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Influence of Weeding Frequency and Pigeonpea (*Cajanus_Cajan L. Millsp*) Population Density on Growth, Yield and Yield Components of Maize-Pigeon_Pea Intercropping

Fitsum Merkeb[1]*, Demelash Kefale (PhD)[2] and Tenaw Werkayehu (PhD)[3]

[1]Ethiopian Institute of Agricultural Research, Pawe Research Center, *Tel. +251585500270, Fax +251585500336*
[2]Hawassa University College of Agriculture, Department of Plant science, Hawassa, Ethiopia.
[3]Southern Agricultural Research Institute, Hawassa Agricultural Research Center, Hawassa, Ethiopia.
*Corresponding author: fitsummerkeb8@gmail.com

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A field experiment was conducted to evaluate the influence of weeding frequency and pigeon_pea population density on the performance and productivity of maize-pigeon_pea intercropping at Hawassa. Treatment combinations consisting of two weeding frequency and three pigeon_pea population densities intercropped with maize and sole crops of maize and pigeon_pea were tested in randomized complete block design (RCBD) with three replications. The results indicated that increase in weeding frequency to twice caused 83.6% reduction in weed biomass as compared to weeding only once. On the other hand increasing the pigeon_pea population density to 187,000 and 250,000 plants ha^{-1} decreased weed biomass by 34.6 and 23.8% respectively. Growth parameters and yield components were also significantly influenced by weeding frequency rather than population density. Pigeon_pealeaf area index and grain yield were significantly affected by all the treatments. Significantly higher grain yield (4.17t/ ha) of maize and (0.80t/ha) of pigeon_pea were obtained from weeding twice. The highest grain yield was obtained from the highest pigeon_pea population density 250,000plants ha^{-1}. Land use efficiency was increased by weeding frequency. The highest total LER (1.26) was obtained from weeding twice. Total LER of 1.24 was recorded from pigeon_pea plant population of 250,000 plants ha-^{1}.

Key word: Maize, pigeonpea, LER, weeding frequency, plant density

INTRODUCTION

Intercropping is the growing of two or more crops in proximity in the same field during a growing season to promote interaction between them. Available growth resources, such as light, water and nutrients are comparatively better absorbed and converted in to crop biomass by the intercrop as a result of differences in competitive ability for growth factors between intercrop components. The more efficient utilization of growth resources leads to yield advantages and increased stability compared to sole cropping (Willey, 1995). Intercropping is considered as the practical application of ecological principles such as diversity, crop interaction and other natural regulation mechanisms. Nitrogen fixing legumes such as cowpea, pigeon pea, common bean, soybean, can be included to a greater extent in arable cropping systems via intercrops.

Ethiopia is one of the countries affected by invasive plant species, which have been clearly identified as one of the emerging problems facing the country (EARO, 2004). A natural stakeholder workshop conducted in August 2000 identified and prioritized invasive Alien Species (IAS) in Ethiopia to be P*rosopisjuliflora, Parthenium_hysterophorus, Striga_spp, Eichornia_creassipes, Lantana_camara and Acacia spp* (TayeTessema, 2001). Decreased weed incidence on maize by means of intercropping is dependent on several factors. One of the possible advantages of growing crops in mixture is that intercrops may exclude or suppress weeds more effectively than monocultures of the component cropskuchinda (2003). And also the advantage of intercropping for weed control is that the crops cover more ground, so there is less space available for weed emergence. Intercropping systems might be more advantageous than mono-cropping systems due to their more efficient competition for the available resources or to their alellophatic effect on weeds. Alternatively, intercropping systems might also use resources not exploited by weeds or they might convert such resources to the economic part of the crop than mono-cropping would (Liebman & Dyck, (1993).

The farmers in the southern region of Ethiopia are highly dependent on production of crops that are well known to adopt moisture deficit environments. Among cereals maize is the dominant staple crop grown around Hawassa. On the other hand, pigeon pea, which can fit in the adverse growing conditions of dry land areas, is not well introduced to the area. Pigeon pea is drought-tolerant, that provides multiple benefits, as it gives good yields even with limited inputs. It is thus expected to directly benefit the resource-poor smallholder farmers, operating in the variable semi-arid environment with limited access to technology, cash, and other resources. Even though intercropping is common in the region maize/pigeon pea intercropping in relation to pigeon pea population density along with weeding frequency is one of the study focus area. Therefore, this study was initiated with the objectives of evaluating the influence of pigeonpea population density, examining the effect of weeding frequency and estimating the performance and productivity of maize-pigeonpea intercropping.

