Original Paper

Weed dry matter production and relative importance value of weeds as affected by age of pepper seedlings and different weed interference periods in pepper

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Abstract

The field trials were conducted at the Teaching and Research Farm Federal University of Agriculture, Abeokuta, Ogun State, Nigeria in the early and late wet seasons of 2012. The objective of the study was to evaluate the influence of weed interference period and age of pepper seedlings on weed dry matter production and relative importance value (RIV) of weed species in pepper. Two ages of pepper seedlings at transplant as the main plot and six weed interference periods as sub-plot treatments were accommodated in a split-plots arrangement of a randomized complete block design with three replications. Results showed that weed dry matter production and number of weed species reduced with weed-free period. There were 13 and 17 weed species present in the early and late wet seasons, respectively, while only *Tridax procumbens* had RIV greater than 5 % irrespective of age of pepper seedling and weed interference period in both seasons. Our findings reveal that either of the two ages of pepper seedlings at transplant can be adopted in its cultivation, and pepper plot should be kept weed free for 12 WAP to reduce weed dry matter production.

Keywords*:* pepper seedlings; *Tridax procumbens*; weed infested; weed free; weed species

Introduction

Chilli (*Capsicum annum* L), an important vegetable crop, is used world-wide as flavour, aroma and for adding colour to foods (Zhuang, et al., 2013). It is the only crop that produces alkaloids called capsaicinoids, which are responsible for the hot taste. Capsaicinoids are important in the pharmaceutical industry for their neurological effects (Hayman and Kam, 2008). Peppers have many biochemical and pharmacological properties which include antioxidant, anti-inflammatory, anti-allergenic and anti-carcinogenic (Lee et al., 2005). Ripe red peppers are also known to reduce the risk of cancer (Nishino et al., 2009) and for their other antimicrobial properties (Wahba, et al., 2010).

Weeds emerge fast and grow rapidly competing with the crop for growth resources viz., nutrients, moisture, sunlight and space during entire vegetative and early reproductive stages of chilli. The wide space provided in between chilli plants allows fast growth of different weed species, causing considerable reduction in yield (Peachey, et al., 2004). The presence of weeds reduces the photosynthetic efficiency, dry matter production and its distribution to economical parts, thereby reducing the sink capacity of the crop and resulting in poor fruit yield. Several studies have found pepper to be a poor competitor of weed. (Darren et al., 2008; Coelho, 2013). Depending on the intensity and persistence of weed density in standing crop, the reduction in pepper fruit yield had been reported to be in the range of 60 to 97 percent (Patel et al., 2004; Darren et al., 2008). Fu and Ashley (2006) remarked that Redroot pigweed (Amaranthus retroflexus L.) and hairy galinsoga (Galinsoga quadriradiata Cav.) were found to reduce pepper yield by up to 88 percent and 99 percent, respectively. Uncontrolled weed infestation throughout crop life cycle had been reported to cause 91 % to 98% reduction in pepper fruit yield (Osunleti et al., 2021)

Weed flora is considered, to date, one of the main causes that interfere in a relevant way with the quantity and quality of agricultural production, even if, on the other hand, some authors point out that weed flora is also an important element that characterizes the floristic biodiversity of countryside (Isbell, et al., 2017; Storkey and Neve, 2018). Currently, weed control management scheduling is addressed to limit dependence on herbicides by keeping the weed flora at a tolerable threshold of control instead of maintaining the crop totally free of weeds (Meisam et al., 2014). The effect of age of pepper seedling on weed dry weight and weed flora under different weed interference period is yet to be explored. Therefore this study was conducted to evaluate the effect of age of pepper seedling at transplanting and period of weed interference on weed dry weight and Relative Importance Value of Weed species in pepper.

Materials and Methods

The field trials were conducted in 2012 early wet season (June to October) and late wet season (August to December) Directorate of University Farms, Federal University of Agriculture, Abeokuta in the forest savannah transition agroecological zone (70, 20'N, 30, 23'E). The site received a total rain fall of 783.0 mm and 453.4 mm during the early wet and late wet season, respectively (Figure 1).

