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Weed Population in Sweet Pepper Farms as Influenced by Land Preparation and Weeding Regime

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Authors' contributions

This work was carried out in collaboration between both authors. Author MDB designed the study, and wrote the first draft of the manuscript. Author MDB also conducted the field experiment. Author MSS supervised the study, did the weed identification and data analysis. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during the 2008 and 2009 rainy seasons to determine the effects of land preparation and weeding regime on the type of weed population in sweet pepper (*Capsicum annuum* L.) farms. The experiments were laid out in a split plot design with land preparation methods (No tillage, plowed, plowed and harrowed, and Raised beds) assigned to the main plot and weeding regime (No weeding, weeded at 2 Weeks After Transplanting, weeded at 2 and 4 Weeks After Transplanting, and weeded at 2, 4 and 6 Weeks After Transplanting) were assigned to the subplots. Data were collected on days to weed emergence, weed count, weed weight and weed height. These were subjected to analysis of variance (ANOVA) from, which means showing

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significant F- test were separated using Least Significance Difference (LSD). Dominant weeds specie was determined using the Relative Frequency (RF), Relative Density (RD) and the Sum Dominance Ratio (SDR) of the flora population. The results attained from the research showa significant (P<0.05) effect of weed weight in 2009. These understandings of weed in sweet pepper fields will help ameliorate dangers of weed damage in any production cycle through a carefully configured control measure. It was noticed that weeds such as *Euphorbia hirta*, *Ipomeoa eriocarpa* R., *Paspalum conjugatum* and *Gomphrena celosioides* Linn were found to grow throughout the production period while *Kyllingia squamulata*, *Cyperus rotundus* and *Acanthospermum hispidum* had higher occurrences with the sweet pepper in the study area.

Keywords: Raised beds; weeds; farms; relative frequency; relative density; Capsicum annuum.

ABBREVIATIONS

WAT: Weeks After Transplanting; SDR: Sum Dominance Ratio; RD: Relative Density; RF: Relative Frequency.

1. INTRODUCTION

Weeds constitutes the most objectionable aggressive and bothersome elements of the world's flora. They are plants which grow out of their right places and whose merits have not yet been revealed [1]. They are also plants whose undesirable values are more than their progressive values [2]. They are considered as plants developing at the wrong place or where they are not preferred [3].

Weed is one of the constraints in sweet pepper production, which can substantially reduce yield without obvious sign of damage [4]. Weeds are a serious negative factor for crop production that may result in great losses in crop yield [5]. Such losses may arise mainly from the direct competition between crops and weeds for light, water, space, and nutrients [6], or indirectly from harboring insect and disease causing organisms [7]. Weeds always act as energy drain in the entire managed ecosystem such as agricultural crops, forestry, range management, aquaculture, and horticulture. Some weeds are toxic [2], and may be poisonous to livestock or reduces human efficiency through causing allergies and poisoning [2]. Weed control is one of the best production practices in farm management [6]. It is an unavoidable need for successful production of vegetable crops [6]. However, farmers do not give desired devotion to the manner in which they make their lands, as well as the number of times at which weeding are done. Although little is known about the best land preparation and hoeing regime as they influence weed vegetation population on the pepper farm. This study will try to determine the effect of land preparation and weeding regimes on the weed flora population in sweet pepper grounds and to evaluate the interaction between land preparation and weeding regime on the growth and population of weeds.

2. MATERIALS AND METHODS

2.1 The Study Area

The experiment was conducted in two years during the 2008 and 2009 rainy periods at the Teaching and Research Farm of the Federal Polytechnic Mubi. Mubi is located in the Northern part of Adamawa State between latitude 9º26' and 10º10' N and longitudes 13º1' and 13º44' E. It has a land area of 506.40 km^2 [8], at an altitude of 696 m above sea level [9]. The climate is categorized by alternating dry and wet season. The rains last from April to October with a mean annual rainfall from 700 mm to 1050 mm [10,8]. The land use forms are mainly arable agriculture and livestock production [11].

2.2 Treatments and Experimental Design

The treatments consisted of four different land preparation methods, namely: Zero tillage, plowed, plowed and harrowed, and Raised seed bed; and for weeding regime: weedy check, weeded at 2 WAT, weeded at 2 and 4 WAT as well as weeds at 2, 4 and 6 WAT. The treatments were laid out using a split –plot design with three replications. Sweet Pepper seeds, SAMARU MILD gotten from Adamawa State Agricultural Development Program were seeded by broadcasting in a nursery.

Before they were transplanted to the field at 6weeks after sowing. Tillage methods were

assigned to the main plot and weeding regimes assigned to the sub-plot. The entire land area used for the research was 9.5 m x 29.5 m (280.25 m^2), with a gross plot size of 2 m x 2 m and a net plot size of 0.9 m x 0.9 m. Alleyways of 0.50 m were allowed between the replications and the plots.

2.3 Soil Sampling and Analysis

Soil samples were collected at random at sixteen (16) different positions within the experimental area at a deepness of 0-15 cm using soil auger, a merged samples of it was made, and the physical and chemical properties of the soil were determined. TheSamples were sun dried, ground and sieved with a 2 mm sieve. A particle size analysis was done by the bouyoucos hygrometer method [12]. Soil pH was determined using the glass probe pH meter in 1:2 soil and water ratio [13]. Organic carbon was determined by the dichromate wet oxidation method [14]. Total N was determined by the micro Kjeldahl method [15]. Obtainable P was determined by Bray- 1 [16]. Bray and Kurtz 1 N ammonium acetate was used to extract the exchangeable bases. Ca and Mg were determined using EDTA complexiometric titration, while K was by flame photometry [16]

2.4 Weeding

Weeding was done using a simple hoe for the plowed, plowed and harrowed, and raised beds while simple hand picking was done for the zero tilled plots. This method was adopted till the end of the experiment in the two years.

