

Feasibility of intercropping *Indigofera zollingeriana* and *Pennisetum purpureum* cv Mott under coconut plantation at different planting space based on indices competition

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ABSTRACT

The point of this exploration was decides the feasibility of intercropping *Indigofera zollingeriana* (Iz) and *Pennisetum purpureum* (Pp) under coconut manor dependent on dry matter yield. This experimentati was led by Completely Randomized Design (CRD) with four treatment mix of establishing space, Iz with establishing space (1) 1.00m x 0.75m, (2) 1.00m x 1.25m, and Pp with establishing space (1) 1.00m x 0.50m, (2) 1.00m x 0.75m. Data collections were analyzed by disagreement analysis of variance and HSD test. The variables measured were aggressivity(A), competitive ratio (CR) and Actual Yield Loss (AYL). The results showed that planting space treatments had significant differences ($P < 0.01$) on A, CR and AYL. The HSD evaluation showed that Iz was the predominant in many combinations establishing designs intercropping, Iz with extension 1.00m x 1.25m and Pp with extension 1.00m x 1.50m have highest A, CR and AYL. It conclusion, that intercropping *Indigofera zollingeriana* and *Pennisetum purpureum* cv Mott are feasibility for all combination planting space, but the most suitable for Aggressivity, Coefficient Relative Crowding and Actual Yield Loss evaluation based on dry matter yield in the size area of 1.00m x 1.25m *Indigofera zollingeriana* and 1.00m x 0.50m *Pennisetum purpureum* cv Mott as planting spacing under the coconut plantation.

Keywords : *feasibility, intercropping, planting space.*

1. INTRODUCTION

The principal justification for utilizing intercropping is the way that it includes incorporating crops utilizing space and work all the more productively. Biophysical reasons incorporate better use of natural elements, more prominent yield steadiness in factor conditions and soil preservation rehearses. The magnitude of inputs and outputs and their contribution to the stability of household food supply are socioeconomic reasons. Intercropping of two or more crop species not only improves yield but also enhances biological diversity, and suppresses pests and diseases [1]. One of the almost universal cultivation practices utilized in sustainable agricultural systems is intercropping. It entertains a significant job in expanding strong ground efficiency and yield soundness [2]. The key help of intercropping is that it assist in using the accessible cycles quickly and augments the fruitfulness of the harvests. Intercropping immerse by giving that gave that shade, decrease draft speed, expanding infiltration with mulch layers, and rising begrime constitution [3]. The primary assurance of intercropping is to comprise an unrivaled way outturn on a land by streamlining processes that can't be utilized in a monocropping exchange quickly [4].

A persuasive and coordinate game-plan of expanding diverseness of an agroecosystem is intercropping exchange that acknowledges interaction between the people of the contradistinctive yields and enhancements[5]. Intercropping buoy aggregate material multifariousness nailed down the progressive planting of contradistinctive crops during corresponding opportunity [6]. The advantage of intercropping of cardinal or bounteous crops to improve final yield depends on spatial arrangements (intercropping pattern) of participated crops [7]. Accrued nutritious comprehension in intercropping organizedwhole buoy eventualize spatially and temporally. Spatial nutritious appreciation float be accumulated made certain about the rising establishment mass, fix material superiorities in nutritious cognizance eventualize when crops in an intercropping exchange chalk up highest point nutritious expects at contradistinctive times. Then again, any combination chalk up inconsistency outcomes on the outturn of the parts under intercropping exchange [8].

Low quality feed of tropical grasses given by the rancher prompts low everyday addition of dairy cattle. The issue is supply of rummages is lacking because of limit of room for search creation and rely upon the seasons astoundingly in dry battery period. At only 8% of crude protein, tropical grasses as the primary source of feed are never sufficient to meet nutritional requirements [9]. *Indigofera zollingeriana* adult luxuriously and accessible on the year, where those corner vegetables bring out foliage could be constructed the predominance of inferior quality grasses. *Indigofera* species has considerables expect as rummages for ruminants. It is a potentiality legume because

it has a first-class aggrandizement [10] with high production [11] and nutritive value [12]. The use of this spice species accumulated protein content of proportion, dry matter confusion degradability, and unpredictable unsaturated fat worth in vitro stomach portrayal [13].

Competition among combinations is believed to be the significant viewpoint influencing yield as contrasted and singular editing of cereals. Species or cultivar selections, seeding ratios, and competition capability within mixtures may affect the growth of the species used in intercropping systems in rain-fed areas [14]. A number of indices such as land equivalent ratio, relative crowding coefficient, competitive ratio, actual yield loss have been proposed to describe competition within and economic advantages of intercropping systems [15]. The purpose of this research was determines feasibility of intercropping *Indigofera zollingeriana* (*Iz*) and *Pennisetum purpureum* (*Pp*) under coconut plantation based on nutrient potential.