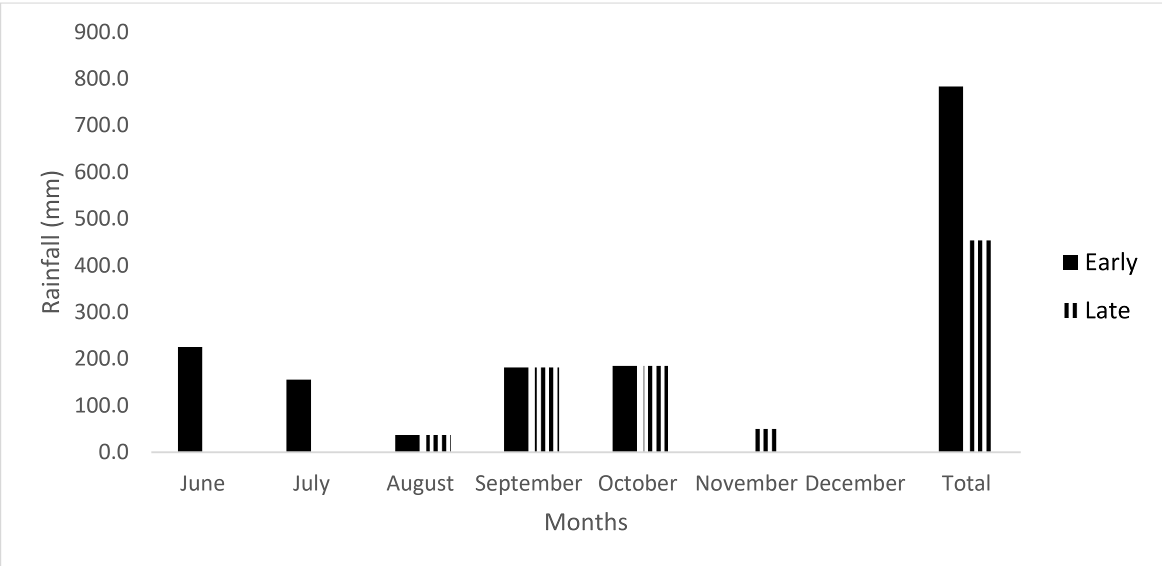

Figure 1. Monthly rainfall data during the experiment

The trials in both seasons were laid in a split-plot arrangement in a randomized complete block design with three replicates. Main plot treatments consisted of two ages of pepper seedlings at the time of transplanting, 4 and 6 weeks while six period of weed interference consisting of weed free for 3 weeks after transplanting (WAT); weed free for 6 WAT; weed free for 9 WAT; weed free for 12 WAT, weed free throughout and weed infested throughout were assigned to the subplot.

Each season, the experimental site was ploughed and harrowed at two-week interval to destroy established vegetation, weed seedlings and to produce a levelled, smooth and weed-free fields. After the removal of weed debris, the land was marked out into various replicates, plots and subplots. Transplanting of 4-week and 6-week old pepper seedlings into appropriate plots, according to the treatments, was done at inter-row and intra-row spacings of 60cm and 50cm, respectively at one seedling per stand. Hoe weeding was carried out according to the treatment requirement using West African hand hoe. The weeding operation on each plot as indicated in the treatments was preceded by collection of weed samples from 0.5 m2 using systematic random sampling on the plots.

Weed samples within 0.5 m2 quadrat were uprooted, sorted into different weed types (grasses, broadleaves and sedges) identified to species level using a Handbook of West African Weeds (Akobundu and Agyakw 1998) and counted. The samples collected were oven dried at 700C until a constant dry weight was obtained and weighed separately as dry matter production of grass, broadleaf and sedge. The dry matter production of each type of weed was cumulated and recorded as total weed dry matter production.

Data collected on weed dry matter production were subjected to analysis of variance (ANOVA) using Genstat 12th edition to determine the level of significance of the treatments. Treatment means were separated using 5 % least significant difference (LSD). Data collected on weed species composition at harvest were subjected to quantitative analysis to compute Relative Frequency, Relative Density and Relative Importance Value using the formulae below according to DAS 2011:

i.) $$\text{Relative Density (RD)} = \frac{\text{Density of a particular species}}{\text{Total densities of all species}} \times 100$$

ii.) $$\text{Relative Frequency (RF)} = \frac{\text{Frequency of a particular species}}{\text{Total frequencies of all species}} \times 100$$

ii.) $$\text{Relative Importance Value} = \frac{\text{Relative frequency + Relative weed density}}{2}$$

Results

Effect of age of pepper seedlings and different weed interference period on weed dry matter production

Age of pepper seedlings had no significant effect on dry matter production of broadleaf weeds, grasses and sedges of weeds in both seasons except sedges in the early wet season where pepper seedlings transplanted at 4 weeks after sowing (WAS) had higher value than the 6 WAS (Table 1). Period of weed interference had significant effect of dry matter production of the weed types (Table 1). In both seasons, the lowest dry matter production for the three type of weeds were recorded on the plot kept weed free throughout. Conversely, plots weed infested throughout had the highest dry matter production for broadleaf weeds, grasses and sedges in the early wet season. In the late wet season however, plots kept weed free for 3 weeks after transplanting (WAT) produced similar grass and broadleaf weed dry matter production to those plot kept weed infested throughout.

