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Research Article

Weed communities on monoculture and intercropping cultivation techniques

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Abstract: Monoculture and intercropping systems are techniques of controlling weeds in technical culture (ecology). Change in cropping system from monoculture to intercropping may affect the growth of weed species which cause different interaction between weed and plant competition. This research aimed to determine the composition of the weed community on the cultivation of monoculture and intercropping systems between maize, peanuts and cowpea. Treatment tested were G0= without crops (weedy), G1 = maize with planting distance of 80 x 25 cm, G2= maize with planting distance of 100 x 25 cm, G3 = maize with planting distance of 80 x 25 cm (+3 row of peanut), G4 = maize with planting distance of 100 x 25 cm (+ 4 row of peanut), G5= maize with planting distance of 80 x 25 cm (+3 row of cowpea), G6 = maize with planting distance of 100 x 25 cm (+ 4 row of cowpea), G7 = peanut with planting distance of 25 x 25 cm, and G8 = cowpea with planting distance of 25 x 25 cm. The results showed that based on Sum Dominance Ratio (SDR) analysis, the weeds in this study consisted of 17 species, i.e. 11 species of broadleaf weeds, 3 species of sedges weeds, and 3 species of grasses weeds. The intercropping system of maize with planting distance of 100 x 25 cm (+ 4 rows of cowpea) gave lower weed communities than the other treatments. Coefficient Community (C) that ranged from 4.54 to14.64 showed differences of weeds and weed communities when the coefficient was under 75% or communities weed species had equality species in the community compared. Shannon-Wienner Index (H') showed the diversity of weed communities the H' value ranged between 1.29 and 2.18. Weed control in intercropping system with cowpea reduced weed dry weight. While intercropping systems of G3, G4, G5 and G6 suppressed weed dry weight by 15.38, 27.69, 55.38, and 53.85% compared with G2, respectively.

***Keywords**: cowpea, intercropping, maize, peanut, weed species*

Introduction

The presence of weeds in crops area, monuculture or intercroping between maize, peanuts and cowpea can be a reference for how to control weeds. Composition of the weeds which have emerged as biotic components may explain the high or low level of dominance or barrage weeds that have emerged in the cultivation of land. A diversity of weeds can be affected by several factors, including condition of land and seasons that have taken place. In the composition of monoculture, it has weeds higher than in intercropping system. Intercropping pattern is planting more than one crop on the same land at the time. Pasau et al. (2008) suggests that the production of a plant can be increased through expansion or land for planting (extension), increased yield per unit area and time (intensification) and improved cropping systems. Using of intercropping pattern can reduce weed biomass that are result from the closure of the plant canopy by waiting. Weeds that grow on the crop should be controlled so it is not interfere with the plant growth. Poggio et al. (2004) predicted that the intercropping system have different habitats so that the ability to take advantage of environmental factors cause different weed communities. Plant intercropped preferably between legume plants are not a legume hence legumes capable of providing 10-40% nitrogen into the ground, so could benefit other plants in the vicinity (Nielsen et al., 2009). It is also in accordance with Abdin et al. (2000) that planting ground cover between rows can control weeds and does not affect the yield of maize. The objective of this research was to compare the weed community composition between monoculture and intercrop systems on maize, peanut and cowpea crops.

Materials and Methods

The study was conducted at Sidomulyo village, Puncu district, Kediri regency on wet season of March to May 2015. Treatments tested in this study were G0= without crops (Weedy), G1 = Maize with planting distance (80 x 25 cm), G2= Maize with planting distance (100 x 25 cm), G3 = Maize with planting distance 80 x 25 cm (+3 row of peanut), G4 = Maize with planting distance 100 x 25 cm (+ 4 row of peanut), G5= Maize with planting distance 80 x 25 cm (+3 row of cowpea), G6 = Maize with planting distance 100 x 25 cm (+ 4 row of cowpea), G7 = Peanut with planting distance 25 x 25 cm, G8 = Cowpea with planting distance 25 x 25 cm.. The nine treatments were arranged in a randomized block design with three replicates. Observations of weeds were made at 2, 4, 6, 8 and 10 weeks after planting (WAP) for all 27 experimental plots. Random samples were taken from each plot using a 0.5 x 0.5 m quadrate. Five quadrates were sampled in each plot. Weed species collected from within each quadrate were identified, listed and counted. Collected weeds were washed, sorted by species, dried at 70^{o}C to constant weight and then weighed. For weed identification, the nomenclature of Soerjani et al. (1987) was used. Data recorded included Summed Dominance Ratio (SDR), Coefficient Community (C) and Diversity Index Shannon-Wiener (H '). The SDR of the weed species were computed using the following equation of Janiya and Moody (1989),

