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A Comparison of Monoculture and Intercropping Systems in the Cultivation of Tobacco (*Nicotiana tabacum*) var. Prancak 95 in Pakong Village, Pakong District, Pamekasan Regency, Indonesia

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Abstract
This study aims to compare the cultivation techniques, growth, and yield of Prancak 95 tobacco variety in monoculture and intercropping with shallots in Pakong Village, Pakong District, Pamekasan Regency. The research methods used include field observations and farmer interviews to examine differences in cultivation techniques, as well as observations of plant growth and yield using a Randomized Block Design. The technical aspects of cultivation observed included land preparation, planting, fertilization, maintenance, and harvesting. Growth variables observed included plant height and number of leaves, while yield variables included the wet weight and dry weight of tobacco leaves. The results showed that, in general, the technical stages of cultivation in both cropping patterns were relatively similar, but differed in the timing of planting and maintenance intensity due to the presence of shallots in the intercropping pattern. The monoculture cropping pattern resulted in more optimal tobacco growth, indicated by higher plant height and number of leaves compared to intercropping. This difference affected production results, where the wet weight and dry weight of tobacco in the monoculture cropping pattern tended to be higher. However, in the intercropping pattern, there was additional production from shallots.

Keywords: Tobacco, Monoculture, Intercropping, cultivation techniques, growth, production results

1. Introduction

Pamekasan Regency is one of the tobacco productions centers on Madura Island, with a trend of increasing planted area and production in recent years. Tobacco plays a significant role as a leading regional commodity, contributing significantly to farmers' income, reaching 40–80% of total household income (Sudianto, 2023) [10]. One of the superior tobacco varieties developed is the Prancak 95 variety, known for its leaf quality and distinctive aroma, making it highly sought after by the clove cigarette industry (Medina & Trilaksana, 2017) [7]. However, this variety is relatively rarely cultivated by farmers due to its perceived lower productivity compared to other varieties. However, research shows that the production potential of Prancak 95 can be increased through the implementation of appropriate Good Agricultural Practices (GAP) cultivation practices (Verona *et al*., 2021) [12].

To increase farmer interest in cultivating Prancak 95 tobacco, the East Java Provincial Government, in collaboration with the Pamekasan Regency Government, launched the Tobacco Development Innovation Program using a monoculture planting pattern and the Tobacco Farming Diversification Program using an intercropping pattern with shallots. Farming diversification is considered capable of increasing farmer income and reducing the risk of crop failure (Asmiati *et al*., 2024) [1]. Differences in these planting patterns have the potential to affect technical aspects of cultivation, plant growth, and production yields. Monoculture and intercropping with shallots differ in technical aspects such as land management and planting time, thus creating different growing environments for tobacco plants. Tobacco plant growth, as indicated by plant height and number of leaves, is an agronomic characteristic that can change according to environmental conditions and the applied cultivation management (Boaretto *et al*., 2020) [2].

In an intercropping system, the presence of shallots has the potential to create competition for nutrients, water, and light, thus affecting the vegetative growth of tobacco (Darwis, 2017) [4]. These differences in plant growth will subsequently affect the production yield of the Prancak 95 tobacco variety. Tobacco production yield is largely determined by the number and size of leaves, both in terms of fresh and dry weight (Yusra *et al*., 2025) [14]. Suboptimal vegetative growth can result in low tobacco leaf yields. However, studies specifically comparing monoculture and intercropping patterns for the Prancak 95 variety within the context of government programs are still limited. Therefore, this study was conducted to compare the technical and agronomic aspects of Prancak 95 tobacco cultivation in monoculture and intercropping patterns in Pakong Village, Pamekasan Regency.

2. Method

This research was conducted from May to September 2025 on the land of the Mulyo Abadi Farmers Group and the Mulyo Farmers Group, Pakong Village, Pakong District, Pamekasan Regency. The research method used included descriptive, qualitative, and quantitative approaches. Technical data on tobacco cultivation were collected through interviews and field observations, then analyzed descriptively. Data on tobacco plant growth and yield were analyzed using a Randomized Block Design (RBD) with six treatments and three replications, including observations of plant height, number of leaves, fresh weight, and dry weight, which were then analyzed using ANOVA and continued with a 5% LSD test if there were significant differences.

