age of 45 day after sowing (DAS).

2.5. Observation
The observations in this study consist of:

- Research using Lombok and Parung soil was conducted to determine the P uptake, during the vegetative phase of sorghum plant at the age of 45 day after sowing (DAS). Determination of P-total in plant tissue. Establishment of P-total in plant tissue [16].
- Measuring root colonization by mycorrhiza at 45 days after planting (DAP) in Lombok and Parung soil using the method [17].
- Data analysis

Statistical analysis used SAS 9.1 software for analysis of variance (ANOVA) at the 95% confidence level. The results of the analysis that showing significant effect on the treatment were further tested by the DMRT (Duncan's Multiple Range Test) at the 95% confidence level.

3. Results and discussion
The analysis results of soil analysis from Desa Akar-Akar, Bayan District, North Lombok show that the soil texture is dominated by sand fraction. Management of nitrogen (N) nutrients in soils with high sand content needs to be carried out carefully because of the potential for high leaching rates. Soil organic (C-organic) content of roots is very low. This can indicate that the land degradation process has been running intensively. Organic matter management is one aspect that needs attention because it will greatly affect the improvement of soil physical, chemical and biological properties. The contents of N and cations (Ca, Mg, K, Na and Al) are low to very low. While the total P content is very high, namely 739.67 ppm P and available P is very high being 40.2 ppm P. However, sufficient soil moisture is needed so that P becomes more available to plants because P nutrients move more through the diffusion mechanism.

The analysis results of the Parung soil analysis showed that the soil texture was dominated by the clay fraction. Organic matter (C-organic) content of the soil is medium. This can indicate that the land degradation process has been running intensively. Organic matter management is one aspect that needs attention because it will greatly affect the improvement of soil physical, chemical and biological properties. The N content and cations (Ca, Mg, K, Na and Al) are low to very low. While the total P content is very high is 62.14 ppm P and P is available very high is 26.52 ppm P. However, sufficient soil moisture is needed so that P becomes more available to plants because P nutrients move more through the diffusion mechanism.
Table 1. Results of soil analysis from Lombok and Parung.

| No | Parameter                  | Analysis Results | Criteria     | Analysis Results | Criteria     |
|----|----------------------------|------------------|--------------|------------------|--------------|
|    |                            | Lombok Soil      |              | Parung Soil      |              |
| 1. | Soil texture               |                  |              |                  |              |
|    | - Sand (%)                 | 66.9             | Clay Sandy   | 20.38            | Clay         |
|    | - Dust (%)                 | 11.4             |              | 9.94             |              |
|    | - Clay (%)                 | 21.7             |              | 69.68            |              |
| 2. | pH                         |                  |              |                  |              |
|    | - H₂O                      | 5.12             | Acid         | 5.29             | Acid         |
|    | - KCl                      | 4.68             |              | 4.84             |              |
| 3. | Organic Materials          |                  |              |                  |              |
|    | - C-Organic (%)            | 0.31             | Very low     | 2.26             | Medium       |
|    | - N-total (%)              | 0.2              | Low          | 0.11             | Low          |
|    | - C/N                      | 1.55             | Very low     | 20.54            | High         |
| 4. | P total                    |                  |              |                  |              |
|    | - HCl 25% (mg 100 g⁻¹)     | 739.67           | Very high    | 62.14            | Very high    |
|    | - Bray (ppm P)             |                  |              | 26.52            | Very high    |
|    | - Olsen (ppm P)            | 40.2             | Very high    |                  |              |
| 5. | Cations                    |                  |              |                  |              |
|    | - Ca (cmol, kg⁻¹)          | 12.06            | High         | 9.32             | Medium       |
|    | - Mg (cmol, kg⁻¹)          | 0.59             | Low          | 2.54             | High         |
|    | - K (cmol, kg⁻¹)           | 0.14             | Low          | 0.30             | Low          |
|    | - Na (cmol, kg⁻¹)          | 0.11             | Low          | 0.62             | Medium       |
|    | - Al (cmol, kg⁻¹)          | <0.05            | Very low     | -                |              |
| 6. | Cation exchange capacity   | 22.6             | Medium       | 5.54             | Low          |
| 7. | Base Saturation (%)        | 57.1             | Medium       | 14.44            | Very low     |

Assessment of soil physical and chemical properties criteria based on Chemical Analysis of Soil, Plants, Water, and Fertilizer, Soil Research Institute (2009) [16].