SDR (%) = (RD+RI+RF)/3

RD (%) = (density of certain species/density of all species in plots) x 100

RI (%) = (coverage of certain species/coverage of all species in plots) × 100

RF (%) = (number of plots where appear certain species/number of plots where appear all species) × 100

$$\text{Coefficient Community (c)} = 2\,\frac{W}{A+B}\,x\,100\%$$

W = The sum of two lowest Relative Density for each type of community

A = The sum of entire Relative Density from first community

B = The sum of entire Relative Density Relative from second community

Diversity Index Shannon-Wiener (H ')

$$H' = -\sum_{n=i}^{n}\left(\frac{ni}{N}\right)\left(\ln\frac{ni}{N}\right)$$

H' = Diversity Index Shannon-Wiener

ni = The sum of important value of certain species

N = The sum of important value of all species in plots

Ln = Natural Logarithm

Results and Discussion

Analysis of vegetation

Weed vegetation analysis done before tillage showed that there were 9 types of weeds which comprised eight broadleaf weeds and weeds kind of grasses (Table 1). Data presented in Table 1 show that before the tillage activity, the dominant weeds were *C. arvense* (broadleaf weed) with the SDR value of 14.03%. Another dominant species were C. *benghalensis* and *E. geniculata* with the SDR values of 13.88% and 12.42%, respectively.

Table 1. Analysis of vegetation using Sum Dominance Ratio (SDR) before soil tillage

Species	Type	SDR (%)
Amaranthus spinosus	B	12.34
Ageratum conyzoides	B	9.36
Clome rutidosperma	B	9.26
Euphorbia geniculata	B	12.42
Pylanthus niruri	B	6.21
Commelina benghalensis	B	13.88
Boreria alata	B	11.71
Circium arvense	B	14.03
Eleusine indica	S	10.78

Note : B = broadleaf weed type S = grasses weed type

Data presented in Table 2 show that weeds grew on the treatment plot of G0 (without plant) were nine species which consisted of five species of broadleaf weeds, two species of sedges weed, and two species of grasses.

Table 2. SDR observation each treatment at 6 and 10 weeks after planting.