2.5 Weeds Sampling and Measurement

After all the land was prepared as designed, weeds in the field were collected at the completion of the second week but before the first weeding. The collection was done using a 1meter square, quadrant thrown at random in each of the plots for the first, second and third weeding regimes and at the beginning of harvest for weedy check plot. The weeds gathered there in (whole plant) were carefully sorted specie by specie and were instantly weights using a digital weighing scale of 1kg capacity. Each weed specie identified was later carefully counted. Mean values were determined and then subjected to analysis of the sum dominance ratio (SDR), relative density (RD) and relative frequency (RF) as described by Riaz et al. [17].

2.6 Days to First Weed Emergence

Physical observation of the plots was done from the date of transplanting to determine the number of days taken for the first weeds to emerge on each plot. This observation continued for each weeding regime.

2.7 Weed Count

The weeds sampled within 1m^2 quadrant were identified and separated on species basis and counted. The data on weeds count were analyzed following the formulae of Wirjahadja and Pancho [18] and Riaz et al. [17] where:

$$\text{Relative frequency} = \frac{\text{Frequency value for one weed species}}{\text{Total frequency value for all weed species}} \times 100$$

$$\text{Relative Density} = \frac{\text{Density of one weed species}}{\text{Total Density of all weed species}} \times 100$$

$$\text{Summed dominance ratio} := \frac{\text{Relative density} + \text{Relative frequency}}{2} \times 100$$

2.8 Weed Weight

Weed weight per plot was determined on a wet weight basis. A metal square measuring 1 meter in diameter was thrown randomly on each plot and the weeds there in (both roots and shoot) together were collected and weighed using a digital weighing scale. Weighing was done at each weeding regime. The total was computed at the end of the season for weeded and weedy check plots.

2.9 Weed Height

Height of five tallest weeds per plot was taken at last harvest and averaged to give weed height per plot. Measurement was done using a measuring tape of 15 metres capacity.

2.10 Statistical Analysis

The experiments were arranged out in a split plot design replicated three times. Data collected were analyzed using Analysis of variance (ANOVA) procedure in accordance with Gomez and Gomez [19]. Data for the two years were combined and analyzed for growth, yield and weed characters. Mean separation was made for means with significant F- test at the 5 % level of probability using Least Significant Difference (LSD) test.

3. RESULTS

3.1 Weed Flora Population

The weed flora population in the sweet pepper field during the 2008 and 2009 rainy periods is presented in Table 1. The absolute frequency value of 0.43 for *Ipomoea eriocarpa* was the lowest in the 2008. *Amaranthus spinosus* Linn. recorded the highest absolute frequency value of 7.34. in the same year. The largest flora population of 5,033 was recorded on *Kyllinga squamulata* Thorn. in 2008 as against the highest of 5,800 recorded for *Cyperus rotundus* Linn in 2009. A total of 26,308 various weeds was found growing in the sweet pepper field in 2009, and 29,298 in the 2008 rainy season. The highest sum dominance ratio of 395 and 373 were recorded for *Euphobia hirta and Amaranthus spinosus* in 2009 and 2008 respectively. The lowest sum dominance ratio of 21.93 and 46.36 was recorded for *Ipomoea eriocarpa* R in 2008 and 2009 respectively. The relative density values range between 22.05% and 0.08% for *Cyperus rotundus* Linn. And *Eleusine indica* respectively in 2009, and 17.24% and 0.11% for *Cyperus rotundus* Linn. and *both Monechma ciliatum and Trianthema portulacastrum* respectively in the year 2008. Similarly, relative frequency (RF) of the weed flora population follows the same trends as *Amaranthus spinosus* Linn recorded 7.34% in 2008 while *Ipomoea eriocarpa* R. recorded the lowest RF value of 0.43% in the same year. In 2009, the highest RF value of 7.83% was recorded in *Euphorbia hirta* while *Ipomoea eriocarpa* recorded a least RF value of 0.93%. The total, absolute frequency of weed flora stood at 100% in both years.

3.2 Days to Weed Emergence

Mean standards for days to weed emergence in sweet pepper fields during the 2008 and 2009 rainy seasons are presented in Table 2. There were no significant ($P \geq 0.05$) difference for days to weeds emergence after land preparation in both the periods for both land preparation and weeding regime. Similarly, there was no significant > 0.05) effect of land preparation and weeding regime on days to the weed occurrence at 2WAT in 2008 and 2009. However, at 2WAT there was a highly significant P<0.01) effect of weeding regime on days to weed emergence at 2WAT in 2008 and 2009. However, at 2WAT there was highly significant ($P \leq 0.01$) effect of weeding regime on days to weed emergence in both 2009 and the pooled (Fig. 1). Plots weeded once and twice all recorded 4.50 days while plots weeded 3 times recorded 4.58 days. At 4WAT, there was no significant ($P \geq 0.05$) result of land preparation on days to weed emergence for both the seasons. However, weeding regime had a highly significant ($P \leq 0.01$) effect on days to weed emergence at 4WAT in 2008 and 2009. At 6WAT land preparation only had a significant effect on days to weed emergence in 2009. Both the control plot (zero tilled) and plowed plots recorded 0.92days while raised bed plots and plowed and harrowed plots noted 1.58 days and 1.25 days respectively. Also, weeding regimes had a highly significant (P<0.01) outcome on days to weed emergence at 6WAT in both the seasons. Plots weeded 3 times recorded 5.08 days, 4.67 days, and 4.88 days for 2008, 2009 and in the combined years (Fig. 1) respectively.

