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Forage Production and Nutrient Composition of Different Sorghum Varieties Cultivated with Indigofera in Intercropping System

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ABSTRACT

The experiment aimed to evaluate the production of nutrients by different varieties of sorghum grown with high valuable indigofera legume in intercropping system and to determine the suitable variety of sorghum that produced the highest nutrient in the system. The experiment was done at Jonggol Animal Science Teaching and Research Unit (UP3J) Jonggol, from November 2014 to March 2015. This experiment was conducted using completely randomized design with 2 factors (3 x 4) and 4 replications. The first factor was sorghum varieties (PATIR 3.2 (S1), PATIR 3.7 (S2), and CTY-33 (S3)). The second factor was indigofera composition (0% indigofera (I0), 30% indigofera (I1), 40% indigofera (I2), and 50% indigofera (I3)). Data were analyzed using analysis of variance and HSD test. There was no interaction among varieties of sorghum and indigofera composition. Indigofera population of up to 50% in multiple cropping system had the highest (P<0.01) dry matter content, crude protein content, ash content, total fresh weight production, total dry weight production, total crude protein production, total ash production, and carrying capacity. Sorghum variety CTY-33 planted in multiple cropping system had the highest (P<0.01) dry matter content, total dry weight production, and (P<0.05) total crude protein production. PATIR 37 sorghum variety planted in multiple cropping system had the highest (P<0.05) ash content and (P<0.01) total ash production. It is concluded that Indigofera population of up to 50% planted with different varieties of sorghum in multiple cropping system had the highest nutrient production.

Key words: forage, indigofera, intercropping, nutrient production, sorghum

ABSTRAK

Penelitian ini dilakukan dengan tujuan untuk mengevaluasi produksi nutrien beberapa varietas sorgum yang dibudidayakan bersama leguminosa berkualitas (indigofera) dalam sistem tumpangsari, dan juga untuk menentukan kombinasi sorgum yang cocok dengan komposisi indigofera yang menghasilkan produksi nutrisi yang tertinggi dalam sistem. Penelitian ini dilakukan di Unit Pendidikan dan Penelitian Peternakan Jonggol (UP3J), sejak November 2014 sampai Maret 2015. Penelitian ini dilakukan dengan menggunakan rancangan acak lengkap pola faktorial dengan 2 faktor (3 x 4) dan 4 ulangan. Faktor pertama adalah varietas sorgum (PATIR 3.2 (S1), PATIR 3.7 (S2), dan CTY-33 (S3)). Faktor kedua adalah komposisi indigofera (0% indigofera (I0), 30% indigofera (I1), 40% indigofera (I2), dan 50% indigofera (I3)). Data dianalisis menggunakan analisis varian dan uji BNJ. Hasil analisis keragaman menunjukkan bahwa tidak ada interaksi antara varietas sorgum dan komposisi indigofera. Populasi indigofera yang mencapai 50% menghasilkan kandungan bahan kering, kandungan protein kasar, kandungan abu, produksi bobot segar, produksi bobot kering, produksi protein kasar, produksi abu dan kapasitas tampung tertinggi (P<0,01). Varietas CTY-33 menghasilkan kandungan bahan kering, produksi bahan kering (P<0,01), dan produksi protein kasar (P<0,05) tertinggi, sedangkan PATIR 37 menghasilkan kandungan abu (P<0,01) dan produksi abu (P<0,05) tertinggi. Dapat disimpulkan bahwa populasi indigofera hingga 50% yang dibudidayakan bersama beberapa varietas sorgum pada sistem tumpangsari menghasilkan produksi nutrisi tertinggi.

Kata kunci: hijauan, indigofera, produksi nutrisi, sorgum, tumpang sari

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INTRODUCTION

Intercropping is one of the most common cultivation practices used in sustainable agricultural system. It plays an important role in increasing land productivity and yield stability. This cropping system improves resource utilization and environmental factors (Najafi & Kestehgar, 2014). The main purpose of intercropping is to produce a greater yield on a land by optimizing resources that cannot be utilized in a monocropping system efficiently (Moradi *et al*., 2014). The main advantage of intercropping is that it helps in utilizing the available resources efficiently and increases the productivity of the crops. Intercropping can conserve soil water by providing shade, reducing wind speed, increasing infiltration with mulch layers, and improving soil structure (Mobasser *et al*., 2014).

