NPK fertilizer on peanut and maize cultivar under agroforestry system

D Purnomo, Mth S Budiatuti and AT Sakya
Department of Agrotechnology, Sebelas Maret University, Jl. Ir. Sutami 36 A, Kentingan, Surakarta, 57126, Indonesia

Email: djokopurnomo@staff.uns.ac.id

Abstract. According its characteristics, the sengon (Albizia chinensis) forests have potency for crop cultivation as Agroforestry (AF) system. Sengon canopy at 3-4 years old has Fraction radiation transmission (FRT) about 80%, moreover soil fertility under tree has medium, especially, N (Nitrogen) and P (Phosphor), and low K (Potassium) content. This study was performed to observe the effect of NPK fertilizer on maize and peanut, representing C4 and C3 crop type, which were cultivated between sengon stands. The study was conducted under 3, 4, and 5 years old of sengon stand. In each sengon stands age group, the experiment was designed as Randomize Complete Block Design (RCBD) consists of 7 factors treatment. The treatments were without fertilizer as control, P and K fertilizer (3 levels), N, P, and K fertilizer (3 levels), then data were analyzed using orthogonal contrast. The result showed that peanuts were cultivated successfully in all of sengon stand (3, 4, and 5 years old). Whereas maize only grow well under 3 years old of sengon stand. The application of P and K fertilizer were able to increase the growth and yield of both crops and will be improved if N was applied at the same time.

1. Introduction
Peanut and maize are important crops that cultivated post paddy (rice) cultivation in the same area. Recently, the rice filed area in Indonesia is threatened due to functions changing into other purpose, therefo land alternative is needed. In the other side, some forest areas have been developed as albazia plantations considering it various advantages such as for medicinal plant [1,2,3], as legume, having symbiosis with many bacteriaand the timber can be harvested in relativelz short time (8 years). This condition carry a great opportunity for agricultural extension purpose on suboptimum area (crop among trees stand) namely agroforestry systems (AF) [4].

The AF system has a function as an environmental friendly crop cultivation [5] because it maintains carbon storage [6], improves social and economic level of the farmers [7]. In the cultivation of plants with AF system, the availability of light is a very important factor, both radiation transmission fraction (FTR) and the hydrological behavior of tree canopies depend on its structure (number and density of branches, and leaf types) [8]. Tree canopy develop pararelly with tree age, for example in coconuts, FTR is lower in the group of 8 years old trees than in 4-6 years old [9]. In 2, 4 and 6 years old albazia trees, FTR decreases from 35,500 to 27,025 and 19,800 Lux respectively [10]. The decrease of FTR due to more age in sengon (Albizia sp) is caused by the increase of canopy density. To improve light availability, it can be achieved by trimming down one third of canopy at the lower tree as in teak-based on AF (Tectona grandis) and pine (Pinus mercusii) [11].
Despite the limited availability of light, the Albizia-based on AF system has the advantage of being a legume tree as it can produce litter. At one year old of sengon, this tree is able to produced 30 kg of litter per tree per year [12]. Sengon leaves are small and easy to decompose [13], low C/N ratio, and enables to maintain soil physical properties. Besides N, sengon litter also can be used to increase Mg [14]. Nutrient release from the litter of A. procera follows the K> N> P trend, and found more in the pod, followed by the leaves and petiole [15]. Based on this facts, the sengon-based AF system is very potential as organic crop cultivation. For that, this study want to observe the potential of maize and peanut under 3, 4 and 5 year old sengon-based on AF systems, and how the plants respond to N, P, and K fertilizer.