Species	**G0**		**G1**		**G2**		**G3**		**G4**		**G5**		**G6**		**G7**		**G8**	
	Weeks After Planting (WAP)																	
	6	**10**	**6**	**10**	**6**	**10**	**6**	**10**	**6**	**10**	**6**	**10**	**6**	**10**	**6**	**10**	**6**	**10**
Amaranthus spinosus	-	-	-	-	-	-	-	-	1.41	-	7.40	-	-	-	-	5.91	-	16.39
Acalypha indica	-	-	-	-	-	-	-	1.78	-	-	-	-	-	-	-	-	-	-
Spigelia anthelmia	2.59	-	-	-	-	-	2.40	-	2.74	3.08	-	-	-	-	2.47	2.03	3.03	-
Clome rutidosperma	5.90	2.78	10.38	-	11.14	4.84	6.39	10.12	13.23	17.49	6.42	6.58	10.88	-	11.97	12.07	12.27	9.68
Euphorbia geniculata	-	-	9.76	-	7.40	10.77	3.13	6.63	11.13	17.34	4.54	9.28	7.02	4.84	5.62	0.00	2.27	3.73
Emmilia sonchifolia	-	-	5.24	-	-	-	1.25	-	1.81	-	2.16	-	5.72	-	-	2.65	1.73	-
Pylanthus niruri	-	4.18	-	-	2.12	-	2.48	-	-	-	-	5.65	-	8.49	4.14	-	-	-
Portulaca oleracea	-	-	6.69	-	4.93	-	3.08	-	1.41	-	-	-	-	-	9.03	-	-	-
Commelina benghalensis	-	-	-	7.03	2.51	-	-	16.58	1.80	-	4.57	12.83	-	-	4.83	-	4.17	-
Boreria alata	24.86	16.86	10.01	13.98	12.71	18.57	18.43	15.27	19.17	5.83	14.63	19.17	31.74	21.21	15.16	15.53	20.58	30.62
Ageratum conyzoides	17.67	3.85	4.85	-	13.75	3.32	9.31	6.45	6.99	-	5.39	1.99	-	11.20	4.57	3.51	7.52	-
Euphorbia hirta	26.49	17.03	22.42	14.85	22.21	6.66	23.68	17.44	18.78	12.22	20.33	13.06	20.04	23.07	16.29	21.47	19.16	28.19
Cyperus iria	-	-	-	-	4.67	-	-	-	-	-	-	-	-	-	-	-	-	-
Eleusine indica	-	5.72	15.16	8.38	3.19	14.86	8.45	4.57	2.04	10.28	7.35	6.70	12.63	-	4.00	9.65	10.80	-
Fimbrislylis miliceae	-	5.80	-	-	-	4.33	3.63	-	2.11	-	-	-	10.73	-	-	-	-	-
Hedyotis corymbosa	-	14.68	-	20.93	-	15.45	-	-	-	-	-	12.96	-	-	-	10.55	-	-
Digitaria ciliaris	22.48	29.09	15.50	34.82	15.37	21.20	17.77	21.18	17.39	33.76	27.21	11.79	29.24	31.19	21.92	16.65	18.46	11.39

Description: G0 = Without plants (weedy) ; G1 = maize 80 x 25 cm; G2 = maize 100 x 25 cm; G3 = maize 80 x 25 cm (+ 3 row of peanut) ; G4 = maize 100 x 25 cm (+ 4 row of peanut) ; G5 = maize 80 x 25 cm (+3 row of cowpea); G6 = maize 100 x 25 cm (+ 4 row of cowpea); G7 = peanuts 25 x 25 cm; G8 = cowpea 25 x 25 cm

The nine species were *C. rutidosperma, P. niruri, B. alata, A. conyzoides, E. hirta, E. indica, F. miliceae, H. corymbosa,* and *D.ciliaris.* The highest SDR value was observed for *D.ciliaris* (SDR = 29.09 %). The observation on the treatment of G1 (maize 80 x 25 cm) showed six species of weed i.e. *C. benghalensis, B. alata, E. hirta, E. indica, H. corymbosa,* and *D. Ciliaris*. The dominant weed was *D. ciliaris* (SDR = 34.82%). Observation of G2 (maize 100 x 25 cm) treatment showed ten weed species i.e *C. rutidosperma, E. geniculate, B. alata, A. conyzoides, E. hirta, C. iria, E. indica, F. miliceae, H. corymbosa,* and *D.ciliaris*. The highest SDR value was found for grass of weed of *D.ciliaris* (SDR = 21.20%). While on the G3 (maize 80 x 25 cm (+ 3 row of Peanut) treatment there were nine species of weeds i.e *A. indica, C. rutidosperma, E. geniculate, C. benghalensis, B. alata, A. conyzoides, E. hirta , E. indica* and *D. Ciliaris*. The highest value of SDR was observed for the type of grass weed of *D. ciliaris* (SDR = 21.18%).