2.1. Problem formulation

At this stage, the author identifies the problem and determines the problems that will be discussed in the research according to the issues that occur.

2.2. Literature search

The author reviews and collects information relevant to the research topic from various written sources, such as journals, books, regulations, and other scientific documents, to strengthen the theoretical basis and support the research analysis.

2.3. Data Collection

The author used both primary and secondary data. Primary data was obtained from field observations and interviews. Secondary data was based on theoretical studies from various literature sources.

2.4. Data analysis and interpretation

The research data were analyzed using Analysis of Variance (ANOVA), and if significant differences were found, a 5% BNT test was used. The linear model for RAK in this study is as follows.

$$Xij = \alpha ij + \beta j + Pi + eij$$

Description:
Xij = Observations on the i-th treatment located in the jth repetition
αij = True average
βj = Effect of the jth repetition
Pi = Effect of treatment i
eij = influence of the i-th treatment error and the j-th replication

$$\text{BNT} = t_{\alpha/2,\, df_e} \times \sqrt{\frac{2 \cdot MSE}{r}}$$

Description:
$t_{\alpha/2,\, df_e}$ = t-value at the α significance level (two-tailed) and
MSE = Mean Square Error dari ANOVA.
r = number of replications per treatment

3. Results and Discussion

3.1. Results

Based on the research conducted, it was found that monoculture and intercropping with shallots in the cultivation of Prancak 95 tobacco varieties have several differences in cultivation techniques, growth, and crop yield. Data from interviews and observations regarding cultivation techniques are explained descriptively and presented in tabular form. Meanwhile, data on plant growth and yield were subjected to ANOVA and 5% BNT tests for significant differences.

Technical Differences Between Monoculture and Intercropping Tobacco Cultivation

The monoculture and intercropping patterns with shallots in the cultivation of the Prancak 95 tobacco variety have several technical differences. These differences are grouped according to components, including land preparation, planting, maintenance, harvesting, and post-harvest. Table 1 shows the technical differences between monoculture and intercropping. Generally, the technical stages of cultivation in both cropping patterns are relatively similar, but differ in planting timing and maintenance intensity due to the presence of shallots in the intercropping pattern.

Table 1: Technical Differences in Tobacco Cultivation

Monoculture Tobacco	**Intercropping** Tobacco + Shallots
Land cultivation Tractor 25-35 cm ↓ Land beds l 100 x t 30 cm, distance 80 cm. ↓ Double row. 40 x 40 cm	Land cultivation Tractor 25-35 cm ↓ Land beds l 100 x t 30 cm, distance 80 cm. ↓ Double row. 40 x 40 cm