Table 1. Weed flora distribution study in the experimental sites for the 2008 and 2009 rainy periods

Scientific name	Number of specie In all quadrants		Number of quadrants specie occur		Total. number of quadrants in all		Absolute frequency		Relative frequency		Absolute density		Relative density		Sum Dominance Ratio	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
Dactyloctenium aegyptium (Linn.) P.Beauv	1174	700	95	68	1404	1404	6.77	4.84	6.77	4.84	4.01	2.66	4.01	2.66	342.33	244.83
Amaranthus spinosus Linn	1968	2112	103	78	1404	1404	7.34	5.56	7.34	5.56	6.72	8.03	6.72	8.03	373.53	285.81
Tephrosia pedicellata. Bak	1001	101	66	47	1404	1404	4.70	3.35	4.70	3.35	3.42	0.38	3.42	0.38	238.46	167.76
Waltheria indica Linn	360	100	65	54	1404	1404	4.63	3.85	4.63	3.85	1.23	0.38	1.23	0.38	232.71	192.69
Panicum maximum Jacq	1425	863	53	61	1404	1404	3.77	4.34	3.77	4.34	4.86	3.28	4.86	3.28	193.61	220.52
Axonopus compressus (SW.) P. Beauv	2000	1563	76	83	1404	1404	5.41	5.91	5.41	5.91	6.83	5.94	6.83	5.94	277.48	301.53
Eleusine indica Gaertn	637	20	100	41	1404	1404	7.12	2.92	7.12	2.92	2.17	0.08	2.17	0.08	358.30	146.09
Tridax procumbens Linn	844	1197	54	82	1404	1404	3.85	5.84	3.85	5.84	2.88	4.55	2.88	4.55	195.19	296.57
Eragrostis tenella (Linn.) P. Beauv. ex Roem & schult	1100	200	55	108	1404	1404	3.92	7.69	3.92	7.69	0.08	2.17	3.75	0.76	199.62	385.38
Kyllinga squamulata Thorn. Ex Vahl	5033	4412	99	89	1404	1404	7.05	6.34	7.05	6.34	4.55	2.88	17.18	16.77	369.74	333.72
Acanthospermum hispidum DC	2488	3480	63	75	1404	1404	4.49	5.34	4.49	5.34	8.49	13.23	8.49	13.23	232.85	280.32
Euphorbia hirta Linn	1237	1061	61	110	1404	1404	4.34	7.83	4.34	7.83	4.22	4.03	4.22	4.03	221.46	395.77
Cyperus rotundus Linn	5051	5800	69	60	1404	1404	4.91	4.27	4.91	4.27	17.24	22.05	17.24	22.05	262.97	235.72
Ipomoea aquatic Forsk	782	1112	56	31	1404	1404	3.99	2.21	3.99	2.21	2.67	4.23	2.67	4.23	202.10	114.63
Sida rhombifolia Linn	1222	742	31	31	1404	1404	2.21	2.21	2.21	2.21	4.17	.82	.17	.82	114.57	113.22
Mimosa pudica Linn	533	589	29	28	1404	1404	2.07	1.99	2.07	1.99	1.82	.24	.82	.24	105.10	101.95
Ageratum conyzoides Linn	490	240	40	34	1404	1404	2.85	2.42	2.85	2.42	1.67	.91	.67	.91	144.12	121.99
Chrysanthellum indicum (Linn)	526	40	20	26	1404	1404	1.42	1.85	1.42	1.85	1.80	.15	.80	.15	73.02	92.74
Gomphrena celosioides Mart	307	100	25	34	1404	1404	1.78	2.42	1.78	2.42	1.05	0.38	1.05	0.38	90.08	121.46
Ipomoea eriocarpa R. Br	165	16	6	13	1404	1404	0.43	0.93	0.43	0.93	0.56	0.06	0.56	0.06	21.93	46.36
Physalis angulata Linn	204	50	51	39	1404	1404	3.63	2.78	3.63	2.78	0.70	0.19	0.70	0.19	182.32	139.08
Pennisetum pedicellatum Trin	134	50	23	41	1404	1404	1.64	2.92	1.64	2.92	0.46	0.19	0.46	0.19	82.37	146.20
Elipta alba (L) Hassk	90	527	33	45	1404	1404	2.35	3.21	2.35	3.21	0.31	2.00	0.31	2.00	117.83	162.26
Monechma ciliatum (Jaeq) Milne-Redhead	33	524	43	41	1404	1404	3.06	2.92	3.06	2.92	0.11	1.99	0.11	1.99	153.25	148.00
Trianthema portulacastrum Linn	33	340	44	30	1404	1404	3.13	2.14	3.13	2.14	0.11	1.29	0.11	1.29	156.81	108.13
Paspalum conjugatum Berg	104	300	29	30	1404	1404	2.07	2.14	2.07	2.14	0.35	1.14	0.35	1.14	103.63	107.98
Aspillia bussei O. Hoffm & Muschel	60	69	15	25	1404	1404	1.07	1.78	1.07	1.78	0.20	0.26	0.20	0.26	53.62	89.29
Total	29298	26308					100.00	100.00	100.00	100.00						

Table 2. The effects of land preparation and weeding regime on days to weed occurrences in 2008 and 2009 rainyseasons