In the G4 (maize 100 x 25 cm (+ 4 rows of peanut) treatment, there were seven species of weeds i.e. *S. anthelmia, C. rutidosperma, E. geniculate, B. alata, E. hirta, E. indica* and *D. ciliaris*. The highest SDR value of 33.76% was observed for in the type of grass weed of *D. ciliaris*. In the treatment of G5 (maize 80 x 25 cm (+ 3 row of cowpea) there were ten species i.e *C. rutidosperma, E. geniculate, P. niruri, C. benghalensis, B. alata, A. conyzoides, E. hirta, E. indica, H. corymbosa* and *D. ciliaris*. The dominant weed was the broadleaf weed of *B. alata* (SDR = 19.17%). Treatment of G6- (Maize 100 x 25 (+ 4 row of Cowpea) were found 6 species of weeds, i.e. *E. geniculate, P. niruri, B. alata, A. conyzoides, E. hirta* and *D. Ciliaris.* The dominant weed was *D. ciliaris* (SDR = 31.19%). Treatment of G7 (Peanuts 25 x 25 cm) were found 10 species of weeds, i.e. *A. spinosus, S. anthelmia, C. rutidosperma, E. sonchifolia, B. alata, A. conyzoides, E. hirta, E. indica, H. corymbosa* and *D. ciliaris.* This treatment was dominated by broadleaf weeds *E. hirta* (SDR = 21.47%).

In the G8 (cowpea 25 x 25) treatment, there were 6 species of weeds, namely *A .spinous, C. rutidosperma, E. geniculate, B. alata, E. hirta* and *D. ciliaris* that was dominated by *B.alata* (SDR = 30.62%). There were six species on the 6 WAP having SDR values that ranged from 2.59 to 26.49. In the G0 treatment, the SDR value of G0 *E. hirta* was 26.49. On the G1 treatment, there were nine 9 species having SDR values that ranged from 4.85 to 22.42, and the SDR of *D. ciliaris* species was 15.50. The difference in total weed species on the G0 and G1 treatments was found which on the 6 WAP/ The G1 treatment had 50% more weed species encountered that the G0 treatment. The G2 treatment encountered eleven species of weeds with SDR value ranging from 2.12 to 22.21. The differences in total weeds between G2 with G0 and G1 were 83 and 33%. The G3 treatment had SDR value ranging from 1.25 to 23.68 with twelve weed species found. The G3 treatment had 100% total weeds more than G0.

The G4 treatment had SDR value of fourteen species which means over 100% weeds more than G0. On the G5, there were ten species of weeds which was 67% more than G0. The G6 treatment had the highest SDR value of 31.74 on the species of *B. alata*, the difference in the number of species of G6 with G0 was two species. The G7 treatment had eleven species which means five species more than G0. At the G8 treatment there were ten species with SDR value ranging from 1.73 to 20.58 and showed differences in the number of species with G0 that was five species or 83%. Observation of G0 weed indicated that the numbers of weed found at age of 6 WAP consisted of six species and at age of 10 WAP the number of weeds increased to nine species.

On the G1 treatment, there were nine species found at 6WAP, but at 10 WAP the number of weeds found decreased to six species. On the G2 treatment there were eleven species found at 6 WAP, and at 10 WAP there were nine species of weed. On the G3 treatment there were twelve species of weed found at 6 WAP, where the highest weed wass *E. hirta* which had SDR value of 23.68. At 10 WAP, there were nine species weed found with the highest number was *D. ciliaris* with SDR value of 21.20.

The observation of G4 at age 6 WAP indicated that the highest number of weed was *B. alata* with SDR value ofs 19.17, and there were twelve species of weed found. At 10 WAP, there seven species with the highest value of weed was *D. ciliaris* with SDR value of 33.76. On G5 at 6 WAP there were ten species found with the dominant species was *D.ciliaris* having SDR value of 27.21. At the age of 10 WAP, there were also ten species found with the dominant species was *B. alata* having SDR value of 19.17. On the G6 treatment, eight species were found at 6 WAP, while at 10 WAP there were six species of weeds. *D. ciliaris* was the dominant species at 6 WAP and 10 WAP observations. On the G7 treatment, there were eleven species found at 6 WAP with *D. ciliaris* was the dominant species. At 10 WAP, the dominant species weed was *E. hirta*. On the G8 treatment, the number of weeds found in each plot weree 10 species with the dominant species was *B. alata*. At 10 WAP, the dominant was also *B. alata*. The species found in each plot were different. Dekker (2011) pointed out that too dense leaf canopy can affect quality and number of sunlight received by weeds. The environmental conditions such as intensity of sunlight that received by weeds may affect plant and the dominance of weed species in each experimental plot. Each species of weed has different properties in the reception amount and quality of light that can affect the growth of weeds.