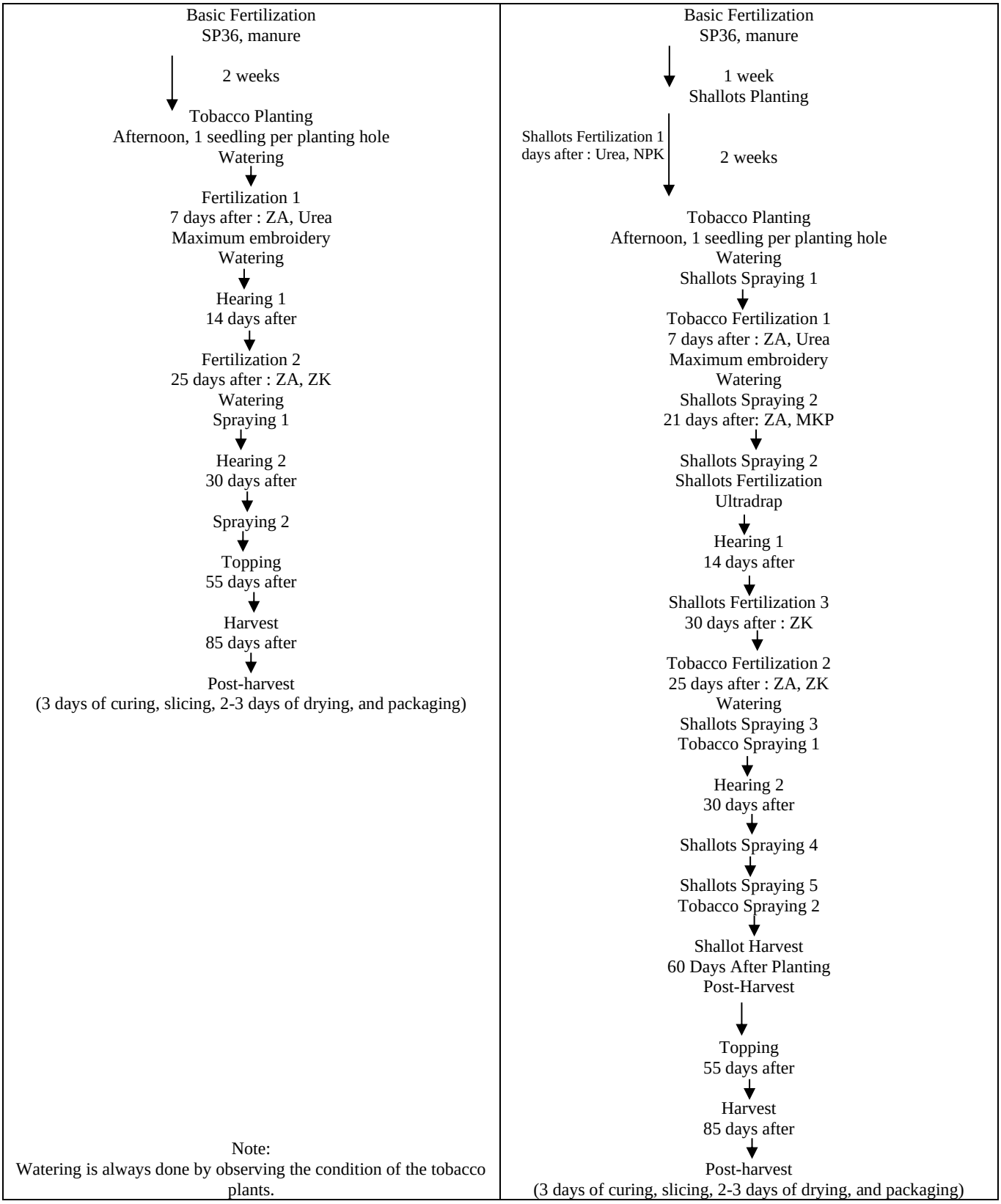

Table 2: Average Height of Tobacco Plants (cm) of Prancak 95 Variety

Treatment	Plant height (cm) at HST age		
	35	**49**	**63**
M1	29,00	55,00	111,33
M2	27,33	56,33	107,00
M3	30,67	54,67	103,67
T1	30,33	56,00	98,00
T2	22,33	56,33	96,67
T3	21,33	53,00	94,67
BNT 5%	tn	tn	tn

Table 3: Average Number of Tobacco Leaves (strands) of Prancak 95 Variety

Treatment	Number of leaves (blades) at HST age		
	35	49	63
M1	10,67	13,33	16,67 c
M2	9,00	13,67	15,00 b
M3	9,67	13,67	15,33 b
T1	10,33	14,33	12,67 a
T2	8,67	11,67	14,33 a
T3	8,33	12,67	12,67 a
BNT 5%	tn	tn	*

Table 4: Tobacco and Shallot Production Results (Kg/Ha)

Treatment	Tobacco		Shallots	
	Wet Weight	Dry Weight	Wet Weight	Dry Weight
Monoculture				
M1	5.778	1.056	-	-
M2	5.280	960	-	-
M3	5.293	967	-	-
Average	5.450	994	-	-
Intercropping				
T1	2.473	445	11.000	6.600
T2	2.527	464	9.000	5.400
T3	2.619	476	11.167	6.700
Average	2.540	460	10.389	6.233
BNT 5%			tn	tn

