Centrepoint Journal (Science Edition)
Volume 19, No. 1, pages 69 – 80
http://www.unilorin.edu.ng/centrepoint

2141-3819/2013 $5.00 + 0.00
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CPJ 2012147/19106

Effect of Weed Removal and Plant Population on Weed Suppression and Performance of Maize (*Zea mays* L) in the Southern Guinea Savanna of Nigeria

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(Received December 20, 2012; Accepted March 12, 2013)

ABSTRACT: Effect of hand hoeing regime and plant population on grain yield of maize was studied in Ilorin during 2010 and 2011 growing seasons. It was a split- plot arrangement based on a randomized complete block design with three replications. The main plots were different hand hoeing regimes while the sub-plots were three plant populations. This study showed that there was significant variation in grain yield of maize with an increased in hand hoeing beyond the first at 3 WAP while two, three and four hand hoeings had similar grain yield. Increasing maize plant population from 25000 plants/ha to 50000 plants/ha and above increased the yield of maize. The grain yield of maize obtained from 50000 plants/ha and 75000 plants/ha plots were similar. Therefore, for small holders and/or resource limited farmers in southern Guinea savanna of Nigeria, planting maize at 50000-75000 plants/ha with 2 to 3 hand hoeing might eliminate the bulk of weed infestation and give a reasonable grain yield of maize.

Keywords: Weeds, plant population, hand hoeing, maize yield, Nigeria

Introduction

Maize grain is a valuable source of protein (10.4%), fat (4.5%), starch (71.8%), fiber (3%), vitamins and minerals like Ca, P, S and small amounts of Na. Its flour is considered to be a good diet for heart patients due to its low gluten (protein) content (Hamayun, 2003). Its importance as increase as it has replaced other food staples, particularly sorghum and millet (Smith *et al*, 1994) and its has also become a major source of cash for small holder farmers in sub-Saharan Africa (Smith *et al*, 1997).

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Maize yield on per hectare basis in Nigeria as low as 1.3 ton/ha compared to other maize growing regions of the world, especially in the developed countries where an average yield of maize can reach 8.6 ton/ha (IITA, 2007). There is a greater scope for improvement in maize productivity. Important factors that should be considered seriously for enhancing maize production include high yielding, disease and pest resistant varieties, favorable planting date, rate and methods of sowing, application of optimum production inputs and protection of crop from weeds, insects and other pests.

Weed menace has been a major constraint in maize production in southern Guinea savanna (Rajcan and Swanton, 2001). They cause important yield losses worldwide with an average of 12.8 % despite weed control applications and 29.2 % in the case of no weed control (Oerke and Steiner, 1996). In Nigeria, yield losses attributed to unchecked weed growth throughout the crop lifecycle has been estimated at about 50 to 87 % (Magani,1990).

Maize plants show pronounced competition among themselves and with the weeds, resulting in low yields. If this competition is intense then large number of plants will fail to produce seeds while the production will dwindle in others (Hamayun, 2003). Plant spacing or plant population plays an important role in the competitive balance between weeds and maize (Abouziena et al, 2008). Singh and Singh (2006) reported that weed density and other measures of weed abundance usually decrease as crop density increases.

Therefore, weed control is an important management practice for maize production that should be carried out to ensure optimum grain yield. Weed control in maize is carried out by mechanical and/or chemical methods. Weeds between plant rows are removed generally by mechanical cultivation, while weeds on the rows are controlled by hand hoeing or by herbicides. Although both methods are effective in controlling weeds. Zimdahl (1999) suggested that hand hoeing can be an acceptable method for weed control if human labour is abundant and labour cost is not high. This study was therefore designed to evaluate the performance of maize at different plant populations as affected by hand weeding regimes.

Materials and Methods

Site description

This study was conducted at the Research Farm of the National Centre for Agricultural Mechanization, Ilorin during 2010 and 2011 growing seasons. The farm is located in the southern Guinea savanna zone (4° 30' East and 8° 26' North). The area had a peak of rainfall in July which decreased gradually subsequently, and a daily temperature range of 20°c – 35°C.

Experimental layout

The experiment was laid out, each year in a randomized complete block design (RCBD) with a split-plot arrangement and three replications. The main plots consisted of four weeding regimes, which include: hand hoeing at 3 weeks after planting (WAP), hand

hoeing at 3 & 6 WAP, hand hoeing at 3, 6 & 9 WAP and hand hoeing at 3,6,9 & 12 WAP. The sub-plots consisted of three plant population, made up of 25,000 plant/ha, 50,000 plant/ha and 75,000 plant/ha.