MATERIALS AND METHODS

Experimental site description

The study was conducted at Hawassa University research and farm center located at $7^0 4$ ' N latitude and $38^0 3$' E longitude, with an altitude of 1760 amsl. The average annual rainfall for the last 15 years is 1100 mm ranging from 674 to 1365 mm while, the average annual minimum and maximum temperatures are 12^0C and 27^0C respectively. The area has two rainy seasons, Belg (Feb-May) and Meher(Jun-Oct). However the main rainy season can extends from April to September interrupted by some dry spells in June and sometimes in May.

Monthly rainfall data was taken during the experimental season and compared with the long-term season (1997-2007).

Rainfall: Distribution of rainfall at tasseling, silking and grain filling stage was variable (August-November). The total amount of rainfall during the growing season from June to December was 12% higher than the long-term rain fall. The rainfall was also 34.7% greater than the long term during the grain filling stages of maize creating water logging situations during the growing season of September. Table 1

Experimental details

Experimental treatments and management practices

The treatments were three-population densities (P_1=250000, P_2=187500 and P_3=125000 plants ha^{-1}), and two weeding frequencies (W1=25-30 and W2=55-60 days after emergency (DAE). Each weeding frequencies was combined with three population densities of pigeon pea. Population densities of pigeonpea for both once and twice weeding's were 250,000 plants ha^{-1}, 187,500 plants ha^{-1}, and 125,000 plants ha^{-1} to maintain 100%, 75% and 50% of the recommended population of sole pigeonpea (250,000 plants ha^{-1}), respectively. Sole pigeon pea was planted using 40 cm by 10 cm (inter and intra row spacing, respectively) with a total population density of 250000 plants ha^{-1}. Maize was planted using the recommended population density (25 cm x 80 cm = 50,000 plants ha^{-1}). The experiment was laid out in randomized complete block design (RCBD) with three replicates. Maize variety "Melkassa-2", and Pigeon pea variety ICP-9444 was used. Chemical fertilizer was applied for both sole and intercropped maize using the recommended rate (64:46 kg N: P_2 O_5 ha^{-1}). DAP was applied at the rate of 100 kg ha^{-1} (18 kg N and 46kg P_2O_5 ha^{-1}), at planting. Then Urea at the rate of 100 kg ha^{-1} (46 kg N ha^{-1}) was applied as top dressing in two splits one-third at 20 days after maize emergence (DAE), and two third just before the tasseling of maize. At the vegetative stage karate (lamdacyhalothrin) was applied to the experimental field to protect the crops from insect damage.

Table: 1 Amount of rainfall during crop growing season and long term monthly mean rainfall

Rain fall (mm)		
Months	**Long term mean (1993-2007)**	**Growing season**
June	111.8	118.2 (+6%)
July	122.6	120.5 (-1.7%)
August	128.4	123.5 (-3.8%)
September	118.8	160 (+34.7%)
October	80.6	66.1 (-18%)
November	32.8	97.1 (+196%)
December	22.9	5.8 (-74.7)
total	617.9	691.2 (12%)

Source: Southern zone National Meteorological Agency (2008)

Data collection and analysis

Growth parameters

Plant height and ear length were measured while leaf area was estimated by portable leaf area meter (Model LI-3000A) from leaves of five sample plants in each plot just after flowering. Leaf area index was calculated by dividing the leaf area to the ground area occupied by the respective plants for both crops as necessary.

Weed count

Weed count taken by using quadrant of iron rod of 25cm width by 25cm length from three places in each plot. Weed dry matter was determined at first weeding by oven drying the samples at 70^0cfor 48 hours.

Yield and yield components

Number of cobs plant^{-1} and seeds cob^{-1}in maize were determined from five randomly selected plants from each plot. While in pigeon pea pods plant^{-1}, seeds pod^{-1} and pod length were measured from 20 randomly selected plants of each plot. Grain yield was taken from the central rows and the moisture content was taken using electronic moisture tester after which the final grain yield was adjusted to 12.5%. Hundred seed weight and shelling percentage were determined. Harvest index of maize was calculated as a ratio of the economic (seed) yield to the total biomass. Biomass yield of both maize and pigeonpea were determined by taking 250g plant sample from each plot and chopped and oven dried at 70^0c for 48 hours.