The interaction of intercropping system could increase root activity and microbial quantity in the rhizosphere (Zhang *et al.,* 2013). Rhizospheric interspecies interaction may also affect nutrient availability and uptake in intercropping. Alley cropping can maintain and sequester soil C and N beyond organic conservation tillage and more than conventionally tilled, chemically and fertilized treatment.

Sorghum is one of the important cereal crops grown in rainfed areas of over 42 million ha used for grains and fodders in semi-arid tropic of Africa, Asia, and Latin America (Reddy *et al*., 2004). Sorghum has a high yield potential, compared to rice, wheat, and maize. In field condition, its yields exceed 11 ton ha^{-1}, with average yields ranging from 7-9 ton ha^{-1} where water is not limited. In the areas where sorghum is commonly grown, yields of 3-4 ton ha^{-1} are obtained under normal condition. Sorghum is also known to have wide adaptability, ranging from lowland, medium to highland altitude. As an alternative animal feed, sorghum has good nutritional content, short-lived (100-110 days), resistant to drought and resistant to pest attack. Sorghum also has great potential to supplement fodder resources because of its wide adaptability, rapid growth, high green and dry fodder yields with high ratoon ability (Reddy *et al*.,2004). One important sorghum cultivar is brown midrib mutant line, Patir 3.7, which has higher dry matter production and lower lignin content compared to other brown midrib mutant line, Patir 3.1 (Sriagtula, 2016). Mixed cropping with legume helps to increase protein content in associated cropping of sorghum. Sowing of sorghum in double row strips with legume as intercrops led to the highest dry matter accumulation and NPK uptake observed during the intercropped sorghum compared to sole sorghum (Rashid *et al*., 2004).

Indigofera *sp*. is a plant of the legume group (family Fabaceae) with genus Indigofera and has 700 species spread in Africa, Asia, Australia, and North America (Schrire *et al*., 2009). Indigofera species serves as forages for ruminants. It is a potential legume because it has a good growth with high production and nutritive value (Abdullah, 2010). Protein content of indigofera's herbage is 29.16 % (Abdullah, 2014), and total dry matter production for 88 day after pruning was up to 5,410 kg/ha/harvest (Abdullah & Suharlina, 2010). Indigofera is utilized as protein sources in ruminant ration. The use of this legume species increases protein content of ration, dry matter degradability, and volatile fatty acid value in *in vitro* rumen model (Suharlina *et al*., 2016). The high protein levels of indigofera and the ability to tolerate drought, floods, and salinity make them agronomically desirable, while the deep-rooted growth form ability to respond to small rainfall, and resistance to herbivory make them potentially valuable cover crops and forage species for semi-arid and arid areas (Hassen *et al*., 2008).

Indigofera in alley cropping system improves the physico-chemical properties of soil, and ultimately improves the growth and development of the associated crop. Soil properties like soil pH, organic C, total N, available P, exchangeable K and Ca increase due to alley cropping (Ahmed *et al*., 2010b). *Indigofera* legume can maintain the content of N and available P in soil and improve soil organic C content and P-solubilizing bacterial population (Abdullah, 2010). Tomato grown in indigofera alley cropping system resulted in better number of fruits, fruit diameter, fruit length, fruit weight, and fruit yield compared to sole cropping (Ahmed *et al*., 2010a). Cabbage grown in alley cropping system had better number of outer leaves, outer leaf fresh weight, head length, head diameter, head weight, and head yield compared to sole cropping (Ahmed *et al*., 2010a). Brinjal grown in indigofera alley cropping system in resulted better plant height, fruit diameter, fruit length, number of fruits, fruit weight, and fruit yield compared to sole cropping (Ahmed *et al*., 2010a)

There are no reports on nutrient production of different varieties of sorghum that are grown with high valuable indigofera legume in intercropping system. This study was conducted to evaluate the nutrient production of different sorghum varieties grown with high valuable indigofera legume in intercropping system.

MATERIALS AND METHODS

Time and Location

This experiment was done at the Field Laboratory, Faculty of Animal Science IPB [Jonggol Animal Science Teaching and Research Unit (UP3J)]. It is located 60 km Northeast of Bogor, in the village of Singasari, Jonggol subdistrict, Bogor regency. It is located on 106.53^0 East longitude and 06.53^0 South latitude, with a height of 70 m above sea level. The experiment was done from November 2014 to March 2015 in a total area of 169 ha; about 67 ha was used for pasture, training, practical class, and research. The research land area was 7,000 m^2; it was divided into 48 plots, with each area having 100 m^2 experimental unit.