Field establishment

Prior to the cultivation, the vegetation cover of the experimental sites was slashed to ground level, disc ploughed, harrowed and ridged. Thereafter, the field, with an area of 1872 m^2, was divided into three replications with main plots (20 m x 5 m) and sub plots (5 m x 4 m) in size. Four seeds of maize(Oba hybrid) were sown per hill at plant spacing of 1m x 0.8m, 1m x 0.4m and 1m x 0.27m and later thinned to one, two and three plants/hill at 2 WAP depending on the treatment allocation to give an approximate density of 25,000, 50,000 and 75,000 plants/ha, respectively. Basal application of NPK (15.15.15) at the rate of 60 kg/ha each of N, P and K. At 6 WAP, Calcium Ammonium Nitrate at the rate of 60 kg/ha of N was top-dressed.

Data collection

Data on weed weight was determined at 10 WAP, weed cover rating was assessed at 8 and 10 WAP. Dry matter production by the weeds was determined by pulling out weed seedlings within two fixed 0.5 m^2 quadrats. Samples from the same plot were bulked and put in the same envelop, oven dried to a constant weight. Weed cover rating was assessed at 8 and 10 WAP using a beaded string method (Sarrantino,1991) with knots at 10 cm intervals along a string stretched across both diagonals of each sub-plot (Fadayomi and Takim,2009).

Data on crop vigour and Leaf Area Index (LAI) were assessed at 7 and 9 WAP, respectively. Crop vigour was assessed using a scale of 1 to 5 (1 = poor, 2 = fair, 3 = good, 4 = very good and 5 = excellent) while leaf area index was determined using the following procedure:

- counting the number of crop plants per net plot to obtain total plants per net plot (P);
- counting all functional (green) leaves on five randomly selected crop plants per net plot to obtain average number of leaves per plant (N);
- measuring the length and breadth of a single functional leaf each at the top, middle, and bottom levels of the selected crop plants per net plot and obtaining an average per net plot. -the average value of length (L) and breadth (B) of the leaves from plot will be substituted into the equation: L x B x b (coefficient), to obtain the area of a single leaf (S)

Total leaf area per plant (T) = N x S

Canopy leaf area per plant (C) = P x T

LAI = canopy leaf area (m^2) / plot size (m^2).

Crop yield(ton/ha) was obtained by harvesting all the crops from the each plots and weighing the harvested crop per plot and extrapolate the weight per plot to yield per hectare.

Data analysis

All data collected were analysed using Gen stat Discovery Edition 3 and means were separated using standard error mean of difference (Sed). The composition of the weed flora was analysed by calculating the relative abundance (RA) of each species within each experimental unit as follows: RA = (RD + RF) / 2, where RD (relative density) = number of a weed species per unit area (within a quadrat) in the plot divided by the total number of weed species within the same unit area (quadrat); and RF (relative frequency) = proportion of quadrat in which the species was present per experimental unit divided by the total frequency of all species in the experimental unit (Takim & Fadayomi, 2009)

Results

Weed species composition

Thirty-three (33) weed species belonging to 28 genera within 14 families were observed comprising of 64 % were broadleaf weeds while grass and sedge weed species accounted for 24 % and 12 %, respectively (Table 1). *Tridax procumbens, Cleome viscose Cyperus tuberous, Fimbristylis littoralis, Euphorbia heterophylla, Eleusine indica, Brachiaria deflexa* and *Rottboellia cochinchinensis* had relative abundance of 5% and above across the plant population plots and there were thereafter referred to as prevalent weed species. The relative abundance of individual weed species seedling was not affected with increase in maize plant population except some weed seedlings like *Cleome viscose, Cyperus tuberous, Euphorbia heterophylla* and *Brachiaria deflexa* that their relative abundance decreased with an increased in maize plant population.

Weed infestation

The effect of weeding regime and plant population significantly affected weed seedlings infestation in both years (Table 2). The plots that had more than one hand hoeing had similar and statistically lower weed cover per plot at 8 WAP in 2010 and 10 WAP in 2011 growing seasons while at 10 and 8 WAP in 2010 and 2011, respectively, 3 and 2 hand hoeing plots had similar weed cover, percentage weed cover obtained in plots weeded 4 times was significantly lower although similar to 3 hand weeded plots in 2010 at 10 WAP. The single hand weeded plots had significantly higher percentage weed cover across the assessment periods and years.