Table 1: Effects of age of seedlings at transplant and period of weed interference on cumulative weed weight in early and late wet seasons at Abeokuta

	Cumulative dry matter production (kg/ha)					
	Grasses		Broad leaves		Sedges	
Treatments	Early	Late	Early	Late	Early	Late
Age of seedling at transplant (A)						
4 WAS[1]	3948	3089	2004	2552	266	38
6 WAS	3835	3015	2044	2692	103	47
LSD	122.66ns	452.63ns	125.93ns	88.51ns	43.36	63.86ns
Period of Weed Interference (P)						
Weed Infested THROUGHOUT	7587	6085	2882	4229	593	117
Weed free for 3 WAT	6585	5810	3385	4163	90	21
Weed free for 6 WAT	4095	3451	3136	3843	43	19
Weed free for 9 WAT	2211	2011	2205	2671	127	16
Weed free for 12 WAT	1594	1201	444	686	18	11
Weed Free THROUGHOUT	106	90	103	154	2	10
LSD	618.95	828.75	334.07	530.32	70.45	94.15
Interaction (AxP)	ns	ns	ns	ns	ns	ns

Age of pepper seedlings had no significant effect on total weed dry matter production in both seasons (Figure 2). There was significant decrease in total weed dry matter production with increase in weed free period in both seasons (Figures 3 and 4). Also, there was 5.8 % to 97.8 % reduction in total weed dry matter production as a result of different weed interference period relative to the maximum on plots weed infested throughout (Figure 5) in both seasons. Furthermore, there was 56.9 % and more reduction in total weed dry matter production when plots were kept weed free for 9 WAP and more (Figure 5).

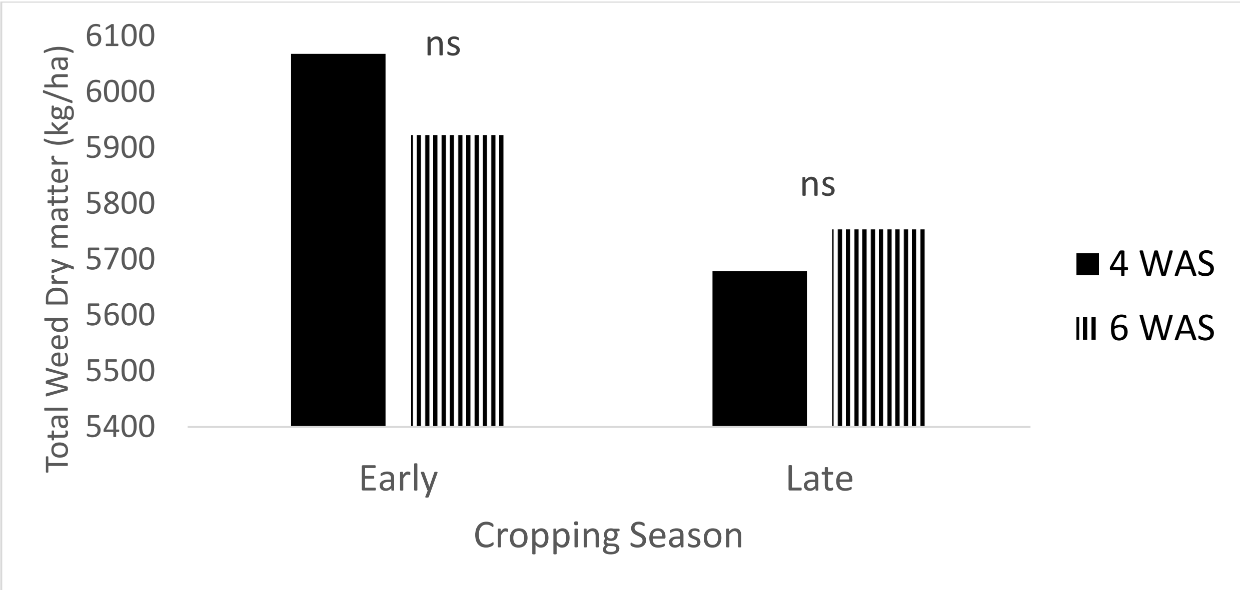

Figure 2: Effect of age of pepper seedling on total weed dry matter production in early and late wet seasons