System Productivity

Land Equivalent Ratio (LER): The benefit of intercropping is most frequently quantified by LER which is defined as the relative land area in pure stands that is required to produce the yields of all products from the mixture (Vandemeer, 1989). Intercropping efficiency was evaluated by using land equivalent ratio.

LER= Yim/Ysm + Yipp/Yspp
Where Yim and Yipp are yields of intercropped maize and pigeon pea, and
Ysm and Yspp are yields of sole maize and pigeon pea, respectively.

Statistical analysis

The data were subjected to analysis of variance (ANOVA) for factorial arrangement in randomized complete block design using SAS program (SAS, 2000). Means were compared using LSD at 0.05 and 0.01 proability level of significance.

RESULT AND DISCUSSION

Influence of Maize – Pigeon pea intercropping

Weed biomass: The results indicated that weeding frequency and population density of pigeon pea had significant influence on weed biomass (Table 2).

Weeding twice caused 83.6% reduction in weed biomass as compared to weeding only once. The decrease in weed biomass with increase in weeding frequencies was also noted by Meseret*et al*, (2008) in haricot bean and Sesaya, (1997) in ground nut.

Pigeon_pea population density also had significant influence on weed biomass production. Increasing pigeonpea population from 125,000 to 187,000 and 250,000 plants/ha caused 34.6 and 23.8%, reduction in weed biomass, respectively. High plant density in intercropping caused severe competition with weeds and reduced weed growth.

Table: 2 Influence of Maize/pigeonpea intercropping on weed biomass

Treatment	Weed biomass(g/m^2)
Weeding	
Once	764.13^a
Twice	125.37^b
LSD (5%)	36.32
Population Density	
125000	552.25^a
187000	361.19^c
250000	420.80^b
LSD (5%)	44.48
CV (%)	11.81

NS-Non significant, Means with the same letter are not significantly different

Weed flora and density: Even though about 15 weed species were identified the most frequently observed weed species in the experimental field were *Galinsogaparviflora*. (153.4), *Guizotiascabra* (119.4), and *Nicandraphysalodus* (47.4). But other weeds (*Ageratum_conyzoides, Tagetes_minuta, Commelina_benghalensis, Leucusargentea, Amarantheshybrides*,) were not frequently observed. In line with this Rezene and Gerba, (2003) reported that the most frequently found weed species in Ethiopian highland food legumes were broad leaf weed species particularly, *Bidens_*species*; Guizotia_scabra, Galinsoga_parviflora, Galium_spurim, Polygonum_nepalense, and Commelina_benghalensis* including annual grass weeds. Figure 1

Influence of Maize – Pigeon pea intercropping on Maize

Leaf area index (LAI)

LAI of maize was significantly affected by weeding; the lowest LAI (2.25) was obtained from weeding once might be due to competition from the weed slightly decreased the maximum leaf area index (LAI) of the crop. The highest LAI (2.69) was recorded from weeding twice. Dehnaviet*et al* (1996) also recorded higher leaf area index (LAI) of maize with increase in weeding frequencies. Pigeon pea plant population densities had no significant effect on LAI of maize. Slightly higher LAI was obtained from the lowest (125,000 plants ha^{-1}) pigeonpea population density. This agrees with the results obtained by Muoneke and Mbah, (2007) who noted lower LAI of cassava with increasing the population density of okra.

Leaf area index of maize was noted to be higher (3.02) under sole cropping as compared to intercrop due to no interspecies competition and large number of leaf area per plant. Jose (2000) also recorded higher LAI in sole maize as compared to intercropping system.

Plant height

Plant height of maize was significantly affected by weeding frequency where the highest maize plant height was from weeding the plots twice. As a result it was received more solar radiation necessary for growth. Muhammad *et al.,* (2003) reported that the taller plants in hand weeding plots were probably as a result of ample space, nutrients, light and moisture. The finding of Begna*et al.,* (2001) indicated lower maize plant height due to the presence of weeds.

Population density had no significant effect on maize plant height. The study indicated that varying pigeonpea plant population had no significant influence on plant height of maize in maize–pigeonpea intercropping. In line with this Geremew (2006) reports a non significant effect of cowpea population density on sorghum height in intercropping. Also Fikre (2004) reported that different plant population of cowpea did not significantly affect maize PH in maize-cowpea intercropping. Similarly Thwala and Ossom, (2004) found no significant difference in plant height of maize, in maize – legume intercropping, despite the taller nature of maize provides an advantage of more solar radiation than the component legume. Even though, they have no significance difference there was an increased PH in intercropped maize as compared to sole maize.