A fairly similar trend was also observed on weed weight at 10 WAP in both years. In 2010, 4 and 3 hand hoeing plots, 3 and 2 hand hoeing plots produced similar dry weed weight while in 2011, these plots produced a statistically the same weed weight. In both years, single hoe weeded plots had significantly higher dry weed weight.

Table 1: Mean relative abundance (%) of weed species at two different growing seasons at 8 WAP

Family	Weed species	Types	Relative Abundance PP I	PP II	PP III
Asteraceae	*Aspilia africana* (Pers.) C.D. Adams	PB	1.13	2.23	0.65
	Chromolaena odorata (L.) R.M.Kings	PB	0.90	0.00	1.14
	Tridax procumbens L.	AB	8.59	10.09	7.98
	Vernonia galamensis (Cass) Less.	AB	1.81	1.24	0.65
Cleomaceae	*Cleome viscosa* L.	AB	8.71	6.41	5.37
Commelianaceae	*Commelina benghalensis* L.	PB	0.34	0.42	0.81
	C. diffusa Burm	PB	1.02	1.24	0.98
	C. erecta L.	APB	0.23	0.14	0.00
Convolvulaceae	*Ipomoea involucrata* P. Beauv	APB	0.34	0.14	0.16
Cyperaceae	*Cyperus esculentus* L.	PS	1.24	1.95	4.07
	C. tuberous Rottb	PS	20.81	16.85	14.49
	Fimbristylis littoralis Gaudet	AS	13.12	13.23	18.40
	Pycerus lanceolatus (Poir). C.B. Cl.	PS	1.58	1.24	4.72
Euphorbiaceae	*Euphorbia heterophylla* L.	AB	8.94	9.47	7.17
	E. hirta L.	AB	1.92	1.24	1.79
	Phyllantus amarus Sch. Thonn	AB	0.90	0.28	0.00
Laminaceae	*Hyptis suaveolens* Poir	AB	0.00	0.00	1.14
Loganiaceae	*Spigelia anthelmia* L.	AB	0.00	0.56	0.00
Nyctaginaceae	*Boerhavia coccinea* Mill	PB	0.45	0.00	0.65
	B. diffusa L.	PB	0.79	0.42	0.00
Poaceae	*Brachiaria deflexa* (Schum.) C.E. Hubbard ex Robyns	AG	6.90	5.99	4.39
	Cynodon dactylon (L.) Pers.	PG	0.29	0.14	0.00
	Eleusine indica Gaertn	AG	8.94	6.69	8.79
	Imperata cylindrica Anders	PG	0.00	2.01	0.00
	Paspalum orbicolare Forst	PG	0.00	1.95	0.98

Table 1 continued: Mean relative abundance (%) of weed species at two different growing seasons at 8 WAP

Family	Weed species	Types	Relative Abundance PP I	PP II	PP III
Poaceae	*Rottboellia cochinchinensis* (Lour.) Clayton	AG	8.94	7.99	8.79
	Setaria barbata (Lam) Kunth	AG	0.00	0.84	1.30
	Digitaria horinzontalis Willd	AG	1.24	2.65	2.93
Rubiaceae	*Diodia scandens* SW	PB	0.00	0.14	0.65
	Mitracapus villosus (SW) DC	AB	0.90	1.39	0.00
Portulacaceae	*Portulaca oleracea* L.	AB	0.34	0.00	1.14
	Talinum triangulare (Jacq) Willd	PB	0.45	0.69	0.00
Solanaceae	*Physalis angulata* L.	AB	0.23	0.42	0.33

PPI= 25,000 plants/ha, PPII = 50,000 plants/ha, PPIII = 75,000 plants/ha, A = annual weed species, P= perennial weed species, AP= annual/perennial weed species, B= broadleaf, G= grass, S= sedge