Growth of Tobacco Plants of the Prancak 95 Variety

Tobacco plant height and leaf number were observed at 14-day intervals, starting at 35 days after planting, continuing at 49 days after planting, and finally at 63 days after planting. Table 3 shows the average height of tobacco plants cultivated in monoculture and intercropping with shallots. Although these did not produce significantly different results, especially at 35 days after planting and 49 days after planting, at 63 days after planting, the average height of tobacco plants cultivated in monoculture was higher than that of plants cultivated in intercropping with shallots. The average number of tobacco leaves was analyzed using analysis of variance, showing that there was no significant difference at 35 days after planting and 49 days after planting, but at 63 days after planting, there was a significant difference. This means that monoculture and intercropping of tobacco plants significantly influence the number of tobacco leaves. The M1 monoculture planting pattern had the highest average leaf number, reaching 16.67 leaves. The results of this analysis can be seen in Table 4.

Tobacco and Shallot Crop Yield

Tobacco leaf wet weight was obtained by weighing freshly picked tobacco leaves, including the entire leaf mass, including the middle, upper, and lower leaves. Table 4 shows that the average wet leaf productivity of tobacco planted in monoculture was 5,450 kg/ha, higher than the average productivity of tobacco planted intercropped with shallots, which averaged only 2,540 kg/ha. Meanwhile, the dry leaf weight of tobacco was obtained by weighing the dry, shredded tobacco leaves. The average dry leaf weight of tobacco planted in monoculture reached 994 kg/ha, higher than the productivity of tobacco planted intercropped with shallots, which was only 462 kg/ha. Table 4 also shows the productivity of shallots in the intercropping pattern, expressed as wet and dry weight per hectare. Analysis revealed no significant differences among all treatments.

3.2. Discussion

Technical Differences Between Monoculture and Intercropping Tobacco Cultivation

Tobacco cultivation begins with tilling the land using a tractor to a plowing depth of 25-35 cm. This is done to create optimal growing conditions for tobacco plants by improving soil structure and aeration. Deep tillage of up to 35 cm can improve soil physical properties by increasing total porosity, capillary porosity, and soil water content in the 0-40 cm profile. Deep tillage significantly stimulates root growth and improves root spatial distribution, which can benefit tobacco plants' absorption of water and nutrients from deeper soil layers (Xiao *et al*., 2024) [13]. The soil is then leveled, and raised beds and drainage channels are created. The beds are approximately 100 cm wide, 20-30 cm high, and 40-50 cm apart. Once the beds are formed, planting holes are made in a double-row pattern with a spacing of 40 x 40 cm. The results of research by Rahmatzadeh *et al* (2023) [8] showed that the application of double row planting distance combined with spraying nitrogen (N) and potassium (K) fertilizers through the leaves was able to provide a significant increase in the growth index and yield of tobacco plants.

Basic fertilizer, SP 36 fertilizer, and manure are also applied when digging the planting holes. Then, the planting holes that have been fertilized are covered and left for two weeks. In monoculture planting patterns, tobacco is planted after the land is prepared. Meanwhile, in intercropping planting patterns, shallots are planted one week after land preparation, and after the shallots are 14 days after planting, tobacco is planted. According to Kurniawan *et al*. (2024) [6], the best planting time is in the afternoon, around 2:00 PM to 5:00 PM, to prevent leaf wilting. Replanting of dead seedlings is carried out at a maximum of 7 days after planting. When the tobacco plants are 7 days after planting, the first fertilization is carried out using urea as a starter, and the second fertilization is carried out at 25 days after planting using ZA and ZK fertilizers.

The first fertilization of red onions is also carried out at 7 days after planting, followed by ZA and MKP at 21 days after planting, and the final fertilization with ZK at 30 days after planting. Additional fertilization is carried out with Ultradrap.