Treatments	0WAT			2WAT[1]			4WAT			6WAT		
	2008	2009	Combined	2008	2009	Combined	2008	2009	Combined	2008	2009	Combined
Land preparation (LP)												
Ploughed	6.17	6.17	6.17	3.25	3.42	3.33	2.67	2.75	2.71	1.33	0.92^{c}	1.13
Plowed & harrowed	5.75	5.75	5.75	4.00	3.75	3.86	3.17	2.17	2.67	1.42	1.25^{b}	1.33
Raised Bed	5.83	5.83	5.83	4.25	3.42	3.83	3.33	2.67	3.00	1.33	1.58^{a}	1.46
Zero Tilled	4.67	4.67	4.67	2.42	2.67	2.54	2.08	2.50	2.29	1.00	0.92^{c}	0.96
Level of Significance	ns[2]	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	**[3]	Ns
LSD											0.24	
Weeding regime (WR)												
0 WAT	5.67	5.58	5.63	0.00	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}
2 WAT	5.50	5.50	5.50	4.67	4.33^{a}	4.50^{a}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}
2,4 WAT	5.67	5.67	5.67	4.58	4.42^{a}	4.50^{a}	5.58^{a}	5.25^{a}	5.42^{a}	0.00^{b}	0.00^{b}	0.00^{b}
2,4.6 WAT	5.58	5.67	5.63	4.67	4.50^{a}	4.58^{a}	5.67^{a}	4.83^{a}	5.25^{a}	5.08^{a}	4.67^{a}	4.88^{a}
Level of Significance	Ns	Ns	Ns	Ns	**	**	**	**	**	**	**	**
LSD					0.64	0.39	0.53	0.71	0.43	0.47	0.21	0.25
LP X WR	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	**	**
LSD											0.41	0.51

1 = Weeks After Transplanting 2 = Not Significant 3 = Highly significant at 1% Level of Probability; Means within columns with similar letters are not significantly different (P>0.05)

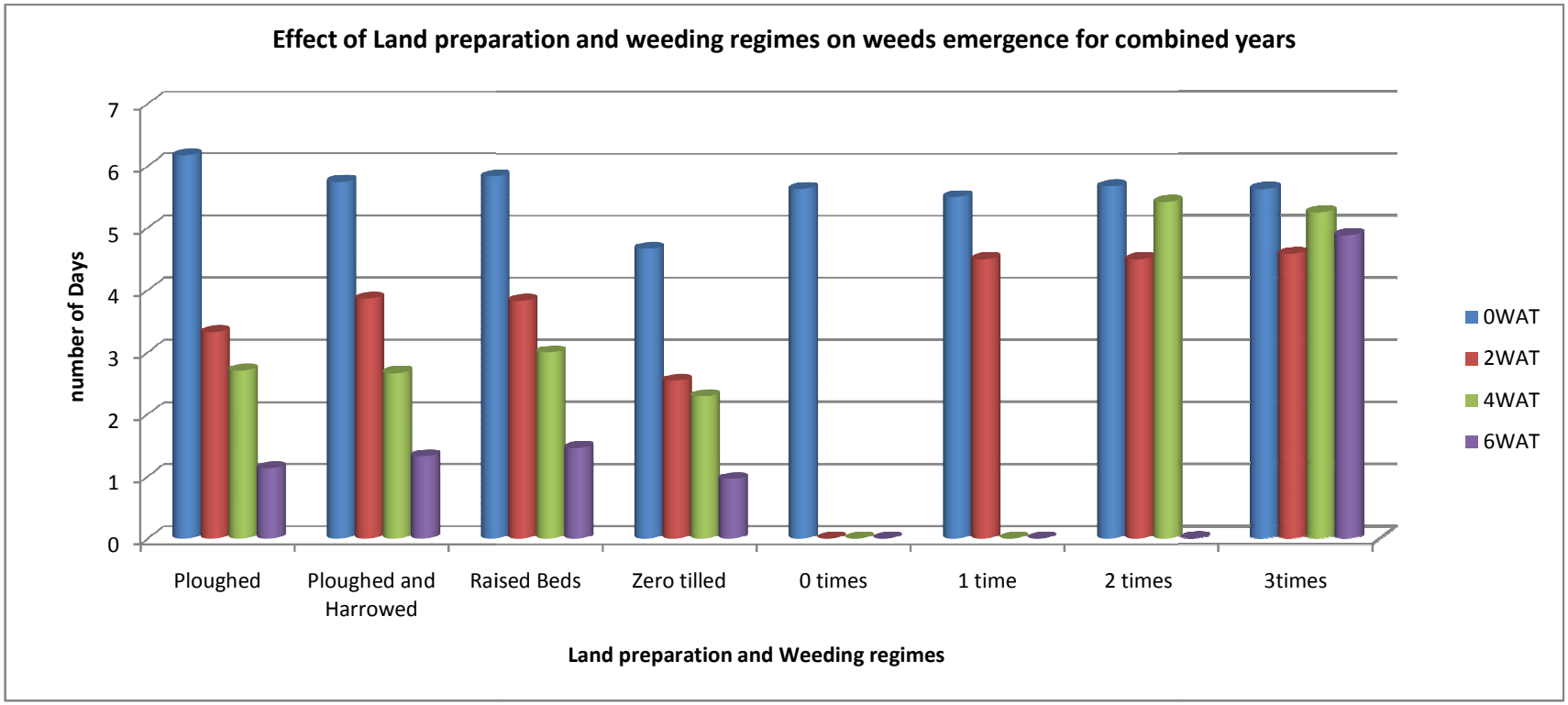

Fig. 1. The effects of land preparation and weeding regime on days to weed emergence for the combined years of 2008 and 2009