Table 2 Effect of weeding regime and maize population on weed infestation

	Weed cover (%) 2010 trial		2011 trial		Weed weight (g/m^2) 2010	2011
Treatment	8 WAP	10 WAP	8 WAP	10 WAP	10 WAP	10 WAP
Weed control (WC)						
HW @ 3 WAP	59.4b**	88.8c	77.3c	92.4b	134.02c	149.81b
HW @ 3 & 6 WAP	37.2a	72.8b	45.2b	71.6a	89.09b	77.84a
HW @ 3,6 & 9 WAP	35.4a	66.6ab	40.6b	69.7a	83.61ab	68.73a
HW @ 3,6,9 & 12 WAP	32.4a	61.0a	35.9a	64.3a	49.56a	56.67a
Sed	4.30	3.78	2.70	3.53	17.69	20.33
Maize population (MP)						
25000 plants/ha	50.5c	84.8b	59.5c	89.2c	87.09	96.67
50000plants/ha	40.8b	69.6a	48.2b	73.4b	81.04	89.09
75000plants/ha	32.1a	62.4a	41.6a	60.8a	99.14	79.14
Sed	3.43	4.31	3.34	4.13	15.15	13.12
Interaction						
WC x MP	NS	*	NS	*	NS	NS

HW = hoe weeding, WAP = weeks after planting.

** = Figures followed by the same letter(s) in the same column are not significantly different at P ≤ 0.05 according to standard error mean of difference (Sed)

The effects of maize population on weed cover were similar in both years. The plots with higher maize population had least significantly weed cover followed by plots that had 50000 plants/ha except at 10 WAP in 2010 where these two plots had similar weed cover while least populated maize plots had significantly higher weed cover rating. Weed weight was not significantly influenced by different population of maize.

The interaction between weed control and plant population on percent weed cover was significant at 10 WAP in both years. In both years, single hand weeded across the plant populations and the least maize populated plots across the weeding regimes had significantly higher weed cover while all other plots had significantly lower and similar weed cover rating (Table 3).

Table 3 Interaction effect of weeding regime and maize population on percentage weed cover at 10 WAP

Treatment	25000 plants/ha	50000 plants/ha	75000 plants/ha
		Maize population in 2010 trial*	
Weed control (WC)			
HW @ 3 WAP	97.0f	89.7ef	79.7de
HW @ 3 & 6 WAP	77.0d	64.0bc	58.7abc
HW @ 3,6 & 9 WAP	89.3ef	68.7cd	60.3abc
HW @ 3,6,9 & 12 WAP	76.0d	56.0ab	51.0a
Sed		5.34	
		Maize population in 2011 trial	
HW @ 3 WAP	96.3e	90.0e	91.0e
HW @ 3 & 6 WAP	81.7de	72.0cd	61.0bc
HW @ 3,6 & 9 WAP	88.3e	66.3bc	54.3b
HW @ 3,6,9 & 12 WAP	90.7e	65.3bc	37.0a
Sed		7.62	

HW = hoe weeding, WAP = weeks after planting.

* = Figures followed by the same letter(s) in the same column are not significantly different at $P \leq 0.05$ according to standard error mean of difference (Sed)

Crop performance

Hand hoeing significantly influenced the performance of maize crop on the field except leaf area index (Table 4). Crop vigour rated showed that single hand weeded plots had significantly lower vigour as compared to other plots that had similar and statistically higher crop vigour in both years. Grain yield of maize per plant was significantly affected by hand weeding regime. Higher quantities were obtained in plots that had more than one hand hoeing in both years. In 2010, two hoe weeded plots had better maize grain yield but similar to 3 hand weeded plots while 3 and 4 hand weeded plots were also similar in maize grain obtained. In 2011, 4 hand weeded plots had better yield, similar to 3 hoe weeded plots which in turn is similar to 2 hand weeded plots. The single hand weeded

plots had a relatively lower maize grain yield, these plots had similar maize grain with 2 hoe weeded plots in 2011 growing season.

The plant population showed significant effect on crop performance. Poor crop vigour was obtained in plots that had a population of 25000 plants/ha in both years. The other plots had similar crop vigour in 2010 while a better crop vigour was rated in plots that had 50000 plants/ha in 2011. The highly populated maize plots had similar leaf area index with the immediate populated plots in 2011 and the latter plots had the lower in 2010. The least populated maize plots had significantly lower LAI in both years. Grain yield per plant significantly affected by plant density, the least maize populated field had significantly lower grain per plant compared to other maize populated plots that had similar and significantly higher grain per plant. Maize grain yield obtained in plots with 25000 maize population was significantly lower as compared to other plots that had similar and statistically higher maize grain yield. Interaction effects between weed control and plant population on LAI and grain yield were significant in both years.