Ear height and Cob (ear) length

Weeding frequency was significantly influence ear height of maize where there is high weed growth in once weeding suppresses maize ear height. On the other hand an increase in weeding frequency leads to be better in crop emergence and facilitates the growth to become competitive with weeds leading to the highest ear height (79.91cm) obtained from twice weeding.

The findings of the present study showed that

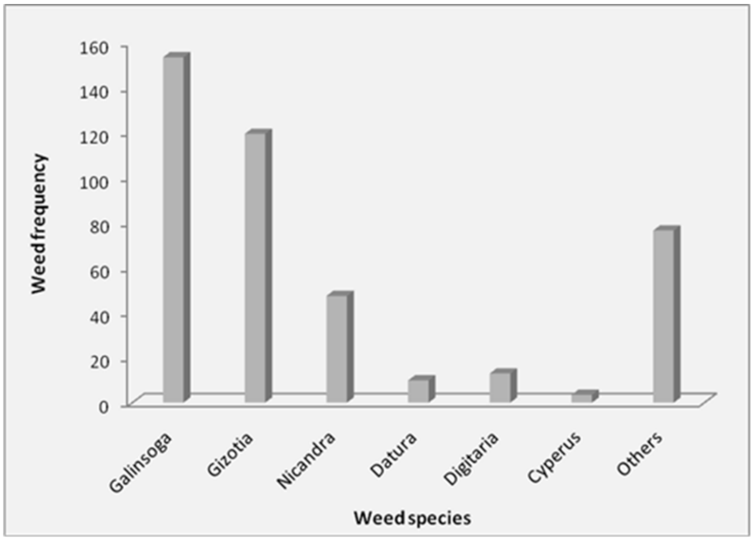

Figure: 1. Weed species and frequency during the growing period

Table 3: Growth and yield parameters of maize as influenced by differences in weeding frequency and pigeon pea population density.

Treatment	Leaf area index	Plant height (cm)	Ear height (cm)	Cob length (cm)	Seeds cob^{-1}	Grain yield (t ha^{-1})	Total Biomass Yield (t ha^{-1})
Weeding							
Once	2.25^{b}	173.89^{b}	71.49^{b}	16.25^{b}	401^{b}	3.25^{b}	5.03^{b}
Twice	2.69^{a}	189.89^{a}	79.91^{a}	18.16^{a}	453^{a}	4.17^{a}	5.75^{a}
LSD (5%)	0.23	7.09	4.44	0.62	26.00	0.31	0.39
Population Density							
125000	3.49	179.67	75.46	17.65^{a}	429	3.54	5.43
187500	3.30	182.33	75.59	17.35^{ab}	429	3.69	5.36
250000	3.30	183.67	76.05	16.61a	423	3.90	5.38
LSD (5%)	NS	NS	NS	0.76	NS	NS	NS
CV (%)	13.37	5.64	8.47	5.03	8.71	12.02	10.59
Cropping system							
Sole	3.02	181.89	87.17	16.83	415	4.25	6.34
Intercrop	2.46	186.33	75.69	17.20	427	3.83	5.39
LSD (5%)	NS	NS	NS	NS	NS	NS	NS
CV (%)	12.13	3.15	4.04	1.68	8.10	14.59	6.43

NS-Non significant,

Means with the same letter are not significantly different

pigeonpea population density results a significant difference on the cob (ear) length (Table 3). The result indicates population density of 250,000 and 187,500 are significantly different from that of 125,000. Similar results were also observed by Akbar (1998) who reported that cob length decreased linearly with increase in plant population.

Cropping system had no significant difference. In line with this the report Thwala and Ossom, (2004) showed that there was no significant difference in cob length whether maize was mono-cropped, or intercropped with bean or with groundnut. Abreham (2008) also founds cropping system had non-significant effect on cob length.

Number of seeds per cob: Weeding frequency had a significant influence on the number of seeds per cob (ear). Maize produced a maximum of 453 and a minimum of 401 seeds per cob (ear) in intercropping with different treatments. Higher number of seeds per cob (ear) was resulted from weeding twice with 11.5% increment.