Dry weight of weeds

Competition between crops and weeds for nutrients, light and water can affect the total dry weight of weeds and the variety of weed species that grow around the crops. The observation of the weed dry weight at 2 WAP showed that the weed dry weight in the G0 (without plant) and G2 (maize 100 x 25 cm) treatments were low because of the soil tillage that could indirectly inhibit the weed growth. The G6 (maize 100 x 25 cm (+ 4 row of cowpea) treatment had a higher shade than intercropped with peanut. The decrease growth of sedges of the G6 treatment was because of environmental conditions. The weeds were covered by shade of cowpea that reduced the light received by weeds (Figure 1). Cowpea shade that was created by canopy of cowpea with large numbers of leaves reduced light intensity. Puspitasari et al. (2009) stated that 80% shade could reduce weeds by 50%, while 98% shade on weeds could cause death. Corre-Hellou et al. (2011) stated that crop pattern could affect the presence of weed biomass where in the monoculture system weed biomass was higher than that in the intercropping system.

The light intensity in the bottom of the plants that was amounted to 30.51% could cause 19.77% lost of broadleaf weed dry weight. While on sedge and grass group of weeds with light intensity of 30.51% could decrease weed dry weight by 29.06%. This was consistent with the statement of Marsal et al. (2014) that the light intensity received by the weeds on the photosynthesis process to produce photosyntate in plant tissues affected the total dry weight.