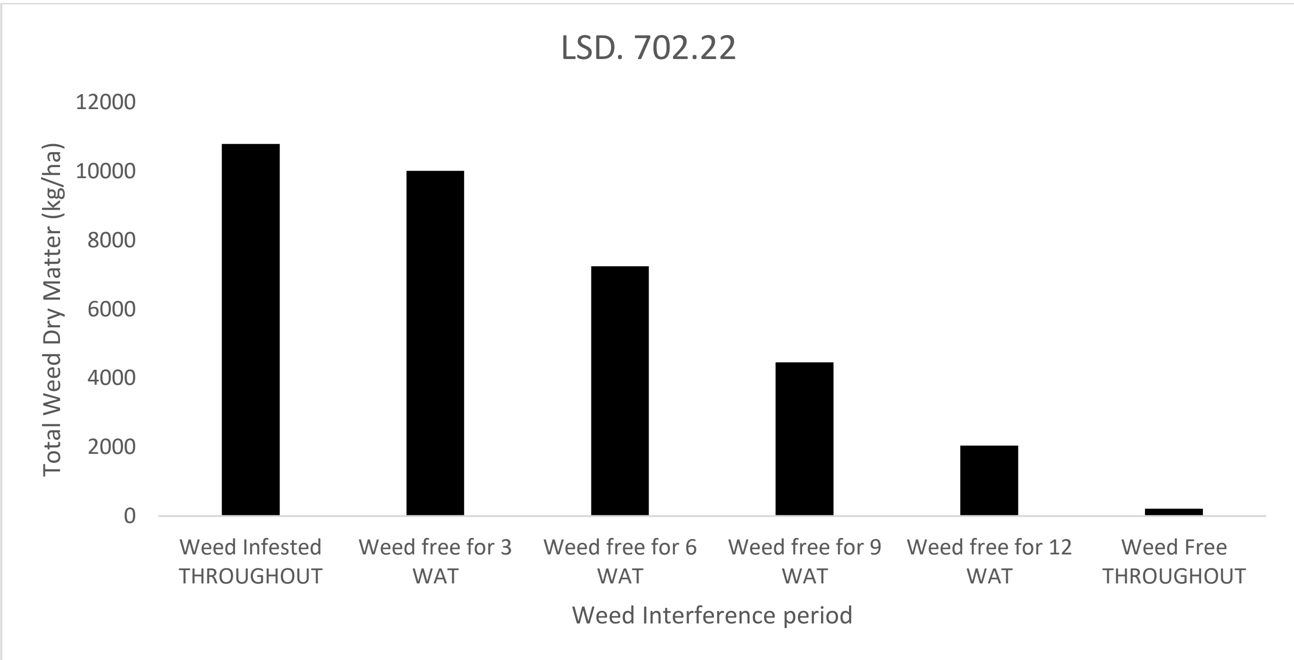

Figure 3: Effect of period of weed interference on total weed dry matter production in early wet season

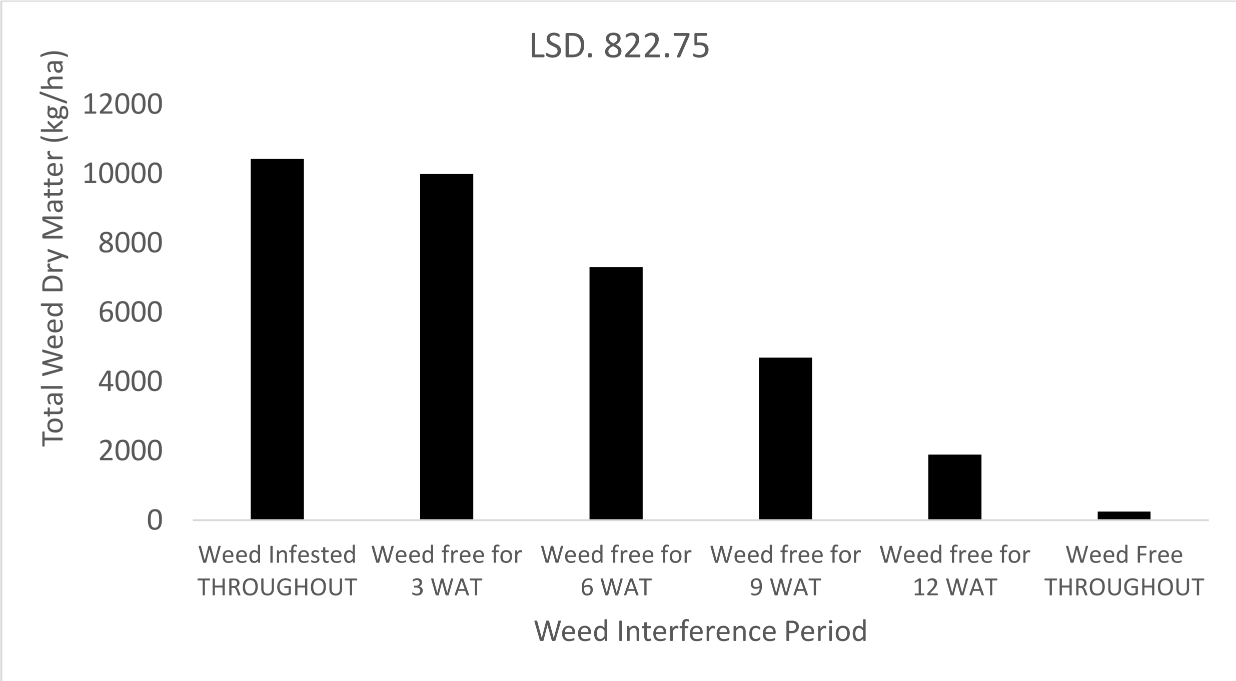

Figure 4: Effect of period of weed interference on total weed dry matter production in late wet season