3.1. Morphologi identification of mycorrhiza

Based on data table 2 showed that the morphologi identification (shape and color) of mycorrhiza in the rhizosphere of sorghum roots of varieties samurai 2 from the soil of the Village of Roots of North Lombok, West Nusa Tenggara, the mycorrhiza genus found consisted of three genera, namely *Glomus etunicatum*, *Gigaspora margarita*, *Sclerocyttis rubiformis*. 
Table 2. Types of mycorrhiza spores in Desa Akar-Akar, Bayan District, North Lombok.

| No | Species                  | Figure | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----|--------------------------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | *Sclerocystis rubiformis* | ![Sclerocystis rubiformis](image) | Sporocarps dark brown, subglobose to ellipsoid 180x180-375x 675 µ, consisting of a single layer of chlamydospores surrounding a central plexus of hyphae, resembling a miniature blackberry. Peridium nearly absent, individual spores at times partially enclosed in a thin network of tightly appressed hyphae. Chlamydospores dark brown, obovoid to ellipsoid or subglobose, 37-125 x 29-86 µ, with a small pore opening into the thick walled subtending hypha. Spore wall laminate, 3-7.6 µ thick up to 13.5 µ thick at spore base, often perforated, and often with thick, perforated projections on the inner surface. A variable stalk like projection protrudes near the base of some spores [18] |
| 2  | *Glomus etunicatum*      | ![Glomus etunicatum](image)   | Spores borne singly in the soil; pale yellow (3A3) to yellow (3A6); globose to subglobose; (75-)95(-135) µm diam; occasionally ovoid; 110-160 x 140-180 µm; with one subtending hypha. Globose to subglobose 68-144 (162) µm diameter, smooth or roughned from decomposition of the outer wall and adherent debris. Spore wall 4-13 µm thick, composed of an ephemeral hyaline outer wall up to 513 µm thick and a persistent yellow to brown laminate inner wall 2-8 µm thick. intact outer wall rarely present on mature spores, inner wall darkening and becoming laminate with age (15). |
| 3  | *Gigaspora margarita*    | ![Gigaspora margarita](image) | Azygosporas produced singly in soil, large, generally globose or subglobose, with oily contents, borne terminally on a bulbous suspensor like cell, usually with a narrow hypha extending from the suspensor like cell to the spore. Spore wall continuous except for a small occluded pore. Germ tubes produced directly through wall near spore base. Thin walled vehicles borne in soil on coiled hyphae, forming singly or in clusters. Forming endomycorrhiza with arbuscles. Spores hyaline to yellow or greenish yellow with concolorous suspensor like cell and smooth to echinulate soil borne vesicles. Globes spore generally larger than 300 µ, vesicles echinulate, formed in clusters [18] |
3.2. Test viability mycorrhiza spore
Spore samples were taken from 1 kg of zeolit propagules. Mycorrhiza spores (Glomus etunicatum, Gigaspora margarita, Sclerocytis rubiformis) from the Lombok soil from 60 mycorrhiza spores, namely 10 living spores is 16.66%, while mycorrhiza spores (Sclerocytis rubiformis) from Lombok soil from 60 mycorrhiza spores, namely 8 living spores is 13.33%.

![Figure 1](image1.png)

Figure 1. Test viability mycorrhiza spore.

![Figure 2](image2.png)

Figure 2. a) Gigaspora margarita, b) Glomus etunicatum, c) Sclerocystis rubiformis.

3.3. Percentage of root colonisation
Root colonization is the initial form of the symbiotic process between mycorrhiza and host plant roots. The percentage of root colonisation using the root staining method [17]. Based on the data in Table 3 on Lombok soil, it shows that the average control treatment, mycorrhiza without SP 36, mycorrhiza and SP 36 fertilizers has the percentage criteria for sorghum root colonisation categories class 1-2 with a percentage of sorghum root colonisation of 0-15%.

Data table 4 of Parung soil shows that the average control treatment, mycorrhiza without SP 36, mycorrhiza and SP 36 fertilizers have the criteria for the percentage of sorghum root colonisation categories class 1 - 2 with a percentage of sorghum root colonisation of 0 - 10%. The category for assessing the percentage of root colonisation according to Rajapakse and Miller [19] the percentage level of root colonisation does not affect plant growth. According to Powell and Bagyaraj [20] that colonisation of sorghum roots inoculated by mycorrhiza is not closely related to mycorrhiza effectiveness.
Table 3. Effect of mycorrhiza on the degree of root colonisation in soil of Lombok.

| Treatment                                      | Percentage (%) | Category        |
|------------------------------------------------|----------------|-----------------|
| Control                                        | 4.84 ± 1.07    | Class 1 (3-5%)  |
| Fertilizer SP 36                               | 11.11 ± 4.16   | Class 2 (7-15%) |
| Mycofer mycorrhiza                            | 10.59 ± 3.88   | Class 2 (6-14%) |
| Mycofer mycorrhiza + fertilizer SP 36          | 2.83 ± 1.88    | Class 1 (0-4%)  |
| Mikorbi mycorrhiza from Lombok soil            | 5.05 ± 2.99    | Class 1-2 (2-8%)|

Note: Mean value of the percentage of root colonisation. The category of root colonisation according to [20].