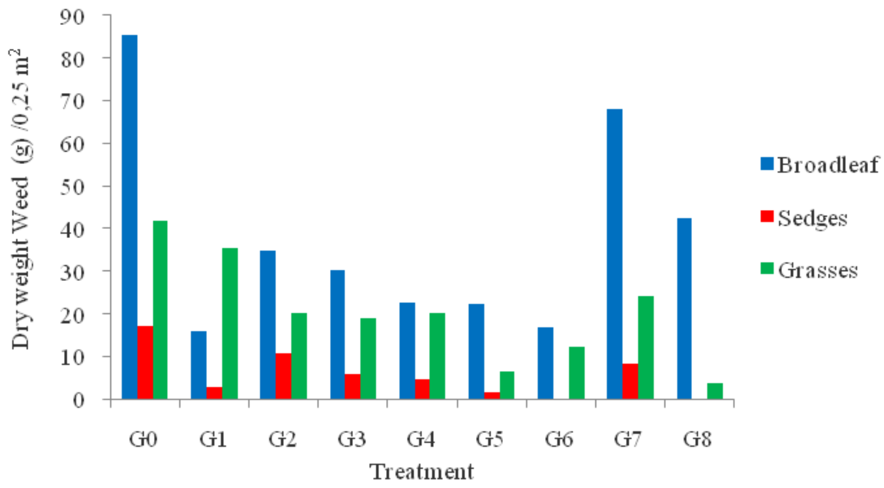

Figure 1. Weed dry weight at 10 weeks after planting

Weeds that grew on each treatment consisted of broadleaf, grasses, and sedges weeds. Broadleaf weed type is C3-type plant. The grass weed type is classified as C4-type of photosynthetic plant which is higher in utilizing sunlight than the C3 type. The G5 (maize 80 x 25 cm (+ 3 row of cowpea) and G6 (maize 100 x 25 cm (+ 4 row of cowpea) treatment showed the lowest weed dry weight compared to other treatments because the level of shade which was created by the canopy of maize and cowpea was too heavy. This made the weeds difficult to grow because of the very low intensity sunlight received. Hector and Smith (2002) reported that cowpea can grow rapidly and is able to shelter up to 13% - 40% so it will give shade that can suppress weeds to grow because cowpea can be more dominant to compete for humidity of soil and nutrients than the surrounding weeds. The linear regression presented in Figure 2 shows that the light intensity and the weed dry weight resulted Y = 0.999x-14.49 with R^2 = 0.949. This means that light intensity influenced weed dry weight by 94.9%, while 5.1% was affected by other factors. The regression for sedges weeds nearly had the same value with the broadleaf that can be seen from the relationship between light intensity and dry weight of weed that had the equation Y = 0.234 X - 5.98 with R^2 = 0.95. This means that the light intensity influenced weed dry weight by 95.1%, while 4.9% was influenced by other factors. This means that every 1% increase of light intensity could increase weed dry weight by 0.23 g. The grasses had an equation of Y = 0.379x + 4.484 with a value of R^2 of 0.924. This indicates that the light intensity could influence weed dry weight by 92.4%, while 7.6% was influenced by other factors. Plants response to quality of light spectrum. The energy balance of plant is determined by radiation used by photosynthesis to increase biomass production. Competition between plants to receive light intensity occurs between crops and weeds in the same area because they need light for photosyntesis process. Each species of weed has different ability in recepting amount and quality of light that can affect the growth of weeds (Dekker, 2011). Light intensity for each type of plant has different needs, the broadleaf weeds has type of C3 plant which has a low point to receive light and bounded by high photorespiration. On the other hand, sedges and grasses that belong to the C4 plant type could receive higher light than C3 type and it is not limited by photorespiration. Dekker (2011) stated that the dense leaf canopy can affect quality and amount of sunlight received by weeds. The intensity of sunlight and type of weeds could influence the growth and dominance weed species in the trial plot at each treatment.

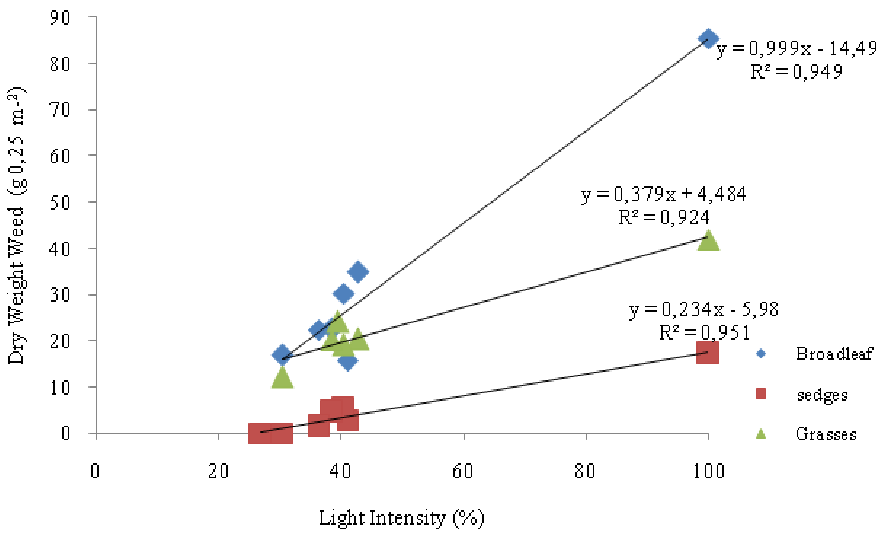

Figure 2. Relationship between light intensity and dry weight of weeds

Coefficient of community of weeds

Based on observations presented in Table 3, the coefficient of community in each treatment showed coefficient of community (c) of less than 75%. This means that each treatment had similarity of weeds. Results of observation showed that the coefficient of community on all treatments in comparison to G0: G6 amounted to 13.10%. This means that the G6 treatment (maize 100 x 25 cm (+ 4 row of cowpea) had similarities with the G0 treatment (without plant)/control. According to Tjitrosedirdjo et al. (2008), the value of the coefficient of community of above 75% means there is a difference of weeds, and coefficient of community is below 75% the weed species has equality in the compared community. Factors that can affect community of weeds or weed density are the technical culture (cropping), soil conditions and staple crop conditions. Novalinda et al. (2014) stated that a community will have a high diversity when there are many types or abundance of similar.