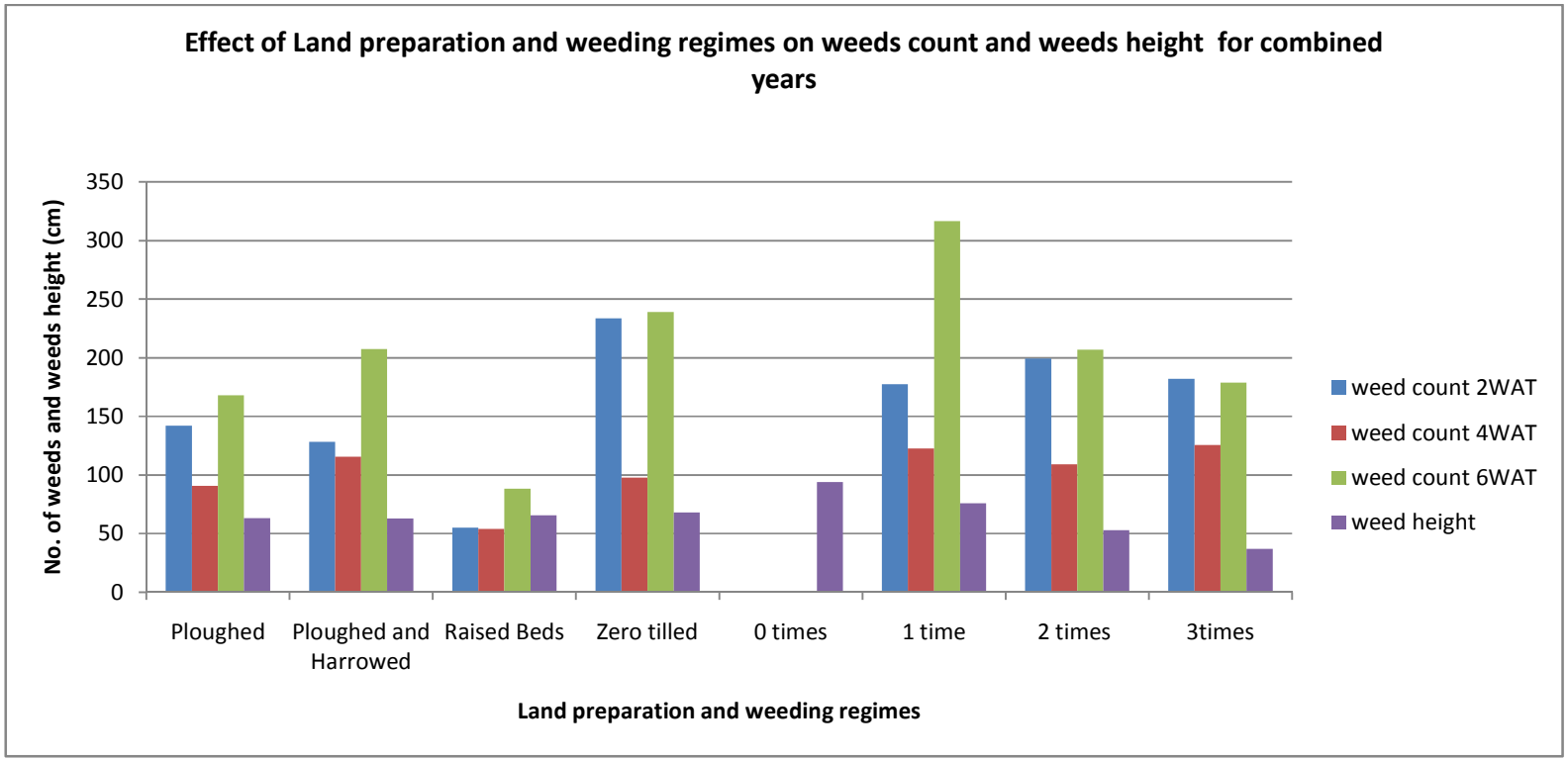

Fig. 2. The effects of land preparation and weeding regime on weed count and weed height during the combined years of 2008 and 2009

3.3 Weed Count

Mean values for weed count and weed height at harvest during the 2008 and 2009 rainy seasons are presented in Table 3. Weed count at 2WAT had a significant ($P \leq 0.05$) difference for land preparation in 2008, and a highly significant ($P \leq 0.01$) difference in 2009 and in the combined years. Similarly, weeding regime had a highly significant ($P \leq 0.01$) effect on weed count in both the seasons and the combined years. At 4WAT, weeds count was not significantly affected by land preparation in the two seasons, but was significant ($P \geq 0.05$) in the combined analysis. Furthermore, weeding regime was highly significant ($P \leq 0.01$) on the weeds count in both 2008, 2009 and the combined. Also, at the 6WAT land preparation did not have any significant effect on the weeds count in both seasons. However, weeding regime had a highly significant ($P \leq 0.01$) effect on weed competition in both 2008, 2009 and the combined analysis. Plots weeded 3 times had at least weeds number of 277.30 (2008), 130.50 (2009), and 178.90 (combined) while plots weeded only once recorded least a value of 422.50, 211.20, and 316.80 for 2008, 2009 and the combined, for 2008, 2009 and the combined (Fig. 2), respectively.

3.4 Weed Height

Weed height was measured at harvest, and had no significant ($P > 0.05$) variation as per land preparation in both the seasons and the combined years (Table 3). However, weeding regime had a highly significant ($P < 0.01$) effect on the height of highest weed at harvest in both the seasons and in the collective analysis (Fig. 2). The mean tallest weed measuring 103.50 cm was observed on zero weeded plots in 2009 season while the shortest weed measuring 22.60cm was noticed on plots weeded 3 times.