Material and Plot Design

The materials used in this study were the seeds of sorghum mutant lines CTY-33 and *Brown midrib* (BMR) consisting of PATIR 3.2, PATIR 3.7. They were taken from SEAMEO BIOTROP and *Indigofera zollinge-*

riana obtained from Agrostology Laboratory, Faculty of Animal Science IPB. The plot size was 10 x 10 m. The total number of plot was 48 consisting of 3 (sorghum) x 4 (composition of indigofera) x 4 (replications).

Indigofera zollingeriana seeds were planted in *seeding tray*. Three weeks after seedlings, the plants were transplanted to polybags (1 plant/polybag) which were filled with 2 kg growing media (consisting of 1 kg latosols and 1 kg cattle manure). The plants were nursed for 3 months in growing media. After 3 months of the nursery period, the plants were transplanted to experimental plot in the field.

Sorghum was planted with indigofera in various compositions, for designing an *in situ ration*. Sorghum seeds were sown by using sorghum planter at 5 cm depth. Each hole comprised 4-5 seeds. The sorghum plant space was 70 x 20 x 40 cm in *alley cropping* combined with indigofera; there was 120 cm space between rows. The plot area was 10 x 10 m with fixed number of sorghum plants; there were as many as 360 individual plants. About 70% of sorghum composition and 30% of indigofera correspond to 360 sorghum and 48 indigofera individual plants respectively; 60% sorghum and 40% indigofera correspond to 360 sorghum and 78 indigofera plants; 50% sorghum and 50% indigofera correspond to 360 sorghum plants and 114 indigofera plants.

Manure was applied at 2.5 ton/ha; it was immersed in the planting hole of indigofera. NPK fertilizer (16-16-16 blue mutiara) was applied at 240 kg/ha for 2 weeks after sorghum was planted in 5 cm of sorghum planting hole. Thinning of sorghum was done 2 weeks after planting. Stitching was performed 10 d after planting.

Experimental Design

This experiment was conducted using completely randomized factorial design with 2 factors (3 x 4) and 4 replicates. The first factor was sorghum varieties (PATIR 3.2 (S1), PATIR 3.7 (S2), and CTY-33 (S3)). The second factor was *Indigofera zollingeriana* (Indigofera) composition (0% indigofera (I0), 30% indigofera (I1), 40% indigofera (I2), and 50% indigofera (I3)). Data were then statistically analyzed by using analysis of variance (ANOVA) by means of MINITAB (Version 16). Honestly Significance Difference (HSD) was applied to determine the difference among treatments. Differences were considered at P<0.05.

Variable Observations

Harvesting biomass of sorghum and indigofera was done simultaneously when 80% of soghum was flowering (± 90 d after planting). Sorghum was defoliated at the first node from the soil surface (approximately 10 cm above ground). Indigofera was defoliated at 100 cm level above ground. Samples were dried at 60^{o}C for about 48 h to determine the dry weight. The samples were analyzed for dry matter, crude protein, crude fiber and ash according to the standard procedure of Association of Official Analytical Chemists (2005).

The variables include fresh weight yield (ton/ha), dry weight yield (ton/ha), crude protein yield (ton/ha), crude fiber yield (ton/ha), and ash yield (ton/ha). Dry matter yield of each plot was calculated through the value of green forage production and dry-weight precentage. Combining the dry matter yield with crude protein, crude fiber, and ash content data allowed us to calculate the mean crude protein, crude fiber, and ash yield. Carrying capacity was determined by the information obtained from the forage harvested; it was collected from productivity estimation of each plot and converted to one ha. Available forage was calculated based on 70% of the total used as factor. It is assumed that animal consumes 6.29 kg DM of forage/day/head (Indonesian condition). The amount of dry matter required to provide 6.29 kg of digestible nutrients based on available forage (70% of the total used as factor) was 9.0 kg.

RESULTS

Environmental Conditions

The field where the experiment was done has approximately 20% of flat land, 60% surge, and 20% of steep hills and valleys. The soil has an average pH of 6 and its colour was dark brown clay. The climate condition of the field area is shown in Figure 1. Precipitation peaks took place in January, with high rainfall intensity (380 mm). This caused high relative humidity (92%). However, in November, December, February, and March, the relative humidity range was 80% to 84%, which was still humid. Air temperature ranged from 25^{o}C to 37^{o}C. These climate conditions were suitable for the growth and production of both experimental plants.