Pigeonpea population density resulted a non significant effect on number of seeds per cob (ear). The different in mean number of seeds per cob were due to the different plant population and weed competition. Lower number of seeds per cob was obtained from the highest plant density though there is no significant difference. Thwala and Ossom (2004) reported that yield components of maize in intercropping with bean, or with groundnut had resulted non significant difference. In contrast Akbar (1998) reported that the number of grains per cob was significantly influenced by different planting patterns.

Cropping system also did not brought any significant difference on the number of seeds per cob (ear). However, intercropped maize was slightly greater as compared to sole cropped maize. Number of seeds per cob of 427 and 415 was obtained from intercropped and sole cropped maize respectively.

Grain yield: Maize grain yield was significantly higher in twice weeding at an interval of 30 days from maize emergency; since the weeds present in once weeding increased the competition for water and nutrients the grain yield was decreased. Maize grain yield was decreased by 22.8% in once weeding compared to weeding twice. The report of Rezene (1994) indicated that twice hand –weeding increased yield by 55 and 24%, respectively, compared with the unweeded check. Though intercropping may reduce weed infestation and growth, still there is a need for some hand weeding in most cases. Mohammad, (2003) also indicated weed free treatments exhibited the maximum number of grains per cob. Tembakazi and Lucas (2001) found that weeding enhances yields of component crops in maize/bean and maize/pumpkin combination by 35% and by 30% respectively. The reduction in maize yield due to the presence of weeds is attributed to the crop- weed competition for water, light and nutrients. When infested by weeds, maize develops stress symptoms earlier due to the lack of water than when it is weed-free (Tollenaar*et al*., 1997). Regarding population density the highest maize grain yield (3.9 t/ha) was obtained from the highest pigeon pea population density 250,000 plants ha^{-1}, indicating that even higher pigeonpea population doesn’t affect the grain yield of component maize.
Comparing with the sole grain yield maize was not significantly different from the intercropped in maize-pigeonpea intercrop (Table 3). Thwala and Ossom (2004) reported that there was no significant difference in grain yield of maize, whether it is cultivated as a sole crop or intercropped with sugar bean or ground nut.

Biomass yield: Maize biomass was significantly influenced by weeding frequency. The total biomass obtained from one times weeding (5.027t/ha) was significantly lower than that of the two times weeding (5.746t/ha). In once weeding treatment the plots were highly suppressed by weed competition. (Balasubramaniyan and Palaniappan, 2007) reported that the presence of weeds or crop canopy alters the quality of light energy passing through it. Since the weeds that were observed in once weeding were broad leaves such as *Datura_stramonium and Nicandra_parviflora* their influence was significantly high. Because of the higher shade effect of this weed species, competition for light occurs on the main and bonus crop so that the intensity of light received was much lower than the required necessary for optimum growth. The result agree with the finding of Lozanovski *et al*. (1975) who reported that strong weed competition reduces the biomass of maize by two-third.The effect of the current study indicates that pigeonpea population density had no significant effect on maize total biomass (Table 3). The finding of Abreham (2008) also indicates pigeonpea population densities had no significant effect on maize biomass.

3.4. Influence of Maize – Pigeon pea intercropping on Pigeonpea

Leaf area index

Weeding frequency has significantly influenced the LAI of pigeon pea (Table 4). The maximum LAI (2.29) was calculated from the twice weeding and the lowest from once weeding. The lowest LAI from once weeding may be due to higher competition with weeds for light. Since there are broad leaved weed species in once weeded plots they can alter light interception for pigeonpea. Leaf area index of pigeon pea was also significantly influenced ($p<0.05$) by population density. The higher LAI (2.83) was obtained from population density of 250,000 plants ha^{-1}. The possible reason is that as the pigeon pea population increases the leaf area also increases; resulting in better capture of solar radiation as compared to the wider spacing. This finding was supported by Hirpa, (2006) where he obtained the highest pigeonpea leaf area index from the narrower (15cm) intra- row spacing. Walelign (2006) also founds that the higher LAI at closer plant density is due to the more number of leaves per unit area.