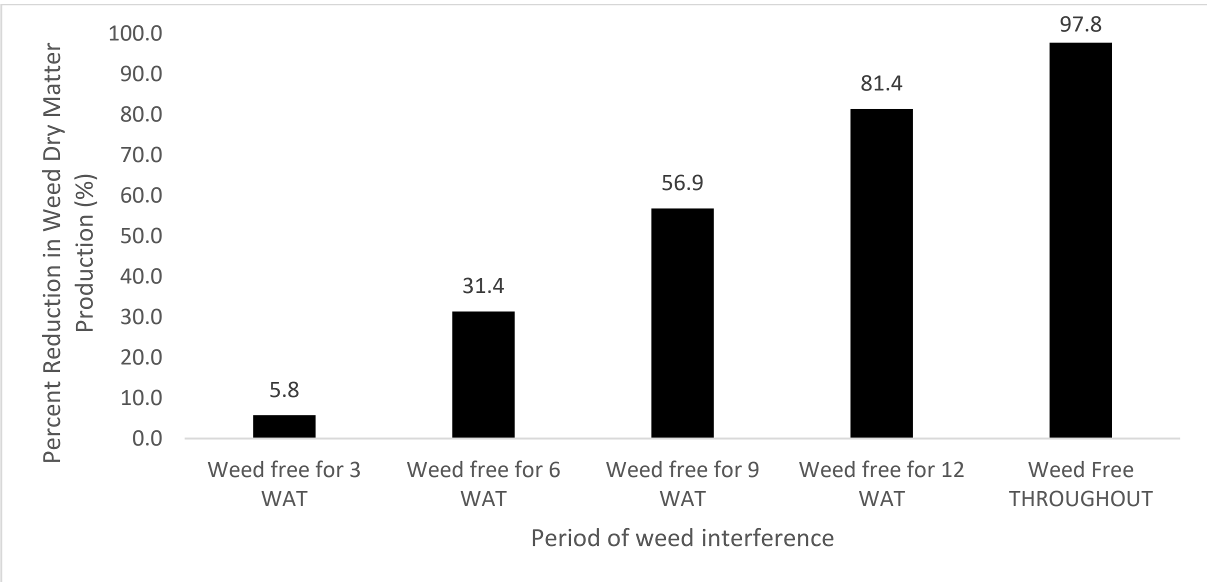

Figure 5: Effect of period of weed interference on percent reduction in weed dry matter production in both seasons

Effect of age of pepper seedlings and different weed interference period on Relative Importance Value of weeds in pepper

A total of 19 weed species belonging to 9 families were encountered in the initial weed survey conducted before the commencement of the trials (Table 2). Family Asteraceae and Poaceae had 4 weed species each, Malvaceae had 3 weed species, Cyperaceae and Fabaceae had 2 weed species each while Commelinaceae, Euphorbiaceae, Loganiaceae and Portulacaceae had one weed species each (Table 2).

Table 2: Common weed flora at the experimental site in early and late wet seasons at Abeokuta

BROADLEAVES	**Plant family**	**Growth form**
Aspillia africana (Pers.) C.D	Asteraceae	ABL
Chromolaena odorata (L) R.M. King & Robinson	Asteraceae	PBL
Commelina benghalensis Linn.	Commelinaceae	PG
Corchorus olitorus Linn.	Malvaceae	ABL
Euphorbia heterophylla Linn)	Euphorbiaceae	ABL
Mucuna puriens Linn.	Fabaceae	PBL
Senna obtussifolia Linn.	Fabaceae	PBL
Sida acuta (Burrn.)	Malvaceae	PBL
Spigelia anthelmia Linn.	Loganiaceae	ABL
Synedrella nodiflora (Gaertn.)	Asteraceae	ABL
Talinum fruticosum (L.) *Juss.*	Portulacaceae	ABL
Tridax procumbens Linn.	Asteraceae	ABL
Urena lobata Linn.	Malvaceae	PBL
GRASSES		
Imperata cylindrica Linn.	Poaceae	PG
Panicum maximum (Jacq)	Poaceae	PG
Pennisetum purpureum	Poaceae	PG
Rottboellia cochinchinensis (Lour.)	Poaceae	PG
SEDGES		

Mariscus alternifolius Vahl.	Cyperaceae	PS
Cyperus rotundus Linn.	Cyperaceae	PS

Note: PBL = perennial broad leaves ABL = annual broad leaves *PG = perennial Grass PS = perennial sedge

Irrespective of age of pepper seedlings at transplant, a total of 13 species consisting of 10 broadleaves, 2 grasses and 1 sedge were identified during the early wet season trial while the corresponding values for late wet season were 17 species consisting 14 broadleaves, 2 grasses and 1 sedge. In the early wet season, *Urena lobata* had the highest RIV of 15.23% and 18.04% respectively on plots planted with four and six-week old pepper seedlings kept weed free for 6 WAT (Tables 3 and 4). *Corchorus olitorus, Phyllanthus amarus, Senna obtusifolia, Spigelia anthelmia, Tridax procumbens* and *Urena lobata* had RIV greater than 5% irrespective of age of pepper seedlings at transplant and period of weed interference. Conversely, *Cyperus rotundus* and *Mucuna pruriens* had RIV less than 5% irrespective of age of pepper seedlings at transplant and period of weed interference (Tables 3 and 4). *Panicum maximum* had RIV less than 5%, when plots were planted with 4 and 6 week old pepper seedlings and kept weed free throughout (Table 3) also with six week old pepper seedlings when plots were kept weed free for 12 WAT (Table 4).