Table 3. Coefficient community of weed of each treatment at 10 WAP

Treatments	G0	G1	G2	G3	G4	G5	G6	G7	G8
G0	-	10.37	11.06	10.26	11.51	11.25	13.10	9.05	10.10
G1	10.37	-	9.09	6.37	4.79	4.65	13.07	10.46	6.60
G2	11.06	9.09	-	11.99	10.61	10.46	6.51	12.32	7.35
G3	10.26	6.37	11.99	-	10.95	6.86	9.27	5.65	10.48
G4	11.51	4.79	10.61	10.95	-	14.61	7.05	10.35	13.86
G5	11.25	4.65	10.46	6.86	14.61	-	11.05	8.86	4.47
G6	13.10	13.07	6.51	9.27	7.05	11.05	-	4.54	12.76
G7	9.05	10.46	12.32	5.65	10.35	8.86	4.54	-	14.64
G8	10.10	6.60	7.35	10.48	13.86	4.47	12.76	14.64	-

Descriptions: G0 = no plant (weedy) ; G1 = maize 80 x 25 cm; G2 = maize100 x 25 cm; G3= maize 80 x 25 cm (+ 3 row of peanut); G4 = maize 100 x 25 cm (+ 4 row of peanut); G5 = maize 80 x 25 cm (+ 3 row of cowpea); G6 = maize 100 x 25 cm (+ 4 row of cowpea); G7 = peanut 25 x 25 cm; G8 = cowpea 25x 25 cm.

Shannon- Wiener Index (H')

Plant diversity index in each plot (Table 4) was measured using Shannon-Wiener Diversity Standard. Based on the index, the H' value of less than 1 means low species diversity in plot area. The H' value of 1-3.322 means medium diversity index in plot area. The H' value of more than 3.322 means high species diversity in plot area. Based on this research, the value of the Shannon – Wiener index contained in any imposition and at every age of observation showed that the value of H ' was ranged from > 1 to 3.3. The G1 (maize 80 x 25 cm) and G2 (Maize 100 x 25 cm) treatments had H ' value of 1.39 while on the G3 (maize 80 x 25 cm (+ 3 rows of peanuts) and G4 treatments had H ' value of 2.12. The G5 and G6 had H' values of 2.09 and 2.36, respectively. The G7 and G8 treatments had H ' values of 2.12 and 2.11, respectively. This conditions were affected by the sandy soil type with low nutrient and water contents. Perdana et al. (2013) reported that the sandy soil with low nutrient contents and dry conditions can affect the diversity of weeds. This has caused the H ' value was on the avarage, not too low and not too high.

By comparing the shade of late cowpea that was higher in the G5 treatment (maize 80 x 25 cm (+ 3 row of cowpea) and the G6 treatment (maize 100 x 25 cm (+ 4 row of cowpea), it could decrease light intensity received by weeds which reduced the diversity of species in weed communities.

Table 4. Values of Shannon – Wienner Index

Treatments	Observation (Weeks After Planting)				
	2	4	6	8	10
G0	1.29	2.08	1.60	2.16	1.93
G1	-	2.22	1.85	1.86	1.65
G2	1.29	2.01	2.17	1.89	2.03
G3	-	1.81	2.14	1.98	2.02
G4	-	1.96	2.16	2.04	1.74
G5	-	2.12	2.04	1.77	2.18
G6	-	2.39	2.14	2.01	1.63
G7	-	2.15	2.19	1.99	2.10
G8	-	2.03	2.04	1.74	1.61

Description : Diversity index value (H') of less than 1 means that species diversity is low, H' = 1-3.322 means diversity index is medium, H' > 3.322 means species diversity is high in plot area.

Conclusion

Diversity of weed communities based on analysis of the Shannon - Wienner Index (H') presented by the H' value ranged from 1.29 to 2.18. The coefficient of community (c) the spread of weed ranged from 4.54 to 14.64. This means there was differences of weeds and weed communities when the coefficient value was below 75% or communities weed species had equality species in the community compared. Based on the total dry weight, the treatments of intercropping systems (G3, G4, G5 and G6) were able to suppress dry weeds by 15.38, 27.69, 55.38, and 53.85% compared with G2, respectively. Crops in the intercropping of maize and cowpea with a distance of 100 x 25 cm (+ 4 rows of cowpea) had lower dominance of weed communities than in other treatments. In conclusion, weed control in ecological ways can be done by using intercropping system between maize and cowpea which has indirectly suppress weed growth broadleaf weeds groups, puzzles and narrow leaf weeds class as well and decreased total dry weight of weeds.

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