Leaf area index obtained in plots with 25000 maize population across weeding regimes were significantly lower as compared to other maize populations except in 2010 where few similarities were observed with 50000 maize populated plots that was hand weeded 3 times with the former plots. The highly populated and the immediate maize plots had relatively similar LAI (Table 5).

Table 4 Effect of weeding regime and maize population on maize yield and yield components.

	Crop vigour		LAI		Grain per plant (g)		Grain yield (ton/ha)	
Treatment	2010	2011	2010	2011	2010	2011	2010	2011
Weed control (WC)								
IIW @ 3 WAP	3.9b**	3.6b	3.14	3.08	72.1c	176.8c	1.77c	3.18c
IIW @ 3 & 6 WAP	4.2a	4.1a	3.24	3.11	74.9bc	233.7a	2.34a	3.22bc
IIW @ 3,6 & 9 WAP	4.2a	4.1a	2.96	3.07	85.7a	212.9ab	2.13ab	3.55ab
IIW @ 3,6,9 & 12 WAP	4.1a	4.3a	2.96	3.07	78.9b	181.9bc	2.02b	3.65a
Sed	0.067	0.128	0.179	0.127	3.06	20.76	0.122	0.165
Maize population (MP)								
25000 plants/ha	3.8b	3.8c	2.56c	2.49b	62.3b	149.8b	1.49b	2.62b
50000plants/ha	4.2a	4.3a	3.20b	3.68a	81.9a	227.8a	2.28a	3.65a
75000plants/ha	4.2a	4.0b	3.47a	3.38a	90.4a	226.3a	2.26a	3.93a
Sed	0.077	0.093	0.090	0.168	4.38	19.73	0.222	0.245
Interaction								
WC x MP	NS	NS	*	*	NS	NS	*	*

IIW = hoe weeding, WAP = weeks after planting.

** = Figures followed by the same letter(s) in the same column are not significantly different at P ≤ 0.05 according to standard error mean of difference (Sed)

Table 5 Interaction effect of weeding regime and maize population on leaf area index at 9 WAP

Treatment	25000 plants/ha	50000 plants/ha	75000 plants/ha
		Maize population in 2010 trial*	
Weed control (WC)	2.40a	3.20de	3.83f
HW @ 3 WAP	2.70abc	3.43ef	3.60ef
HW @ 3 & 6 WAP	2.63ab	2.93bcd	3.30de
HW @ 3,6 & 9 WAP	2.50ab	3.23de	3.13cd
HW @ 3,6,9 & 12 WAP		0.233	
Sed		0.498	
		Maize population in 2011 trial	
HW @ 3 WAP	2.33a	3.53df	3.37c
HW @ 3 & 6 WAP	2.40a	3.27cd	3.67f
HW @ 3,6 & 9 WAP	2.50ab	3.30cd	3.40df
HW @ 3,6,9 & 12 WAP	2.73b	3.37cd	3.10c
Sed		0.141	

HW = hoe weeding, WAP = weeks after planting.
* = Figures followed by the same letter(s) in the same column are not significantly different at P ≤ 0.05 according to standard error mean of difference (Sed)

The maize grain yield obtained showed that 75,000 and 50,000 maize populated plots that received 3 hand weedings had a better and similar grain yield. These plots had similar yield in 2010 with 50000 maize populated plots that had 2 hand hoeings and 75 000 plant /ha with 4 hand weedings plots in 2011. The least maize populated plots had relatively low maize grain yield across the weeding regimes and as compared to other maize populations (Table 6).

Table 6 Interaction effect of weeding regime and maize population on maize grain yield

Treatment	25000 plants/ha	50000 plants/ha	75000 plants/ha
		Maize population in 2010 trial*	
Weed control (WC)			
HW @ 3 WAP	1.38ef	1.86cd	2.07bc
HW @ 3 & 6 WAP	1.92bcd	2.38a	2.05bcd
HW @ 3,6 & 9 WAP	1.66de	2.68ab	2.71a
HW @ 3,6,9 & 12 WAP	1.03f	2.20bc	2.22bc
Sed		0.229	
		Maize population in 2011 trial	
HW @ 3 WAP	2.36f	3.06de	3.41c
HW @ 3 & 6 WAP	2.33f	3.60bcd	3.81bc
HW @ 3,6 & 9 WAP	2.74ef	4.12a	4.69a
HW @ 3,6,9 & 12 WAP	3.03d	3.49bc	4.13ab
Sed		0.324	