2. Material and method
The experiment was conducted from March to December 2017 at KPH (Kesatuan Pengelolaan Hutan) Blitar, Perum Perhutani of East Java, at elevation of 0 - 500 m above sea level (asl), with a geographical position of 8°09′0″ N and 112°0′0″E. The experiment conducted in two series: maize (‘Pioneer’ variety) and peanut (‘Kelinci’ variety). Each series was arranged in a completely randomized design (CRBD) with two factors. The first factor is age of Albizia chinensis (3, 4, and 5 years old) and the second factor is fertilizer. On Maize cultivation, the fertilizer treatment was P and K without N fertilizer (50-50, 100-100, and 150-150 kg ha\(^{-1}\)), NPK fertilizer (100-50-50, 150-75-50, and 200-100-75 kg ha\(^{-1}\)). On peanut cultivation, the fertilizer treatment was P and K without N (50-50, 100-100, and 150-150 kg ha\(^{-1}\)), NPK fertilizer (25-50-50, 50-100-100, and 75-150 -150 kg ha\(^{-1}\)). Recommendation doses of urea, SP36 (Super phosphate), and Urea were used for the research. The data were analyzed using F test at α = 0.05 (analysis of variance) then followed with orthogonal contrast. The observation parameters are vegetative components such as plant height (measured from the base of the stem to end of the plant using a ruler), chlorophyll content (analyzed using spectrophotometer method), content of N (analyzed using Kjeldahl method), biomass (total weight of dry plants after being put in 110°C oven for 24 hours), and the weigh of seed production as generative component.

3. Result and discussion
3.1. Maize
Maize cultivation in 3, 4, and 5 year old albizia-based on AF systems, with FTR of 82, 80 and 56%, respectively, shows that only the cultivation on the 3-year old albizia AF able to grow and produce. The failure of maize growth on the 5-year-old albizia AF suggested because low FTR, while maize, a C4 plant, is responsive to high irradiation [16,17]. But the failure of maize growth still occurs on the 4-year albizia AF with relatively high FTR. This indicated that the determination of maize growth is not limited only to light, but also humidity and high temperature to maintain high decomposition rate. Fertilizers play a major role in the growth and production of corn. Plant height, biomass, ear weight and yield (production) are higher in fertilized (P and K, as well as N, P, and K). Fertilizer with P and K, as well as N, P, and K shows more yield with the increasing doses (Table 1).

The highest maize production (4.14 mg ha\(^{-1}\)) was in plants fertilized by N, P, and K (200-150-150 kg ha\(^{-1}\)), which was lower than maize description which is 9.1 ton ha\(^{-1}\) [18]. This means that the availability of nutrients from Albizia litter is still low. Low nutrient availability can occur due to the relatively low of albizia canopy density which resulting the increase of soil temperature, high decomposition rate, and also lost of nutrients from mineralization due to erosion and leaching. Plant height is closely correlated (r: > 0.9) and is very determining for (R\(^2\): 0.8 to 0.99) biomass, ear weight, and production (Figure 1).
Table 1. Vegetative and generative growth of maize in albizia AF system

| Fertilization | Plant height (cm) | Biomass (g) | Ear weight (g) | Yield (Mgha\(^{-1}\)) |
|---------------|------------------|-------------|----------------|-----------------------|
| Control       | 80.49a           | 51.1a       | 1.26a          | 3.25a                 |
| Fertilized    | 90.46b           | 54.35b      | 2.81b          | 3.68b                 |
| PK            | 86.64m           | 53.14m      | 2.15m          | 3.42m                 |
| NPK           | 94.28n           | 55.57n      | 3.35n          | 3.94n                 |
| P1K1          | 83.85m           | 52.13p      | 1.68p          | 3.41p                 |
| P2K2          | 85.81q           | 53.05q      | 1.97q          | 3.41p                 |
| P3K3          | 90.25r           | 54.22r      | 2.81r          | 3.45q                 |
| N1P1K1        | 92.86x           | 54.82x      | 2.96x          | 3.83x                 |
| N2P2K2        | 94.12y           | 55.55y      | 3.21y          | 3.85x                 |
| N3P3K3        | 95.86z           | 56.34z      | 3.87z          | 4.14y                 |

Information: P1K1, P2K2 and P3K3 is P and K dose of 50-50, 100-100, 150-150 kg ha\(^{-1}\), N1P1K1, N2P2K2 and N3P3K3 is NPK dose of 100-50-50, 150-100-100, 200-150-150 kg ha\(^{-1}\), while TP is no fertilizer. Different letter behind the number in one column there as significance (between a and b; m and n; p, q, and r; and x, y and z).