Pod length and Branch per plant: The effects of weeding frequency and pigeonpea population density were not significantly affect pod length. Even though the difference was not statistically significant weeding twice had resulted the highest pod length as compared to its respective treatment. This result is in conformity with the findings of Prakash *et al.,* (2000) who stated that the highest pod length was recorded under the repeated hand weeding treatments. The lowest pod length was

Table 4: Growth and yield parameters of pigeonpea as influenced by weeding and population density of pigeonpea

Treatment	Leaf area index	Pod length (cm)	Branch plant^{-1}	Pod plant^{-1}	Grain Yield (t/ha)	Biomass Yield (t/ha)
Weeding						
Once	1.82^{b}	6.36	2.41	56.32^{b}	0.42^{b}	2.84^{b}
Twice	2.29^{a}	6.46	4.44	108.77^{a}	0.80^{a}	5.69^{a}
LSD (5%)	0.39	NS	NS	27.13	0.13	1.07
Population density						
125000	1.35^{c}	6.45	3.57	88.98	0.56^{b}	3.88
187500	2.06^{b}	6.35	3.17	70.23	0.53^{b}	3.79
250000	2.83^{a}	6.43	3.55	88.42	0.73^{a}	5.12
LSD (5%)	0.47	NS	NS	NS	0.16	NS
CV (%)	26.93	5.73	49.76	47.55	31.39	36.41
Cropping system						
Sole	1.23	6.40	3.53	90.87	2.34^{a}	13.09^{a}
Intercrop	2.08	6.41	3.43	82.54	0.61^{b}	4.26^{b}
LSD (5%)	NS	NS	NS	NS	1.05	5.84
CV (%)	19.73	6.66	29.42	41.26	20.22	19.15

NS-Non significant,
Means with the same letter are not significantly different

Table 5: Total land equivalent ratio as influenced by weeding frequency and population densities of pigeonpea.

Treatment	Grain yield(tha^{-1})		LER
	Maize	Pigeonpea	
Weeding			
Once	3.22^{b}	0.42^{b}	0.85^{b}
Twice	4.17^{a}	0.80^{a}	1.26^{a}
LSD (5%)	0.31	0.13	0.19
Population density			
125000	3.54^{a}	0.56^{b}	1.10^{a}
187500	3.69^{a}	0.53^{b}	1.00^{a}
250000	3.90^{a}	0.73^{a}	1.12^{a}
LSD (5%)	0.38	0.16	0.24
CV (%)	12.02	31.39	27.16
Sole Crop	4.25	2.34	
Mean			1.06

NS-Non significant,
Means with the same letter are not significantly different

recorded from 187,500 plants ha^{-1} probably due to higher intra-specific competition. While increasing the population density from 125,000 to 250,000 plants ha^{-1} decreased the pod length.

Number of branches per plant was also not significantly influenced by weeding frequency and population density of pigeon pea. The number of branches per plant for the intercropped pigeon pea ranged from 2.41 - 4.44, resulted from once and twice weeding respectively. A population density of 125,000 and 187,500 plants ha^{-1} have a minimum of 3.57 and 3.17 branches per plant. Indicating that further increase in plant population will have a negative effect on branch numbers. The reasons for decrease in branch number under increasing population was due to increased inter plant competition with increase in plant density.

Pod per plant: Number of pods per plant is highly influenced by weeding frequency (Table 4). The highest number of pod per plant was observed in the two times weeding. Where number of pods per plant was reduced by 48.22% in once weeding compared with twice weeding. This was probably because of the effect of competition from weed for limited amount of nutrients available, finally resulting in difficulty for the seed filling of the crop. The result is supported by the findings of Meseret *et al*, (2008) in which highly weed infested treatments set pods shriveled with no seed inside or smaller seed. Muhammad *et al*., (2003) indicated the highest number of pods plant^{-1} (32.92) was obtained from hand weeding, while weedy check plots had the least number of pods plant^{-1}.

The effect of pigeonpea population density had no significant influence on number of pods per plant. The lowest number of pods per plant was resulted from the highest (250,000 plants ha^{-1}) pigeonpea population density. In line with this Muoneke and Mbah, 2007 indicates number of pods per plant decreased as the okra plant population increased. This may be due to stiff competition for growth resources in high-density plantings. Even though, cropping system did not result a significant variation sole cropping pigeonpea had resulted relatively higher number of pods per plant.