2. MATERIALS AND METHODS

2.1. Experimental Site

The consider was led in the observational area of Asasement Institute of Agriculture Technology (AIAT) of Northwards Sulawesi, situated 12 km from Manado City. Observational situation conentional an intermediate precipitation of 500 mm, and moderatly apportioned all the more on all sides of location, apart from for the amplitude of mark down precipitation of 50-100 mm monthly. The pH of the fertile, blond loam begrime was on all sides of 6. Flourescent transmittance at 10.00 a.m on a sunny day after day as PAR underneath mature tall coconuts was averaging of 73 percents. The begrime coloration was dark-skinned chocolate-brown clay. Precipitation peaks took place in January, with high-pitched precipitation concentration. This consideration caused high-pitch comparative humidness of 86 percents. Atmosphere temperature ranged from 23.1 °C to 32.7 °C.

2.2. Experimental Design

Seeds of grass *Pennisetum purpureum* cv Mott (*Pp*) were obtained from Asasement Institute of Agriculture Technology (AIAT) of North Sulawesi. Seeds of legume *Indigofera zollingeriana* (*Iz*) were obtained from the Agrostology region of the institution of Animal Science, Bogor Agricultural University. *Indigofera* seeds sown on land had been processed as a nursery. Plant seeds that had grown well were then moved into the 2.5 kg plastic bag already filled with soil (one plant/plastic bag). Subsequently ontogenesis of two months in a medium plastic bag, the communicate was so transferred in to observational situation in a machination proportion of 3m x 4m that had been clarified with 6 treatment of behaviour towards of planting placement with string placement of 1m apart. Three planting space *Iz* : (i) 1.00m x 0.75m, (ii) 1.00m x 1.25m. After two months *Indigofera* in plant site, *Pp* was planted. Two Planting space *Pp* : (i) 1.00m x 0.50m, and (ii) 1.00m x 0.75m. Intercropping having four combination and each was planted in six plot. The plot combination were: $I_1= 1.00m \times 0.75m \text{ } Iz \ \& \ 1.00m \times 0.50m \text{ } Pp$; $I_2= 1.00m \times 0.75m \text{ } Iz \ \& \ 1.00m \times 0.75m \text{ } Pp$; $I_3= 1.00m \times 1.25m \text{ } Iz \ \& \ 1.00m \times 0.50m \text{ } Pp$; $I_4= 1.00m \times 1.25m \text{ } Iz \ \& \ 1.00m \times 0.75m \text{ } Pp$.

Indigofera was harvested at ± 90 days after planting. *Indigofera* were defoliated at height level 100 cm above ground. *Pennisetum* were defoliated at height level 10 cm above ground. Samples representatives were dried at 60°C for 48 hours. Samples were analyzed for dry matter, crude protein, and crude fiber following Association of Official Analytical Chemists (2005) procedure.

Data were analysed using analysis of variance (ANOVA) by MINITAB (Version 16). Honestly Significance Difference (HSD) was applied to investigate the influence of differentiation sorrounded by treatments. Significant differences were accepted if $P < 0.05$.

2.3. Feasibility

The feasibility of intercropping *Indigofera zollingeriana* with *Pennisetum purpureum* CV Mott at different planting distances can be measured through aggressiveness value, competition ratios and actual yield loss.

(1) The Aggressivity (A) which is often used to determine the competitive relationship between 2 crops used in the mixed cropping. The aggressivity was formulated by [16] as follows:

$$A_I = (Y_{IP} / Y_I \times Z_{IP}) - (Y_{PI} / Y_P \times Z_{PI}), \text{ and}$$

$$A_P = (Y_{PI} / Y_P \times Z_{PI}) - (Y_{IP} / Y_I \times Z_{IP}).$$

where Y_P and Y_I are the yields of *Pp* and *Iz* as sole crops, respectively, and Y_{PI} and Y_{IP} are the yields of *Pp* and *Iz* as intercrops, respectively. Z_{PI} and Z_{IP} were the proportions of *Pp* and *Iz* in the mixture, respectively.

(2) The Competitive Ratio (CR) is another way to assess competition between different species. The CR gives more desirable competitive ability for the crops and is also advantageous as an index over K and AYL [16].