Table 3: Effect of period of weed interference on Relative Importance Value (%) of weeds with four week old pepper seedlings in the early wet season at Abeokuta

	WF 3 WAT	WF 6 WAT	WF 9 WAT	WF 12 WAT	WF Throughout	WI Throughout
Cyperus rotundus	2.84	2.35	1.87	0.54	1.00	4.40
Corchorus olitorus	8.96	9.30	8.70	8.14	10.16	6.87
Imperata cylindrical	8.56	5.77	6.08	7.11	3.98	7.00
Mariscus alternifolius	3.96	5.05	3.07	0.54	3.77	4.26
Mucuna pruriens	4.11	3.49	2.70	0.00	0.00	2.78
Panicum maximum	8.15	7.04	8.19	5.20	2.38	9.01
Phyllanthus amarus	7.98	6.86	9.48	10.01	10.62	9.76
Senna obtusifolia	12.63	13.22	10.40	11.43	12.51	12.09

Spigelia anthelmia	6.37	8.78	9.58	10.18	11.62	10.17
Synedrella nodiflora	7.03	5.95	9.98	8.37	8.00	6.87
Talinum fruticosum	6.00	6.01	7.95	10.55	8.21	6.48
Tridax procumbens	9.70	10.99	9.23	13.83	13.07	10.38
Urena lobata	13.78	15.23	11.42	14.12	14.89	10.00

Note: WF- Weed Free Initially; WI- Weed Infested Initially; WAT- Weeks After Transplanting

Table 4: Effect of period of weed interference on Relative Importance Value (%) of weeds with six week old pepper seedlings in the early wet season at Abeokuta

	WF 3 WAT	WF 6 WAT	WF 9 WAT	WF 12 WAT	WF Throughout	WI Throughout
Cyperus rotundus	2.99	1.44	1.88	0.61	2.41	3.71
Corchorus olitorus	8.69	11.17	8.78	8.95	11.61	7.42
Imperata cylindrica	7.94	6.09	8.00	8.13	4.14	8.00
Mariscus alternifolius	3.94	2.40	3.63	0.61	0.54	3.71
Mucuna pruriens	4.78	2.40	2.61	1.06	0.00	2.94
Panicum maximum	8.12	7.50	5.11	3.60	3.90	10.09
Phyllanthus amarus	7.74	6.33	9.34	9.83	9.29	9.50
Senna obtusifolia	12.31	14.68	12.25	11.39	10.96	11.54
Spigelia anthelmia	7.74	9.33	10.16	10.99	14.54	8.44
Synedrella nodiflora	6.46	4.33	10.69	8.37	5.03	7.12
Talinum fruticosum	6.98	4.36	7.02	8.50	6.21	5.11
Tridax procumbens	9.64	11.91	8.36	12.51	13.42	9.02
Urena lobata	12.71	18.04	12.23	14.48	17.69	13.45

Note: WF- Weed Free Initially; WI- Weed Infested Initially; WAT- Weeks After Transplanting

In the late wet season, *Tridax procumbens* had the highest RIV of 20.92 % and 17.44 % on plots planted with four-week old pepper seedlings kept weed free throughout and six-week old pepper seedlings left weed infested throughout, respectively (Tables 5 and 6). Conversely, *Mucuna pruriens* had the lowest RIV (0.47) when plots were planted with four-week old pepper seedlings and kept weed free for 9 WAT (Table 5). Also on plots planted with six-week old pepper seedlings, *Mariscus alternifolius* had the lowest RIV (0.66 %) when plots were kept weed free for 12 WAT (Table 6). *Amaranthus spinosus, Aspilia africana, Euphorbia* *heterophylla* and *Tridax procumbens* had RIV greater than 5% irrespective of age of pepper seedlings at transplant and period of weed interference. Also, *Aspilia Africana* and *Tridax procumbens* had RIV greater than 10% irrespective of age of pepper seedlings at transplant and period of weed interference. Conversely, *Andropogon tectorum, Mariscus alternifolius, Merremia aegyptia* and *Mimosa pudica* had RIV less than 5% irrespective of age of pepper seedlings at transplant and period of weed interference. Furthermore, *Mariscus alternifolius, Merremia aegyptia* and *Mimosa pudica* had RIV less than 3% irrespective of age of pepper seedlings at transplant and period of weed interference(Tables 5 and 6). Relative to plots left weed infested throughout, there is 6.3% to 37.5 % reduction in number of weed species on four-week old pepper when plots were kept weed free for 6 WAT and more and 5.9% to 41.1% reduction of the same with six-week old pepper seedlings, when plots were kept weed free for 3 WAT and to throughout (Figure 6).