Figure 1. Plant height, biomass, weight of ear, and production of maize on NPK fertilizer in albizia AF system

3.2. Peanut
In contrast to the maize, peanut was successfully grown in 3, 4 and 5 year old albizia-based on AF systems. Peanut has a height and biomass that is almost the same in the three ages of albizia. Plant height as the response parameters for light ranged from 40-41 cm in 3, 4 and 5 year of albizia and biomass as a photosynthetic parameters in the vegetative phase ranged from 41 to 44 g of plant\(^{-1}\) (Figure 2). Vegetative growth is almost the same among different light level, it was indicating that peanuts are tolerant of low light (C3 plants). The differences were occur in the generative growth of pod formation. The weight of the pods only ranges from 11 to 16 g, it was indicated that the number of pods is lower than the description (Kelinci variety): the weight of the pods of each plant were ranged from 24 g (15 pods and weight of 100 seeds is 45 g) [19]. The number of soy pods in the study of Albizia-based on AF [10] was ranged only from 4 to 9 per plant. Peanut pods are formed on the branches of plants, branches grow from pods. Therefore, the smaller number of pods were equals smaller number of branches. Although the plant height are similar but the number of pods is smaller, which means the number of nodes is lower or the internode is longer. The low number of pods were resulted in lower production (0.6-0.8 mg ha\(^{-1}\)), if it was compared to the description (2.3 mg ha\(^{-1}\)). In light, there is blue light which is affecting branch growth. The response of plants to blue light depends
on the species, and it can result in the growth of shoots being stimulated, inhibited, or it has no effect at all [20].

The application of fertilizers were affected to the plant height, biomass, pod weight, and seed production. The addition of N to PK fertilizer were increasing the three parameters, as well as it was increasing in the dose of PK fertilizer and NPK fertilizer (Table 2). The increase in biomass, pod weight, and seed production occurs in groundnut on all 3, 4, and 5 year old albizia AF system. The effect of N concentration on net photosynthesis is different in light intensity. In low irradiation, the N fertilizer is positively correlated with net photosynthesis [21] However, the increasing of N in low irradiation requires a balance of availability of other elements such as P and K because photosynthesis needs energy in the form of ATP (role of P) and stomatal regulation (role of K). This is similar to the shade research studying a dose of manure as a fertilizer, it was suggesting that the best growth of Curcuma zedoaria L. is 25% shade (low light) and 300 g manure per polybag [22].

![Figure 2. Effect of albizia age on 3, 4, and 5 year (FTR 82, 80, and 59%) to the plant height, biomass, pod weight, and yield of peanut](image)

| Fertilization | Plant height (cm) | Biomass (g) | Pod weight (g) | Yield (Mg/ha⁻¹) |
|--------------|------------------|-------------|---------------|-----------------|
| Control      | 14.37a           | 16.57a      | 8.03a         | 0.60a           |
| Fertilized   | 32.35b           | 23.64b      | 12.04b        | 0.74b           |
| PK           | 21.69m           | 21.06m      | 10.81m        | 0.71m           |
| NPK          | 43.01n           | 24.10n      | 12.51n        | 0.76n           |
| P1K1         | 16.37p           | 19.65p      | 9.69p         | 0.68p           |
| P2K2         | 23.63q           | 20.98q      | 11.17q        | 0.71q           |
| P3K3         | 25.01r           | 22.54r      | 11.57r        | 0.75r           |
| N1P1K1       | 38.83x           | 23.62x      | 12.87x        | 0.76x           |
| N2P2K2       | 42.8y            | 26.15y      | 13.09y        | 0.77y           |
| N3P3K3       | 47.40z           | 28.90z      | 13.86z        | 0.78z           |

Information: P1K1, P2K2 and P3K3 is P and K dose of 50-50, 100-100, 150-150 kg ha⁻¹; N1P1K1, N2P2K2 and N3P3K3 is NPK dose of 25-50-50, 50-100-100, and 75-150-150 kg ha⁻¹, while TP is no fertilizer. Different letter behind the number in one column there as significance (between a and b; m and n; p, q, and r; and x, y and z).
4. Conclusion
Peanut able to grow and produce in all 3, 4, and 5 year old albizia-based on AF systems, while maize was only grow and produce on the 3 year old albizia field. Fertilizing using P,K, and N increases production. Peanut and maize productions were associated with the highest dose of NPK fertilizer, 75-150-150 and 200-150-150 kg ha⁻¹ respectively, is 0.8 and 4, 14 mg ha⁻¹.

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