3.5 Total Weed Weight

The mean values of weed weight in the sweet pepper field during the 2008 and 2009 rainy periods are presented in Table 4. There was a highly significant ($P \leq 0.01$) variation of weed weight at 2WAT for land preparation in both seasons and the combined. Zero tilled plots gave the highest weights of 574.80 g, 729.10 g, and 651.90 g in 2008, 2009, and the combined (Fig. 3) respectively, while raised bed plots documented the least mean weed mass of 4.90 g, 92.30 g and 48.10 g for 2008, 2009 and the collective, respectively. Likewise, weeding regimes also had a highly significant ($P \leq 0.01$) effect on weeds weight at 2WAT in both the seasons. In the combined analysis, plots weeded 3 times recorded 318.40 g; plots weeded twice recorded 317.70 g, while plots weeded only once recorded 130.80 g. Weeds weight at 4WAT did not differ significantly ($P > 0.05$) for land preparation in both the seasons. Additionally, at 6WAT, weed weight did not diverge significantly ($P > 0.05$) for land preparation in both seasons. Nevertheless, weeding regime had a highly significant ($P \leq 0.01$) effect on weed weights in both seasons. Plots weeded zero times had 0.00 g while plots weeded once at 2WAT, twice at 2 and 4WAT and thrice in 2, 4 and 6WAT recorded 665 g, 198 g and 185 g respectively in the combined analysis (Fig. 3). Furthermore, at 10WAT, there was a significant ($P \leq 0.05$) change in weeds weight for land preparation in 2008, and a highly significant ($P \leq 0.01$) difference in the combined analysis. Weeding regime had a highly weighty ($P \leq 0.01$) effect on the weed weight in both the seasons. The weedy check plots, from which readings were taken at 10WAT, recorded 2278 g in 2008, 2088 g in 2009 and 2183 g in the combined analysis (Fig. 3).

4. DISCUSSION

The non-significant result of tillage on weed emergence after land preparation in 2008 and 2009, was probably due to the turning over or disturbances of the soil. This brings some of dormant weed seed from beneath the soil surface. These exposing the new weed seeds on the surface for possible emergence. Hence the uniformity in weed seed germination as seen at 2WAT to 6WAT. This is in agreement with the work of [17] that the soil environment under conventional tillage or bed system is quite favorable for weeds emergence and growth. Furthermore, studies have shown that the buried seeds of annual weeds undergo dormancy –non –dormancy cycle and even light does not stimulate germination. But when exposed, transition in membrane properties affects uniform germinability of even the dormant weed seeds. Weeding regimes had effects on weed emergence from 2WAT to 6WAT possibly due to the cumulative weed flora population in the less recurrently weeded plots and the weedy check plots.

Table 3. The effects of land preparation and weeding regime on weed count and weed height in 2008 and 2009 rainy Seasons

Treatments	Weed count											
	2WAT[1]			4WAT			6WAT			Weed height		
	2008	2009	Combined.	2008	2009	Combined.	2008	2009	Combined.	2008	2009	Combined.
Land preparation(LP)												
Ploughed	90.50^{b}	193.50^{b}	142.00^{b}	93.20	88.10	90.70^{a}	222.90	112.70	167.80	69.00	57.30	63.20
Plowed & harrowed	111.30^{b}	145.20^{b}	128.20^{b}	127.30	103.50	115.40^{a}	293.00	121.80	207.40	68.80	57.10	62.90
Raised Bed	40.20^{c}	70.20^{c}	55.20^{c}	66.90	40.80	53.80^{b}	104.10	72.30	88.20	69.00	61.90	65.50
Zero Tilled	193.80^{a}	273.90^{a}	233.80^{a}	98.50	96.70	97.60^{a}	281.20	197.20	239.20	67.00	69.40	68.20
Level of Significance	*[2]	**[3]	**	Ns[4]	Ns	*	Ns	Ns	Ns	Ns	Ns	Ns
LSD	50.02	53.65	32.66			29.23						
Weeding regime(WR)												
0 WAT	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{b}	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{c}	0.00^{c}	84.90^{a}	103.50^{a}	94.20^{a}
2 WAT	133.10^{a}	221.90^{a}	177.50^{a}	129.40^{a}	115.70^{a}	122.50^{ab}	422.50^{a}	211.20^{a}	316.80^{a}	75.20^{ab}	76.30^{b}	75.80^{b}
2,4 WAT	150.90^{a}	248.20^{a}	199.50^{a}	119.20^{a}	99.30^{b}	109.20^{b}	251.40^{b}	162.40^{b}	206.90^{b}	62.30^{b}	43.30^{c}	52.80^{c}
2,4.6 WAT	151.80^{a}	212.70^{a}	182.20^{a}	137.40^{a}	114.00^{a}	125.70^{a}	227.30^{b}	130.50^{b}	178.90^{b}	51.30^{b}	22.60^{d}	37.00^{d}
Level of Significance	**	**	**	**	**	**	**	**	**	**	**	**
LSD	26.74	38.33	22.77	24.74	15.63	14.26	78.1	39.96	42.74	15.68	11.19	9.38
LP X WR	**	**	**	Ns	*	**	Ns	Ns	*	Ns	Ns	Ns
LSD	63.06	79.79	49.55		42.73	36.95			111.93			

1 = Weeks After Transplanting 2 = Significant 3 = Highly significant 4 = Not Significant;Means within columns with similar letters are not significantly different (P>0.05)

Table 4. The effects of land preparation and weeding regime on weed weight in 2008 and 2009 rainy seasons and theCollective analysis