Table 4. Effect of mycorrhiza on the degree of root colonization in soil of Parung.

| Treatment                                      | Percentage (%) | Category        |
|------------------------------------------------|----------------|-----------------|
| Control                                        | 2.87 ± 1.31    | Class 1 (1-4%)  |
| Fertilizer SP 36                               | 4.96 ± 2.57    | Class 1-2 (2-7%)|
| Mycofer mycorrhiza                            | 5.56 ± 5.16    | Class 1-2 (0-10%)|
| Mycofer mycorrhiza + fertilizer SP 36          | 5.76 ± 3.03    | Class 1-2 (2-8%)|
| Mikorbi mycorrhiza from Lombok soil            | 5.05 ± 1.58    | Class 1-2 (3-6%)|

Note: Mean value of the percentage of root colonization. The category of root colonization according to [20].

Figure 3. Root colonization mycorrhiza: a) Vesicula, b) Spore, c) Hypha.

3.4. Weight of sorghum stover and sorghum roots

Based on the statistic, that data in table 5, showed that the average stover weight, P uptake, and root weight on the Lombok soil showed resulted were not significantly different. This is because the soil in Lombok already has a very high P<sub>2</sub>O<sub>5</sub> content, namely 40.2 ppm P. According to Rosmarkam and Yuwono [21] plant production is in optimal conditions. It showed that fertilization is not real or the plant does not respond to fertilization.

The statistic results of table 4 on Parung soil data showed that root weight was not significantly different, while stover weight was a significant difference in plants given SP 36 fertilizer compared to other treatments. Mikorbi mycorrhiza treatment and SP 36 fertilizer on Parung soil gave the second highest yield after SP 36 fertilizer treatment. The combination of mikorbi mycorrhiza treatment and SP 36 fertilizer on Parung soil can increase the stover production by 57.35% compared to the control, by 9.73% compared to the combination of mycofer mycorrhiza and SP 36 fertilizer. This is probably due to SP 36 fertilizer which dissolves easily and can be absorbed directly by plants, add more with mycorrhiza from soil of lombok which suitable for living on that the soil. So that it can effectively contribute to help release P elements that are bound in the soil, so that P becomes more easily absorbed by plants. Therefore, plant growth is increased.
Table 5. Effect of mycorrhiza on sorghum stover weight, P uptake, and sorghum stover and root using soil from Lombok and Parung soil.

| Treatment                                      | Weight of stover | Weight of stover | Uptake P | Uptake P | Weight of root | Weight of root |
|-----------------------------------------------|------------------|------------------|----------|----------|----------------|----------------|
|                                               | With soil from Lombok | With soil from Parung |         |          |                |                |
| Control                                       | 8.63 a            | 2.65 ab           | 9.626 a  | 0.729 a  | 14.10 a        | 2.73 a         |
| Fertilizer SP 36                              | 8.90 a            | 5.13 d            | 10.148 a | 1.299 a  | 14.60 a        | 6.36 a         |
| Mycofer mycorrhiza                            | 8.60 a            | 3.57 abc          | 6.530 a  | 1.309 a  | 5.99 a         | 3.10 a         |
| Mycofer mycorrhiza + fertilizer SP 36         | 7.46 a            | 3.80 bc           | 8.199 a  | 1.222 a  | 12.93 a        | 4.33 a         |
| Mikorbi mycorrhiza from Lombok soil           | 8.06 a            | 2.36 a            | 8.082 a  | 0.851 a  | 12.80 a        | 4.86 a         |
| Mikorbi mycorrhiza from Lombok soil + fertilizer SP 36 | 8.03 a            | 4.17 cd           | 8.611 a  | 1.320 a  | 16.86 a        | 4.76 a         |
| Coefficient of Variation                      | 13.51%            | 21.18%            | 23.34%   | 44.17%   | 39.83%         | 42.18%         |

Note: Numbers followed by the same letters in the same column show results that are not significantly different based on the DMRT test at the error level of 5%.

4. Conclusions
The mycorrhiza genus found on Lombok soil consists of three genera, namely *Glomus etunicatum*, *Gigaspora margarita*, and *Sclerocytis rubiformis*. Treatment of mikorbi mycorrhiza and SP 36 fertilizer on Parung soil can increase stover production by 57.35% compared to control (by 9.73%). Combination fertilizer SP 36 with mycorrhiza (mycofer and mikorbi) did not have any significant effect on stover weight, P uptake, weight of root sorghum plant in Lombok soil.

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