HW = hoe weeding, WAP = weeks after planting.
* = Figures followed by the same letter(s) in the same column are not significantly different at P ≤ 0.05 according to standard error mean of difference (Sed)

Discussion

The results recorded in these studies suggest that weed control in maize field could significantly increase yield and related yield parameters but similar maize grain yield was obtained in maize fields that were hand weeded twice and above. Hand hoeing at 6 WAP corresponded to the period of heavy canopy formation by the crop plants, the shading effect of the canopy results in interception of most of the green and red light, leaving far red to reach the ground. Far red light is known to be inhibitory to weed germination and total ground cover by the crop (Clark & Francis, 1985) could be responsible for the better weed suppression, thereby giving the maize plant competitive advantage over weed seedlings that may emerge thereafter. Weed weight and weed cover reduction at the subsequent period can be explained by the reduction in total incoming photosynthetic active radiation (PAR) reaching the ground (Katsaniware & Manyanhaure, 2009).

In maize, it has been observed that, as the plant density increases, the ratio of net energy at soil surface to that above plant canopy decreases. Upper leaves are well-exposed to solar radiation, they are usually at photo-saturation status, while lower leaves that face radiation deficiency are the first supplying source of carbohydrates for roots. So, plant density can affect suitable distribution of radiation and decrease radiation deficiency of lower leaves (Farhadi-Afshar et al, 2009).

In this study, with increase in maize plant population from 25000 to 50,000 plants/ha, maize yield related parameters and grain yield also had about 29-35 % increased but from 50,000 to 75 000 plants/ha, no significant increase in maize grain yield or related yield components was observed. Williams *et al.* (1985) who studied flint maize at seven densities of 17500-125000 plants/ha in a square planting pattern and found that as the density increased, the maximum grain yield declined. Also, with the increase in plant density, grain dry weight/plant decreased. Stickler and Loude (1995) studied maize in three densities of 39000, 49000 and 59000 plants/ha under irrigation and rain-fed conditions reported that the plant density significantly affected yield and the lowest yield was obtained at the density of 39000 plants/ha. Hashemi-Dezfuli *et al.* (2001) reported that the density of 75000 plants/ha was not appropriate in Khoozestan, Iran due to incomplete canopy coverage of the field. They speculated that higher densities might produce higher yield. Gardner *et al.* (2000) recommended the density of 50000 plants/ha as the best plant density for sweet maize. Smith *et al.* (1996) reported that sweet maize was planted with different densities in California, plant spacing was 17.5-25 cm and row spacing was 16-76 cm for planting one or two rows on one furrow. But they reported 47000-50000 plants/ha as the best density.

Maize grain yield is more affected by variations in plant density than other members of the grass family. Maize hybrids differ in their response to plant density (Luque et al., 2006). One of the most important effective factors is non application of optimal plant population per hectare (Sangoi and Salvador,1998). Higher planting densities increase plant sterility and the interval between male and female blooms, and reduce the number of grains per ear (Sangoi *et al.*, 2002). Adequate planting densities can contribute towards significant grain yield increases for farmers (Cardwell, 1992).

Conclusion

This study demonstrated that, weeds emergence occurs throughout the growing season of maize crop and increased in maize plant population could suppress the population of weed species. There was significant variation in grain yield of maize with an increased in hand hoeing beyond the first at 3 WAP while two, three and four hand hoeing had similar grain yield. Increasing maize plant population from 25000 plants/ha to 50000 plants/ha and above increased the yield of maize. Therefore, for small holders and/or resource limited farmers in southern Guinea savanna of Nigeria, planting maize at 50000-75000 plants/ha with 2 to 3 hand hoeing might eliminate the bulk of weed infestation and give a reasonable grain yield of maize.

References

Abouziena, H.F., I.M. El-Metwally and E.R. El-Desoki (2008). Effect of plant spacing and weed control treatments on maize yield and associated weeds in sandy soils. *American-Eurasian Journal of Agriculture and Environmental Science.* 4(1) 9-17

Cardwell, V.B. (1992). Fifty years of Minnesota corn production: sources of yield increase. *Agronomy Journal* 74: 984-995.

Clark, E. A. & C. A. Francis (1985). Transgressive yielding in maize-bean intercrops: Interference in space and time. *Field Crops Research* 11: 37-53.

Fadayomi, O & F.O. Takim (2009). Residual Effects of Legume Cover Plants on Soil Weed Seed Bank and Weed Growth in a Subsequent Maize Crop. *Nigerian Journal of Weed Science* 22: 15-22.