Treatments	Weed weight (g)											
	2WAT[1]			4WAT			6WAT			10WAT		
	2008	2009	Combined.	2008	2009	Combined.	2008	2009	Combined.	2008	2009	Combined.
Land preparation (LP)												
Ploughed	36.30[b]	311.10[b]	173.70[b]	104.70	94.90	99.80	405	192	299	601[a]	508	554[b]
Plowed & harrowed	39.20[b]	127.00[b]	83.10[b]	139.90	112.30	126.10	355	219	287	459[b]	441	450[c]
Raised Bed	4.90[b]	92.30[b]	48.10[b]	60.80	38.20	49.50	222	95	159	586[a]	521	553[b]
Zero Tilled	574.80[a]	729.10[a]	651.90[a]	88.60	82.80	85.70	369	239	304	633[a]	618	625[a]
Level of Significance	*[2]	**[3]	**	Ns[4]	Ns	Ns	Ns	Ns	Ns	*	Ns	**
LSD	249.00		111.53							68.40		67.90
Weeding regime (WR)												
0 WAT	0.00[b]	0.00[b]	0.00[b]	0.00[b]	0.00[b]	0.00[b]	0[c]	0[c]	0[c]	2278[a]	2088[a]	2183[a]
2 WAT	206.40[a]	436.10[a]	321.20[a]	130.80[a]	114.90[a]	122.80[a]	902[a]	428[a]	665[a]	0[b]	0[b]	0[b]
2,4 WAT	201.80[a]	433.60[a]	317.70[a]	128.20[a]	103.30[a]	115.80[a]	226[b]	170[b]	198[b]	0[b]	0[b]	0[b]
2,4.6 WAT	246.90[a]	389.90[a]	318.40[a]	135.10[a]	109.90[a]	122.50[a]	223[b]	147[b]	185[b]	0[b]	0[b]	0[b]
Level of Significance	**	**	**	**	**	**	**	**	**	**	**	**
LSD	81.90	32.73	42.97	28.18	25.77	18.60	138.20	85.20	79.10	62.70	105.40	59.70
LP X WR	**	**	**	Ns	Ns	Ns	Ns	Ns	Ns	**	*	**
LSD	267.30	60.71	129.84							121.7	213.80	120.40

1 = Weeks After Transplanting, 2 =Significant, 3 = Highly significant 4 = Not Significant; Means within columns with similar letters are not significantly different (P>0.05)

.

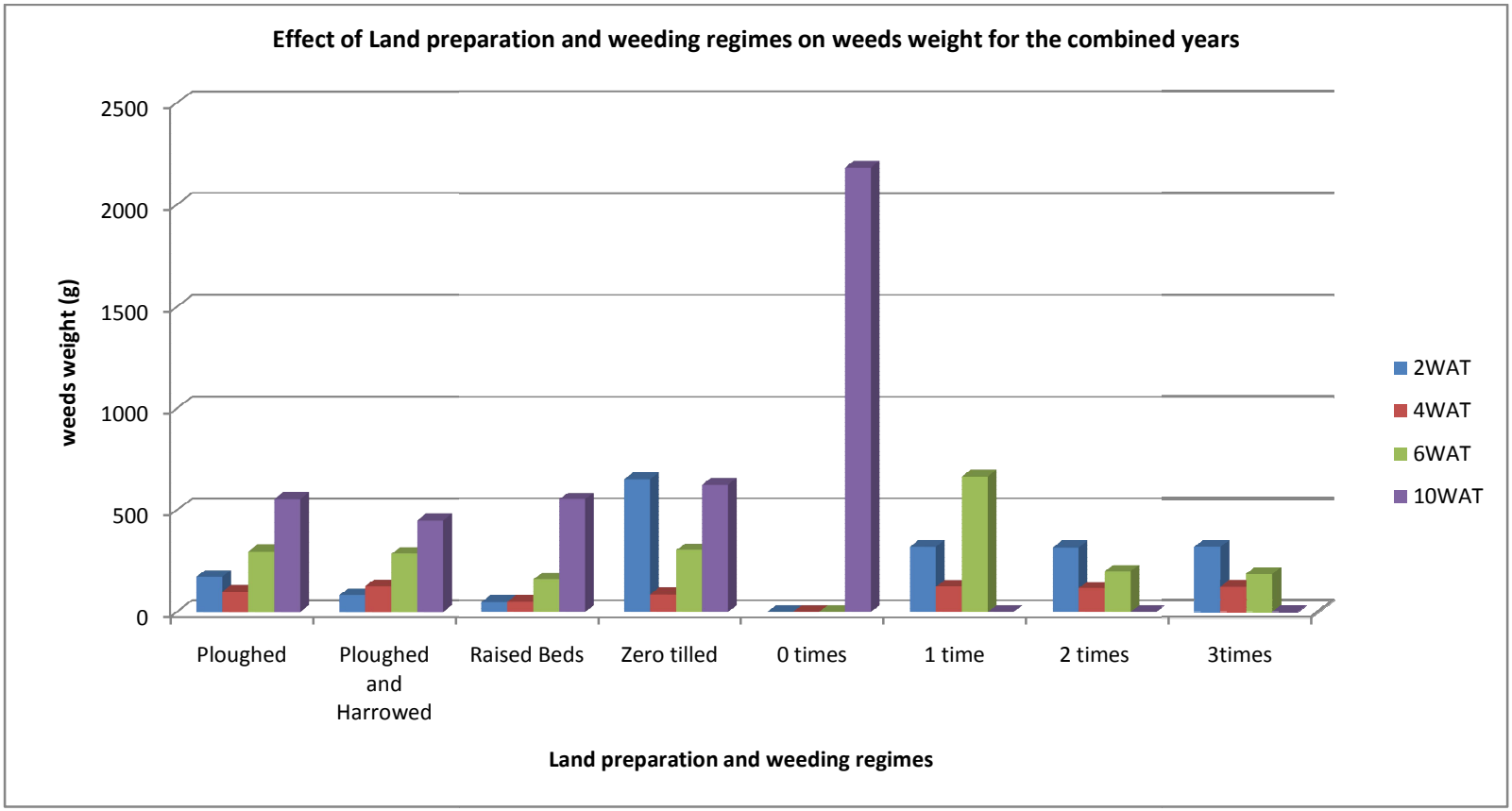

Fig. 3. The effects of land preparation and weeding regime on weed weight during the combined years of 2008 and 2009