The CR represents simply the ratio of individual LERs of the 2 component crops and takes into account the proportion of the crops in which they are initially sown. Then, the CR index was calculated using the following formula:

$$CR_{Pennisetum} = (LER_P / LER_I)(Z_{IP} / Z_{PI}), \text{ and}$$

$$CR_{Indigofera} = (LER_I / LER_P)(Z_{PI} / Z_{IP})$$

where $LER_P = (Y_{PI} / Y_P)$, and $LER_I = Y_{IP} / Y_I$, where Y_P and Y_I are the yields of Pp and Iz as sole crops, respectively, and Y_{PI} and Y_{IP} are the yields of Pp and Iz as intercrops, respectively.

(3) The Actual Yield Loss (AYL) which provides more accurate information on competition than other indicators between and within constituent crops and on the behavior of individual species in the intercropping. This system, because it is based on yield per plant [17]. AYL is the yield loss or gain of the intercrops to their respective single crops, i.e., it takes into account the actual sown ratio of the component crops to its single crops. In addition, an AYLI or AYLP fraction represents the respective yield loss or gain of each species under intercropping, compared with its single plantation yield [16]. AYL is calculated as follow formulas: $AYL = AYLI + AYLP$, where.

$$AYLI = ((Y_{IP} / X_{IP}) / (Y_I / X_I)) - 1$$

$$AYLP = ((Y_{PI} / X_{PI}) / (Y_P / X_P)) - 1$$

where X_{IP} and X_{PI} represent the sown proportion of intercrop *Indigofera* with *Pennisetum*, and *Pennisetum* with *Indigofera*, respectively.

3. RESULTS AND DISCUSSION

3.1. Results

Implication of Aggressivity, competitive ratio, and actual yield loss

Aggressiveness (A) is the dominance of a plant species in intercropping. This situation shows the dominance of plants in competing for resources both vertically and horizontally. Plants that are strong in competition will provide maximum results at the end of their life cycle. The values obtained for aggressiveness are the same but are distinguished by positive (+) and negative (-) signs. If $A_{Indigofera} = 0$, both crops are equally competitive, if $A_{Indigofera}$ is positive, then the *Indigofera* species is dominant, if $A_{Indigofera}$ is negative, then the *Indigofera* is weak. In all planting space, positive $A_{Indigofera}$ values showed that *Indigofera* was the dominant species (Table 1).

The results showed that *Pennisetum* plants were more dominantly aggressive towards *Indigofera* plants in the combination of plant distances Iz 1.00m x 0.75m and Pp 1.00m x 0.50m, as well as the combination of plant distances Iz 1.00m x 1.25m and Pp 1.00m x 0.50m, while *Indigofera* plants were more dominantly aggressive against *Pennisetum* plants in the combination of plant distances Iz 1.00m x 0.75m and Pp 1.00m x 0.75m, as well as the combination of plant distances Iz 1.00m x 1.25m and Pp 1.00m x 0.75m (Table 1).

Table 1. The Aggressivity, Competitive Ratio, and Actual Yield Loss of intercropping *I. zollingeriana* and *P. purpureum* cv Mott based on dry matter potential yield.

| Planting space | | Variable | | | | | | Total |
|----------------|---------------|---------------------|---------------------|--------------------|--------------------|--------------------|---------------------|---------------------|
| Indigofera | Pennisetum | A | | CR | | AYL | | |
| | | Pennisetum | Indigofera | Pennisetum | Indigofera | Pennisetum | Indigofera | |
| 1.00m x 0.75m | 1.00m x 0.50m | 0.097 ^b | -0.097 ^c | 1.957 ^b | 2.078 ^c | 9.833 ^a | 10.445 ^b | 20.240 ^a |
| | 1.00m x 0.75m | -0.064 ^d | 0.064 ^a | 2.228 ^a | 1.811 ^d | 9.874 ^a | 8.035 ^d | 18.400 ^b |
| 1.00m x 1.25m | 1.00m x 0.50m | 0.248 ^a | -0.248 ^d | 1.771 ^c | 2.446 ^a | 8.552 ^b | 11.815 ^a | 20.490 ^a |
| | 1.00m x 0.75m | -0.010 ^c | 0.010 ^b | 1.784 ^c | 2.249 ^b | 7.639 ^c | 9.638 ^c | 17.280 ^c |
| P value | | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | P<0.01 |
| SE Mean | | 0.0099 | 0.0099 | 0.0228 | 0.0214 | 0.1112 | 0.1355 | 0.726 |

^{a,b} Means in the same row with different letters show differences ($p < 0.05$). A: Aggressivity, CR: Competitive ratio, AYL: Actual yield loss, SE: standard error

Competitive Ratio (RC) or competition ratio is the ability of plants to obtain resources both vertically and horizontally. The results of the research showed that the highest competition ratio for *Pennisetum* plants was found in the combination of plant distances Iz 1.00m x 0.75m and Pp 1.00m x 0.75m, while the highest competition ratio

for Indigofera plants was found in the combination of plant distances Iz 1.00m x 1.25m and Pp 1.00m x 0.50m (Table 1.). The competition ratio value strengthens the aggressiveness value, that the higher the aggressive value of a plant in an intercropping system, the stronger the plant competes to obtain resources.