Nutrient Composition

As shown in Table 1, the content of dry matter, crude fiber, and ash were significantly (P<0.05) influenced by varieties of sorghum, and the content of dry matter, crude protein, crude fiber, and ash were significantly (P<0.05) influenced by composition of sorghum. But, the content of dry matter, crude protein, crude fiber, and ash were not significant for the interaction between varieties and composition indigofera. The results showed that sorghum variety CTY-33 and 50% composition of indigofera had the highest (P<0.01) forage quality indicated by dry matter content and crude protein content.

High population of Indigofera (50%) plants planted in multiple cropping system separately had the highest dry matter content up to 25.50%, crude protein content up to 12.46%, and ash content up to 7.83%.

Fresh Weight

The total fresh weight yield was significantly (P<0.01) influenced by composition of indigofera in the cropping system (Table 2). However, the fresh weight was not affected (P>0.05) by sorghum cultivars and interaction between varieties of sorghum and indigofera composition. Increasing population of indigofera up to 30% in the cropping system improved total fresh yield

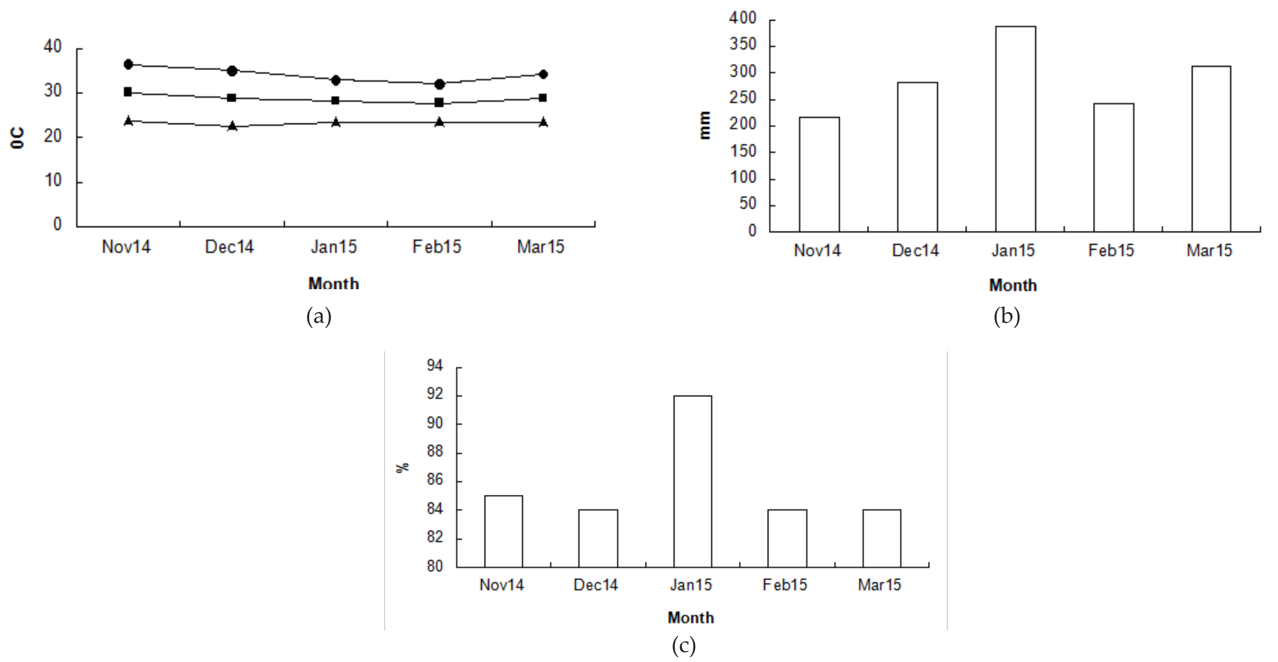

Figure 1. Climate condition of site during field experiment. Note: a= air temperature (-•-, maximum temperature; -■-, average temperature; -▲-, minimum temperature); b= rainfall; c= humidity.