The number of weeds in plots weeded at 2, 4, 6WAT> 2, 4, WAT> 2WAT> No weeding. Similarly, the weed counts for raised beds <plowed and harrowed <plowed< Zero tilled. These allowed most of the negative effects of weeds to be exhibited in the zero weeded plots and zero tilled plots. This agrees with the work of Hakanssons [20] who reported a reduced crop yield in wheat and rice farm due to weed infestation and poor soil tillage. The non-significant number of weeds at 4WAT in both seasons were majorly due to the effect of the first weeding at 2WAT which left most of the plots with fewer weeds. Thus, the effect of cumulative number of weeds in these plots directly responded to the type of land preparation. Sometimes it would appear that there can be a distinct change in the rate of invasion by a weed. A species which establish local populations at the initial point of invasion may exhibit a little increase in abundance for a considerable time, but then undergo sudden range expansion [21]. Thus not allowing all the exposed weed seeds in the soil to fully germinate and get established in just two weeks. The significant difference which existed at 2WAT for number of weeds counted may also be that the weedy check plots were really dense of weeds, and most of these weeds regenerated shortly after land preparation or after the first weeding. Another reason may be the favorable environmental conditions that prevail for rapid growth and development of weeds. This is in agreement with the work of [17] that well pulverized soil at optimum moisture condition is highly suitable for weed emergence, exposure to light and the absence of the upper storey of vegetation promotes germination and growth of weeds. At the 6WAT weed count was significant due to increased precipitation giving a conducive environment for a luxuriant growth of weeds especially in weedy check and weeded once.

Height of weeds at harvest was significant probably as a result of regular weeding in the weeded plots which did not allow weeds to have continuity of growth throughout the season. The height of weeds was taller in the zero tilled plots, and in the zero weeded plots probably due to non-disturbance of the weed vegetation during its period of growth. This is also in conformity with the work of [17], that weeds express all its growth potentials if left undisturbed in the natural ecosystem. Hence, the weedy check plots grew to maximum height, enabling them to exhibit all the growth potentials. Land preparation also influenced the height of weeds as fine tilts in raised beds, plowed and harrowed encourages rapid plant growth, while the rough surface on plowed plots and zero tilled plots do not favor rapid plant growth. Raised beds appear to have less weed growth, especially on the weeded three time plots. This is because of the proper agronomic measure of removing the weeds, thereby reducing weeds re - establishment after weeding. This agrees with the findings of [20] that weeds equally respond to tillage practice just as those of the growing crops.

At 2WAT, the weight of weeds on a wet weight basis was significantly higher, probably due to weeds regeneration of the zero tilled plots. Also on the 10WAT, significant effect of weed weight was felt due to the prolific increase in the number of weeds at each weeding regime. Weed flora population tends to increase with an increase in precipitation and a sustained soil moisture level. Changes in the weed species composition occur as a consequence of tillage practice and that the diversity is as a result of weed species and environmental alteration [22]. Zero tilled plots were able to conserve moisture due to weed vegetation cover which enables the weeds there in to grow rapidly, and ultimately give a higher wet weight value as compared to the weeded plots. Organic materials that result from the weed vegetations removed at weeding will contribute to restoring organic matter and plant nutrients, to the soil, improve soil structures and water holding capacity, ameliorate soil temperatures, control soil losses, and reduce weed pressure [23]. Weeding regime significantly affects weed weight from 2WAT to 10WAT. This could probably be due weeds concentration on the weedy check plots as against the weeded plots.

Kyllinga squamulata Thorn. Ex Vahl, and *Cyperus rotundus*, all sedges were found to be predominant weeds in the two seasons. This primarily was due to the poor fertility status of the soil. Hakanssons, [20] has earlier reported that sedges inhibit depleted soils. The presence of parasitic weeds such as *Eclipta alba* especially on the zero tilled and plowed plots, indicates that these weed species are more likely to do well under poorly drained and damp soil [24]. Hakanssons [20] described a wetland from the type of vegetation that is found in the area. Semi aquatic plants such as: *Euphorbia hirta, Ipomeoa eriocarpa* R., *Paspalum conjugatum* and *Gomphrena celosioides* Linn were found in the field. However, it is most likely that in future this aggressive alien weed may become one of the problematic weeds due to its high reproductive potential, fast growth rate,

allelopathic nature [25] This may have contributed to the poor performance in the zero tilled, ploughed and the ploughed and harrowed as against the raised bed plots which gave the pepper plant a good moisture regime for production. *Mimosa pudica, Tephrosia pedicellata*. Bak, and *Ageratum conyzoides* all belong to *Asteraceae* and the *Leguminosae* families which are well known for their ability to improve the fertility of soils by fixing atmospheric Nitrogen. The existence of these species on the raised beds plots only is an indication of low moisture regimes on the raised beds, and which may also have contributed to the high yield , high number of leaves in the raised bed plots. It was earlier reported by [7] that weeds of semi aquatic species can grow well on seedbed and those found in furrow cease growth or may even die.

Waltheria indica Linn, *Acanthospermum hispidum* DC, also existed but mostly on the ploughed beds. This is an indication of the relationship between the ploughed only and the various weeds species. They are shrubs that establishes easily on rough surfaces [20]. Other weeds species that seem important on the sweet pepper fields include: *Axonopus compressus, Dactylocterium aegyptium, Amaranthus spinosus*, and *Tridax procumbens*

5. CONCLUSION

Weed population in relation to sweet pepper production reveal a lot of weed species were found to share the same or similar ecological niche based on growth requirements with the host crop. *Kyllingia squamulata* Thorn. Ex Vahl with a high sum dominance ratio in both years is seen to grow well in association with sweet pepper. This gives an insight as to the type of weed control measures to adopt when growing sweet pepper. Other weed species such as *Cyperus rotundus* and *Acanthospermun hispidum* with high occurances in sweet pepper fields can attract a similar control measures to avert damages in sweet pepper crop during production.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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