In an intercropping pattern, when tobacco reaches 45 days after planting (HST), shallots are harvested at 60 days after planting. Topping or pruning of shoots is carried out when the plants reach 55 days after planting or when 30% of the plants are ready for topping, namely during the early flowering stage, which is the best time for topping. Pruning tobacco plant shoots effectively encourages leaf expansion, increases leaf area and photosynthesis, and influences metabolite accumulation. This shoot pruning shifts generative growth to vegetative growth, increases leaf photosynthetic capacity, and alters fundamental metabolic patterns (Shi *et al*., 2025) [9].

Harvesting is carried out when the plants are 85 days after planting and is based on leaf maturity. This is done in stages, starting from the bottom leaves and working up to the top. The leaves are harvested when they are yellowish-green and have a flexible texture. After curing for 2-3 days, the leaves are then shredded using a shredding machine. The shredded tobacco is arranged on a bed deck and dried in the sun. The dried, shredded tobacco is then packaged in mats, known as balls.

Growth of Tobacco Plants of the Prancak 95 Variety

Table 2. Although there was no significant difference, at 63 days after planting (DAP), the average height of tobacco plants cultivated as a monoculture was higher than that of plants cultivated intercropped with shallots. The average height of monoculture tobacco plants was over 100 cm, with the highest being 103.67 cm, 107.00 cm, and 111.33 cm. Meanwhile, the average height of intercropped tobacco plants was below 100 cm, with the highest being 98.00 cm and 96.67 cm. The advantage of monoculture cultivation is that plant maintenance is easier and more efficient because the plants are uniform. Plant maintenance can be more focused on a single plant species, resulting in more optimal yields (Cameron *et al*., 2025) [3].

Tobacco grown in monoculture is higher than tobacco grown in intercropping with shallots. Monoculture cultivation has greater growth and production yields compared to other crop cultivation systems due to the absence of competition between plants for nutrients and sunlight (Yusra *et al*., 2025) [14]. Research conducted by Sun *et al* (2025) [11] shows that the tobacco monoculture planting pattern produces a higher proportion of quality tobacco leaves compared to the intercropping pattern, with significant or significantly different results.

Tobacco and Shallot Crop Yields

The difference in tobacco leaf wet weight productivity between monoculture and intercropping patterns reached 2,911 kg/ha, or 36.43%. Leaf wet weight is influenced by good plant growth (Zudri *et al*., 2023) [15]. Based on tobacco plant growth data, including plant height and leaf number, the monoculture planting pattern did indeed produce higher yields than the intercropping pattern with shallots. Meanwhile, the difference in tobacco dry weight productivity between monoculture and intercropping was 532 kg/ha, or 36.53%.

The average wet weight and dry weight of tobacco plants can be influenced by the difference in the number of tobacco leaves between monoculture and intercropping, where the number of leaves in the monoculture planting pattern is higher than that in the intercropping pattern with shallots. This is also in accordance with research conducted by Elina *et al* (2025) [5], whose results showed that the increase in the number of wet and dry tobacco leaves is in line with the increase in the number of leaves. In terms of plant breeding, the size and number of leaves are indeed one of the indicators of Madurese tobacco plant production. Research conducted by on the effects of monoculture and intercropping planting on tobacco plants also shows that the monoculture planting pattern has a significantly higher production yield compared to other planting patterns, including intercropping.

4. Conclusion

Monoculture and intercropping generally have relatively similar technical cultivation stages, but differ in planting time and maintenance intensity due to the presence of shallots in the intercropping pattern. Plant growth and yield in monoculture and intercropping patterns respond differently to the plant height and number of leaves of the Prancak 95 tobacco variety. The monoculture pattern produces more optimal tobacco growth, indicated by higher plant height and number of leaves compared to intercropping. This difference affects production results, where the wet weight and dry weight of tobacco in the monoculture pattern tend to be higher. However, in the intercropping pattern, there is additional production from shallots.

5. Suggestion

Farmers should consider various technical and agronomic aspects when selecting the tobacco planting pattern to be used, to find the most profitable planting pattern and yield the best results.

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