Tabel 1. Nutrient composition of sorghum with indigofera in intercropping system

Treatment	Nutrient composition			
	Dry matter (%)	Crude protein (%)	Crude fiber (%)	Ash (%)
Sorghum				
S1	22.03 ± 1.35^{C}	9.60 ± 2.33	37.22 ± 2.08^{A}	6.76 ± 1.33^{AB}
S2	24.16 ± 1.74^{B}	9.59 ± 2.73	34.50 ± 3.65^{B}	7.14 ± 1.18^{A}
S3	25.46 ± 1.73^{A}	9.76 ± 2.74	37.00 ± 2.25^{A}	6.36 ± 1.52^{B}
Indigofera				
I0	22.13 ± 1.42^{C}	6.78 ± 0.52^{C}	36.30 ± 2.15^{B}	5.22 ± 0.91^{B}
I1	23.50 ± 1.57^{B}	8.90 ± 1.71^{B}	39.00 ± 0.93^{A}	7.17 ± 1.44^{A}
I2	24.41 ± 1.90^{AB}	10.48 ± 1.70^{B}	35.42 ± 2.49^{B}	6.80 ± 0.79^{A}
I3	25.50 ± 2.15^{A}	12.46 ± 1.64^{A}	34.24 ± 3.54^{B}	7.83 ± 1.07^{A}
S vs I				
S1*I0	20.43 ± 0.61	6.95 ± 0.45	36.85 ± 0.49	5.45 ± 0.93
S1* I1	21.90 ± 0.85	8.92 ± 1.52	38.70 ± 0.79	7.18 ± 1.81
S1* I2	22.32 ± 1.26	10.74 ± 2.04	36.79 ± 3.57	6.61 ± 0.42
S1* I3	23.48 ± 0.41	11.80 ± 1.51	36.54 ± 1.98	7.82 ± 0.70
S2* I0	22.34 ± 0.44	6.74 ± 0.81	34.41 ± 1.66	5.76 ± 0.79
S2* I1	24.06 ± 1.68	8.89 ± 2.01	39.31 ± 0.79	7.38 ± 0.34
S2* I2	24.86 ± 1.29	9.96 ± 1.82	34.03 ± 0.81	6.97 ± 0.73
S2* I3	25.39 ± 1.83	12.77 ± 2.01	30.26 ± 2.74	8.45 ± 0.84
S3* I0	23.61 ± 0.23	6.63 ± 0.24	37.63 ± 2.49	4.46 ± 0.55
S3* I1	24.54 ± 0.52	8.87 ± 2.10	39.01 ± 1.29	6.94 ± 1.14
S3* I2	26.05 ± 0.54	10.73 ± 1.63	35.43 ± 2.03	6.82 ± 1.22
S3* I3	27.65 ± 1.34	12.82 ± 1.63	35.93 ± 1.60	7.22 ± 1.41

Note: Means in the same column and species with different superscripts in uppercase differ significantly (P<0.01).

Table 2. Total fresh weight yield (ton/ha/harvest) of sorghum with indigofera in intercropping system

% Indigofera	Variety of sorghum			Average
	Patir 3.2	Patir 3.7	Citayam	
0	10.59 ± 1.33	11.07 ± 1.65	12.76 ± 4.64	11.47 ± 1.44B
30	13.38 ± 3.49	14.25 ± 1.97	14.41 ± 3.00	14.01 ± 2.66A
40	13.23 ± 2.09	14.77 ± 2.11	16.02 ± 1.99	14.67 ± 2.22A
50	16.17 ± 1.53	17.15 ± 3.07	16.00 ± 3.17	16.44 ± 2.50A
Average	13.34 ± 2.86	14.31 ± 3.02	14.80 ± 2.57	

Note: Means in the same column with different superscripts in uppercase differ significantly (P<0.01).

Table 3. Total dry weight yield (ton/ha/harvest) of sorghum with indigofera in intercropping system

% Indigofera	Variety of sorghum			Average
	Patir 3.2	Patir 3.7	Citayam	
0	2.17 ± 0.28	2.48 ± 0.41	3.01 ± 0.11	2.55 ± 0.45C
30	2.94 ± 0.80	3.45 ± 0.71	3.53 ± 0.72	3.31 ± 0.72B
40	2.97 ± 0.61	3.67 ± 0.51	4.18 ± 0.57	3.60 ± 0.73AB
50	3.79 ± 0.34	4.38 ± 1.02	4.45 ± 1.10	4.21 ± 0.86A
Average	2.97 ± 0.77B	3.49 ± 0.94AB	3.79 ± 0.86A	

Note: Means in the same column and species with different superscripts in uppercase differ significantly (P<0.01).

of herbage at average of 31%. This indicated high compatibility of both plant species at this composition level of the plant.