Actual Yield Loss (AYL), in particular, AYLIndigofera and AYLPennisetum had positive values in all planting pattern. The highest AYLIndigofera value belonged to in planting patterns Iz 1.0mx1.25m and Pp 1.00m x 0.50m while the lowest value was in planting patterns Iz 1.00m x 0.75m and Pp 1.00m x 0.75m, while the highest AYLPennisetum value belonged to in planting patterns Iz 1.00m x 0.75m and Pp 1.00m x 0.75m while the lowest value was in planting patterns Iz 1.00m x 1.25m and Pp 1.00m x 0.75m (Table 1). Comparing 2 crops, excepted planting patterns Iz 1.00m x0.75m and Pp 1.00m x 0.75m had the higher AYLIndigofera values than AYLPennisetum (Table 1).

3.2. Discussion

Interspecies rivalry is interceded through contest for soil, water, accessible supplement and sun oriented radiation, albeit different factors, for example, temperature change, bother invasion and agromanagement rehearses are similarly significant. Thickness severally affects crop yield on the grounds that the point of proper dividing between plants is to give a suitable blend of natural variables (water, environment, light and soil) for greatest execution [18]. Search in a shadow climate in coconut manors, albeit the quantity of vegetable populaces has expanded by ha, dry weight doesn't increment straightly. This peculiarity is likely because of the absence of regulation in coconut manor [19]. The creation of rummage drymatter inconveniences is contributed by the arrangement of leaves and stems, which are delivered by cell division and extension. Both physiological medicines are the site of intense metabolic action, including the union of dry matter confusions nailed in the usage of climatic CO₂ photosynthetic exercises [20].

Superiorities of intercropping are credited to a bounteous use of limited processes much as light, supplements and water [21]. The nutrient constitution of plants influenced by fertility rate of the growing media and some factors of the biotic environment. Short distance (increased density) increases nutrient requirement and sunlight competition. Planting extension pretentious micro surrounding (temperature, humidness and light) and dilated the rod to comprehension nutritious [18]. Since light is provided from overhead plants, people that decide their leaves overhead those of neighbors beatitude as the cow flies from accrued photosynthetic censures and by implication by decrease the development of those neighbors through conceal [22].

Physiological complementarity can occur in polycultures composed of species that use C₄ and C₃ photosynthetic pathways and this is illustrated by the earlier North Carolina example of maize, a C₄ type plant that is better adapted to high light environments. Obviously, the most well-known illustration of physiological complementarity is obsession of nitrogen by vegetable parts, implying that dirt nitrogen is accessible for adjoining non-vegetables [23]. The bounteous numerals of branches, the higher the ontogenesis trademark for leave advancement and confirmation be connected the accessibility of energy holds (carbs) something going regrowth of scavenges convey [24]. Research under concealing climate in coconut manors, despite the fact that the quantity of plant populaces expanded per hectare, dry weight had not increment straightly. This peculiarity was likely because of the deficiencies light in coconuts estate [19]. Finding in study was not in accordance with result found in full daylight climate expanding plant populace per unit region. This condition moved toward a furthest restriction of creation straightly [25].

Trial proof showed that plant connections subterranean are regularly more serious than those over the ground and rivalry might restrict take-up. Supplements frequently happen in unambiguous zones of the dirt because of specific ecological circumstances (for example draining), the board rehearses (for example surface applied phosphates), or supplement solvency. Lined up with these distinctions, and frequently somewhat because of them, there are contrasts in root appropriation designs among plants and all through the dirt profile. The creators, further showed as roots can likewise utilize soil assets in an unexpected way: In how the supplement prerequisite is fulfilled (vegetables use N, non-vegetables utilize NO₃ or NH₄). Various species might vary in their prerequisite for an asset. There are fourfold contrast between species for calcium focus, twofold for potassium and phosphate and triple distinction for nitrogen fixation [23].

4. CONCLUSION

Based on the results of this study, it can be concluded that intercropping *Indigofera zollingeriana* and *Pennisetum purpureum* cv Mott are feasibility for all combination planting space, but the most suitable for Land Equivalent Ratio, Coefficient Relative Crowding and Actual Yield Loss evaluation based on dry matter yield in the size area of 1.00m x 1.25m *Indigofera zollingeriana* and 1.00m x 0.50m *Pennisetum purpureum* cv Mott as planting spacing under the coconut plantation.

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