Farhadi-Afshar, H.R., H. Madani, M.H. Shirzadi, and I. Najafi (2009). Study of effects of cultivar, weeds and plant density on yield and yield components of sweet corn under Iranian warm environment. *Plant Ecophysiology* 3: 103-108

Gardner, E.H., N.S. Mansour, H.J. Mack, T.L. Jackson, and J. Burr (2000). Sweet corn eastern. Oregon-east of cascades Oregon state university extension service. http://eesc. Orst. Edu.

Hamayun, M. (2003). Effect of spacing and weed free periods on the productivity of maize (*Zea mays* L.) *Pakistan Journal of Weed Science Research* 9(3&4):179-184

Hashemi Dezfuli, S.A., K. Alimi-e Saeed, S.A. Siadat, M.R. Komeyli (2001). Effect of planting date on yield potential of two sweet corn cultivars under Khoozestan climatic conditions. *Iran Agriculture Science Journal* 32(4): 681-689.

IITA (international institute of tropical agriculture) (2007). maize, internet file Downloaded from www. IITA. org/cons / details / maize_ project details. Aspx ? zone id = 63 & article id= 273-17k on 2nd November 2007.

Katsaruware, R.D., & I.O. Manyanhaire (2009) *EJEAF Che,* 8 (11) 1218-1226.

Luque, S., A.G. Cirilo and M.E. Otegui (2006).Genetic grains in grain yield and related physiological attributes in argentine maize hybrids. *Field Crop Research* 95:383-397.

Magani I.E. (1990). Effects of period of interference and season long weed Control in maize (*Zea mays* L.). M.Sc. Thesis Ahmadu Bello University, Zaria, Nigeria. 93 pp.

Oerke, E.C. and U. Steiner (1996). Absch.tzung der Ertragsverluste im Maisanbau. In: Ertragsverluste und Pflanzenschutz Ð Die Anbausituation f.r die wirtschaftlich wichtigsten Kulturpflanzen-.German Phytomedical Society Series, Band: 6, pp. 63-79, Eugen Ulmer Verlag, Stuttgart.

Rajcan, I. and C.J. Swanton (2001). Understanding maize-weed competition: resource competition, light quality and the whole plant. *Field Crops Research* 71, 139-150.

Sangoi.L., R and J.Salvador (1998). Influence of plant height and of leaf number on maize production at high plant densities. *Agronomy Journal* 33:297-306.

Sangoi, L., MA, Gracietti., C. Rampazzo. and P. Bianchetti (2002). Response of Brazilian maize hybrids from different ears to changes in plant density. *Field Crops Research* 79: 39-51.

Sarrantino, M. (1991). Methologies for screening soil improving legumes. Kutstown, P.A. Rhodale *Institute Research Center* 312p.

Singh, R.P. and R.K. Singh (2006). Ecological approaches in weed management natural symposium on conservation. *Agriculture and Technology* 20:399-409.

Smith, J., A.D. Barau, A. Goldman and J.H Mareck. (1994). The role of technology in agricultural intensification, the evolution of maize production in the northern guinea savanna of Nigeria. *Economic Development and Cultural Change.* 42:537-554.

Smith, R., J. Aguria, and J.Caprile (1996). Sweet corn production. California UC IPM World Wide Web site University of California cooperative Extension form Advisors.

Smith, J., G. Weber, Y.M. Manyong and M.A.B Fakorede. (1997). Fostering sustainable increases in maize productivity in Nigeria. Chapter 8 in Africa's emerging maize revolution, edited by D. Byerlee and C.K Eicher, Iynne Rienner publishers, London UK.

Stickler, F.C., and H.H. Loude (1995). Effect of row spacing and plant population on performance of corn grain sorghum and forage sorghum. *Agronomy Journal* 275-277.

Takim, F.O. and Fadayomi, O. (2010). *Influence* of Tillage and Cropping Systems on Field Emergence and Growth of Weeds and Yield of Maize (*Zea mays* L.) and Cowpea (*Vigna unguiculata* L.) . *Australian Journal of Agricultural Engineering* 1(4) :141-148.

Williams, W.A., R.S. Loomis, and C.R. Lepley (1985). Vegetative growth of corn as affected by population density. *Crop Science* 211-215

Zimdahl, R.L., (1999). Fundamentals of weed science 2nd ed. New York: academic press. Pp 209.