Dry Weight

There was a significant difference (P<0.01) in the dry weight between sorghum cultivars and composition of indigofera (Table 3). CTY-33 variety and 50% composition of indigofera had the highest dry weight yield. There was no significant effect of interaction among varieties of sorghum and indigofera composition on dry weight yield. Increased portion of indigofera (30% and 50%) in the plots led to increase in total dry weight by about 36% and 68%, respectively. It indicates that indigofera contributed to total biomass production of the plots. Meanwhile CTY-33 sorghum produced higher dry weight yield than PATIR 3.2.

Crude Protein

The total crude protein yield is shown in Table 4**.** There was significant difference in the crude protein yield (P<0.05) among sorghum cultivars, and (P<0.01) composition of indigofera. CTY-33 variety and 50% composition of indigofera had the highest crude protein yield. There were no significant differences in interaction among varieties of sorghum and indigofera composition for crude protein yield. Any changes in the composition of indigofera had no effect on crude protein yield.

Crude Fiber

Crude fiber yield was affected (P<0.01) by sorghum cultivars and indigofera composition, but there was no (P>0.05) interaction between varieties of sorghum and indigofera compositions (Table 5). Any changes in the composition of indigofera had no effect on crude fiber yield. Variety CTY-33 and indigofera composition of 50% had the highest crude fiber yield. Crude fiber yield is very closely linked to the production of dry matter and the content of plant crude fiber.

Ash

There were significant differences in ash yield (P<0.05) among sorghum cultivars and (P<0.01) composition of indigofera (Table 6). CTY-33 variety and indigofera composition of 50% had the highest ash yield. There were no-significant differences in interaction between varieties of sorghum and indigofera composition for ash yield. Changes in the composition of indigofera had no effect on growth of sorghum varieties.

Carrying Capacity

Based on the data obtained in Table 7, the lowest forage dry matter production was available in plot of sorghum PATIR 3.2 without indigofera composition. As much as 2.17 ton/ha/harvest could accommodate as 2.68 AU/ha. The highest forage dry matter production was available in plot of sorghum CTY-33 with 50%

Table 4. Total crude protein yield (ton/ha/harvest) of sorghum with indigofera in intercropping system

% Indigofera	Variety of sorghum			Average
	Patir 3.2	Patir 3.7	Citayam	
0	0.160±0.024	0.169±0.049	0.240±0.012	0.189±0.047C
30	0.260±0.080	0.312±0.121	0.313±0.130	0.295±0.105BC
40	0.321±0.126	0.369±0.100	0.448±0.086	0.379±0.110B
50	0.423±0.910	0.562±0.169	0.576±0.189	0.521±0.158A
Average	0.291±0.126b	0.353±0.180ab	0.394±0.173a	

Note: Means in the same column and species with different superscripts in uppercase and lowercase differ significantly at P<0.01 and P<0.05, respectively.

Table 5. Total crude fiber yield (ton/ha/harvest) of sorghum with indigofera in intercropping system

% Indigofera	Variety of sorghum			Average
	Patir 3.2	Patir 3.7	Citayam	
0	0.850±0.139	0.848±0.104	1.358±0.054	1.018±0.268B
30	1.138±0.315	1.360±0.300	1.337±0.276	1.278±0.288AB
40	1.056±0.173	1.245±0.146	1.484±0.258	1.262±0.256AB
50	1.300±0.174	1.339±0.388	1.595±0.372	1.412±0.325A
Average	1.086±0.253B	1.198±0.316AB	1.444±0.262A	

Note: Means in the same column and species with different superscripts in uppercase differ significantly (P<0.01).

Table 6. Total ash yield (ton/ha/harvest) of sorghum with indigofera in intercropping system

% Indigofera	Variety of sorghum			Average
	Patir 3.2	Patir 3.7	Citayam	
0	0.127±0.036	0.143±0.031	0.161±0.020	0.144±0.031[C]
30	0.208±0.067	0.256±0.060	0.239±0.067	0.234±0.062[B]
40	0.194±0.055	0.256±0.048	0.289±0.089	0.246±0.073[B]
50	0.278±0.036	0.372±0.103	0.323±0.106	0.325±0.089[A]
Average	0.202±0.071[b]	0.257±0.103[b]	0.253±0.094[a]	

Note: Means in the same column and species with different superscripts in uppercase and lowercase differ significantly at P<0.01 and P<0.05, respectively.