Table 5: Effect of period of weed interference on Relative Importance Value (%) of weeds with four week old pepper seedlings in the late wet season at Abeokuta

	WF 3 WAT	WF 6 WAT	WF 9 WAT	WF 12 WAT	WF Throughout	WI Throughout
Ageratum conyzoides Linn.	9.10	4.84	10.38	8.13	6.89	3.33
Amaranthus spinosus	7.78	11.05	8.17	11.15	9.75	13.04
Andropogon tectorum	3.20	1.68	2.44	0.00	0.00	2.54
Aspilia africana	13.67	15.31	13.89	16.52	14.32	14.06
Chromolaena odorata	4.99	8.85	11.18	10.23	12.25	5.83
Commelina benghalensis	4.26	7.33	8.43	12.51	3.19	8.49
Euphorbia heterophylla	5.42	9.25	7.71	7.71	15.41	9.36
Imperata cylindrica	6.60	5.09	3.75	1.89	0.00	2.74
Mariscus alternifolius	1.60	1.34	1.08	2.04	0.00	2.74
Merremia aegyptia	0.00	0.00	0.00	0.00	0.00	0.78
Mimosa pudica	2.33	1.34	0.00	0.00	0.00	2.44
Mucuna pruriens.	5.10	3.49	0.47	0.00	0.00	2.34
Panicum maximum	7.05	4.92	4.12	2.41	3.62	2.93

Phyllanthus amarus	5.42	0.00	1.60	1.33	0.00	0.00
Spigellia anthelmia	4.84	5.43	10.17	8.04	12.45	8.86
Synedralla nodiflora	5.00	4.84	0.00	0.56	1.80	3.33
Tridax procumbens	13.66	16.06	16.69	17.51	20.92	17.27

Note: WF- Weed Free Initially; WI- Weed Infested Initially; WAT- Weeks After Transplanting

Table 6: Effect of period of weed interference on Relative Importance Value (%) of weeds with six week old pepper seedlings in the late wet season at Abeokuta

	WF 3 WAT	WF 6 WAT	WF 9 WAT	WF 12 WAT	WF Throughout	WI Throughout
Ageratum conyzoides	9.58	4.86	11.69	10.19	7.01	2.93
Amaranthus spinosus	7.81	10.86	7.08	12.82	14.27	11.23
Andropogon tectorum	3.38	1.86	2.34	0.00	0.00	3.65
Aspilia africana	14.39	13.12	13.64	12.48	13.13	15.06
Chromolaena odorata	5.58	7.80	9.62	7.81	13.79	9.16
Commelina benghalensis	4.62	2.31	7.22	11.10	8.24	6.35
Euphorbia heterophylla	5.74	11.34	9.92	8.53	10.71	8.54
Imperata cylindrica	6.52	5.80	3.80	1.33	0.00	2.48
Mariscus alternifolius	0.97	1.48	0.87	0.66	0.00	2.19
Merremia aegyptia	0.00	0.00	0.00	0.00	0.00	2.19
Mimosa pudica	1.29	1.48	0.00	0.00	0.00	2.19
Mucuna pruriens	4.62	3.43	0.00	0.00	0.00	2.79
Panicum maximum	7.01	5.11	3.01	2.05	3.82	2.05
Phyllanthus amarus	5.74	0.00	1.94	3.51	0.00	2.19
Spigellia anthelmia	4.46	9.89	11.70	11.29	8.57	7.54
Synedralla nodiflora	4.14	4.01	2.15	1.88	3.16	2.07
Tridax procumbens	14.24	16.87	15.07	16.39	17.18	17.44

Note: WF- Weed Free Initially; WI- Weed Infested Initially; WAT- Weeks After Transplanting