Grain and Biomass yield: The effect of weeding frequency and pigeonpea population density results in significant differences in pigeon pea grain yield (Table 4). Weeding frequency of one and two times had significantly different grain yield. The highest grain yield of 0.80t/ha was obtained from the two times weeding in which the critical crop weed competition period during the first 3 to 4 weeks was over and created better environment with weed competition. In once weeding there is a yield reduction of 47.5% comparing with twice weeding. Since weeds use soil moisture that would be available for crop plants and thereby reduce yields. Rezene, (1994) reported that full season weed competition caused yield reduction up to 23.6, 15.3, 50.6 and 30.6% in fababean, fieldpea, lentil and chickpea respectively. Delorit, *et al,* (1984) also indicates yield reduction of crop plants are due to competition for soil moisture, nutrients and light. Since many weeds grow more rapidly and mature sooner than crop plants, they deplete the moisture supply in the soil before the crop plants. Dimitrova (1998) stated that weed competition lowered pea grain yields by 45%.

Increasing pigeonpea population density from 125,000 to 250,000 plants ha^{-1} resulted a significant yield increment from 0.56t/ha to 0.73t/ha. Similar results were reported by Geremew, (2006) indicating that grain yield was highest for 100% and the least for 50% cowpea population density in sorghum/cowpea intercropping. The finding of Tollossa, (1996) at Bako research center in maize/haricot bean intercropping also showed that the highest haricot bean yield was obtained from 100% haricot bean plant density intercropped with 75% maize plant density.

Cropping system also significantly affected grain yield of pigeonpea. The sole pigeonpea had significantly higher grain yield compared to the intercropped. Intercropped pigeonpea had a yield reduction as compared to sole cropping. Prasanna (2008) also indicated that sole cropping of little millet and pigeonpea gave significantly higher grain yield than intercropping system.

The biomass yield of pigeon pea was significantly affected by weeding frequency. The one times weeding which was highly suppressed by weeds produces a biomass yield of only 2.84 t/ha as compared to the two times weeding and it is by 50.1% lower than that of twice weeding. This is due to high competition for resources and since weeds are competitive they absorb more of the nutrients than the crop plants. So that pigeon pea will get lower assimilates and finally it produce lower biomass yields. Similarly Craig*et al.,* (2003) indicated that legume dry matter yield was significantly (*P*< 0.0001) reduced by the presence of weeds in the treatment.

Increasing pigeon pea population from 125,000 to 250,000 plants ha^{-1} did not significantly increase the biomass yield. Balasubramaniyan and Palaniappan, (2007) reports that further increase in plant density may reduce the dry matter production probably due to competition between plants. In contrast the finding of Walelign (2006) indicates when population density increase total biomass was increase linearly. The increment of biomass with rising of population density is due to the increasing number of plants per unit areas.

Productivity of maize-pigeonpea intercropping

Land equivalent ratio (LER): Weeding frequency was significantly affecting the total LER (Table 5). A significant total LER was obtained from once and twice weeding (0.85) and (1.26) respectively. The highest total LER obtained from twice weeding indicates that weeding increased the productivity of intercropping. A total LER of 1.26 tells us that the yield produced in the total intercrop would have required 26% more land if planted in pure stands. Whereas LER of 0.85, indicated the intercrop yield was only 85% of the same amount of land that grew pure stands. Alabi and Esobhawan (2006) founds LER of 0.82 and clarifies as 82% of the yield on intercrops is monocrops. From the present result farmers will be using 85% of the land in intercrops of maize or pigeonpea to produce the same quantity of maize and pigeonpea if they are planted separately. Ray and Mary (1991) reported that when plots were weeded, LER increased from 0.96to 1.13 under fertility stress conditions.

From the present study increasing pigeon pea population from 125,000 to 250,000 plants^{-1} increased total LER from 10 to 12%. However, a plant population of 187,500 plants ha^{-1} was not significantly different from its lower (125,000 plants ha^{-1}). Similarly Tembakazi and Lucas (2001) reported that LER was highest with maize at 10,000 plants ha^{-1} combined with beans at 150,000 plants ha^{-1} (2·60) with weeding frequency.

Taking overall mean grain yield of component crops, intercropping brought yield advantage of 6% (i.e total LER =1.06). This implies that intercropping of pigeon pea with in maize is more productive than planting the two crops separately. Under all pigeonpea population density of 125,000 and 250,000 plants ha^{-1} and twice weeding maize-pigeonpea intercropping was found to be advantageous; which is total LER was greater than one, except once weeding having a total LER of 0.85 and 187,500 plants ha^{-1} had resulted LER of 1.

CONCLUSION

Based on the results obtained in present study maintaining a plant population of 250,000ha^{-1} of pigeon pea intercropped with maize found to be more productive and remunerative cropping system and weeding twice at 25-30 and 55-60 days after emergence is suggested.

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