Table 7. Carrying capacity (AU/ha) of sorghum with indigofera in intercropping system

% Indigofera	Variety of sorghum			Average
	Patir 3.2	Patir 3.7	Citayam	
0	2.68 ± 0.35	3.06 ± 0.51	3.72 ± 0.14	3.16 ± 0.56[C]
30	3.63 ± 0.99	4.27 ± 0.87	4.37 ± 0.89	4.09 ± 0.90[B]
40	3.67 ± 0.75	4.53 ± 0.63	5.17 ± 0.71	4.46 ± 0.90[AB]
50	4.69 ± 0.42	5.42 ± 1.26	5.50 ± 1.35	5.20 ± 1.06[A]
Average	3.67 ± 0.95[B]	4.32 ± 1.17[AB]	4.69 ± 1.07[A]	

Note: Means in the same column and species with different superscripts in uppercase differ significantly (P<0.01).

indigofera composition; it has as much as 4.45 ton/ha/harvest that could accommodate 5.50 AU/ha. There was no-significant differences in interaction among varieties of sorghum and indigofera composition. There were significant differences in carrying capacity (P<0.01) among sorghum cultivars and composition of indigofera. CTY-33 variety and indigofera composition of 50% had the highest carrying capacity. High population of Indigofera of 50% plants planted in multiple cropping system separately resulted significant (P<0.01) increase of 0.93-2.04 animal units.

DISCUSSION

Shorgum and indigofera have different growth characteristics. Shorgum grows in vertical direction while indigofera grows in more horizontal direction. In this study, it was recorded that shorgum height reached 280 cm and had less space than indigofera, which formed canopy shape. About 30%-50% of indigofera population intraspecies competition might not be an important factor influencing total fresh yield. Sorghum shading effects caused the legume component to allocate more photosynthates to vegetative growth and thus height so as to compete with the taller sorghum and thus, have access to more solar radiation (Karanja *et al*., 2014).

Intercropping improve the soil's micro-environment (Salau *et al*., 2011). Soil microorganisms have an important role in maintaining soil function and involving in mineralization and mobilization of nutrients required for plant growth. Due to differential rhizodeposition, the microbial community structure in the rhizosphere may vary with plant species, nutritional status of the plant, manganese availability, soil type, and mycorrhizal colonization. Sharma & Batra (2014) found that wide natural asbuscular mycorhiza fungal diversity in the rhizosphere of date palms, and the root colonization by arbuscular mycorhizal fungi varied significantly; it ranged from 78%-93% in date palms' rhizosphere.

Increasing N in the soil is the most efficient method to increase the yield of plant dry matter. Dantata (2014) suggests that intercropping affects vegetative growth of component crops depending on the adaptation of planting pattern and selection of compatible crops. Intercropping with legume is a desirable agronomic practice to boost crop production.

Higher indigofera composition produces a higher dry matter. It is due to the increasing number of dry matter provided by indigofera. Mobasser *et al*. (2014) suggests that when a non-N fixing plant was cultivated in association with an N-fixing plant, nitrogen taken up by non-N fixing plant in the soil is derived from two source: coming from the N_2 fixation by legume and coming directly from the soil N. Approximately 70% to 90% of N was derived from the atmosphere (not the soil) and the N exported in the grain ranged between 15% and 21%. The direct contribution to the soil was the amount of N in the legume residue crop (incorporated into the soil) derived from the atmosphere (Ndfa). Intercropping that increased Ndfa correlated more closely with dry matter yield (Fan *et al*., 2006); more Ndfa would decrease crude fiber content, due to the good assimilation of N; it causes sufficient N supplies for the formation of protein, and makes crude fiber content decreased (Sanchez et al., 2010)).

Intercropping is one of the ways to do suitable planting. It consumes less and does not use external input, therefore it causes the soil to have more nutrients, leads to more soil fertility, saves water and increases agroecosystem stability (Rajaii & DahMardeh, 2014). In intercropping system, there is higher concentration of Ca in branches and stems and also higher N, P, K, Ca, and Mg in biomass than in monoculture system (Oelmann *et al*., 2010).

CONCLUSION

High population of Indigofera (50%) plants planted in multiple cropping system separately resulted highest nutrient production and carrying capacity. Sorghum variety CTY-33 resulted in highest dry matter content, total dry weight, and crude protein production, and PATIR 37 resulted in highest ash content and ash production.

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