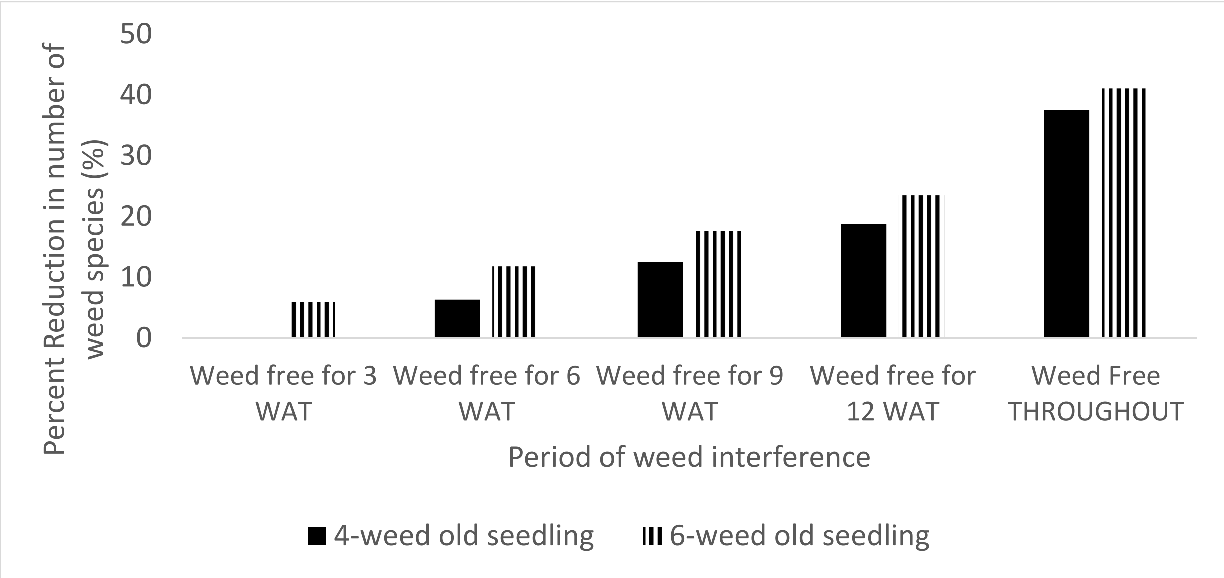

Figure 6: Effect of period of weed interference on percent reduction on number of weed species in the late wet season

Discussion

In the same vein, higher number of weed species observed in the late wet season compared to the early wet season in this study could be attributed to the initial dormancy the weed seeds undergo at the beginning of the planting season. This findings is similar to earlier report of Adeyemi et al., (2015) who reported more weed species in the late wet season compared to the early wet season in okra. Also, Adigun et al. (1992) earlier reported that most weed species exhibit various degrees of dormancy initially before germinating later in the season. The predominance of *Urena lobata* could be attributed to the abundance of the weed seeds in the soil and the fact that the weed is an aggressive weed. Adeyemi et al., (2015) had earlier reported high abundance and occurrence of *Urena lobata*. Randall, 2012 also noted and described *Urena lobata* to as an aggressive, invasive and noxious plant.

In this study and especially in the late wet season, number of weed species reduced with weed free period which is a function of frequent weeding which disturbed the soil often and resulting in burying the weed seeds and preventing them from germinating. This results corroborate the findings of Benvenuti et al. (2001) who carried out an experiment on emergence of weed seedlings from buried weed seeds with increasing soil depth. They observed prompt weed growth when weed seeds were left at the soil surface and ascribed this to the availability of favourable germination conditions at that soil layer. Weber et al. (2017) also reported abundance of weed seeds in the top soil when no tillage was done, and these seeds could easily germinate when environmental conditions are favourable.

The number of broadleaf weeds was more than 60% of the total number of weeds encountered in the course of this study irrespective of age of pepper seedlings, weed interference period and season. This indicates that broadleaf weeds infested the pepper plants more than the other weed types. This could probably be due to high weed seeds production ability of Family Asteraceae to which some of the broadleaf weed present in this study belonged to. This results corroborates the findings of many other researchers including Olorunmaiye et al., 2011; Kumar et al., 2010; Adeyemi et al., (2015) who also reported high number of broadleaf weeds in their respective studies

The observed consistently high RIV of *Tridax procumbens*, a member of Asteraceae family irrespective of the pepper seedling age, weed interference period and season, is an indication of its higher Relative Frequency and Relative Density than other weeds, hence the dominance of the species in this study. Osunleti et al. (2022) had earlier attributed high RIV of *Tridax procumbens* to its prolificacy and plasticity in seed production as well as the ability to adapt to low soil moisture during the short intra-season and long inter-season dry condition. This observation agrees with earlier report of Olorunmaiye et al. (2011) who suggested high colonizing power of the family Asteraceae, readily brought about by the efficient dispersal of seeds. Oluwatobi and Olorunmaiye (2014) also attributed the high relative weed density observed in members of Asteraceae to their aggressive growth, short life cycle, and large seed production.

Conclusion

In this study, age of pepper seedlings at transplant had no significant effect of weed dry matter production and weed species composition. Therefore, either of the two ages of seedlings could be adopted. Weed dry matter production and number of weed species reduced with increase in weed free period. For 80 % reduction in weed dry matter production in pepper, field should be kept weed free for 12 WAT. Also, broadleaf weeds especially Asteraceae should be properly monitored and weeded at short intervals because of their short life cycle in other to prevent them from flowering and seed production.

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