Acta fytotechn zootechn, 22, 2019(3): 90–100
http://www.acta.fapz.uniag.sk

Original Paper

Effects of seed bed types and weed control methods on the vegetative parameters of long cayenne pepper (*Capsicum frutesens* L)

Adijat Temitope Ajibola, Angela Amao*
Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, Ogbomoso, Nigeria

Article Details: Received: 2019-03-03 | Accepted: 2019-05-28 | Available online: 2019-09-30

https://doi.org/10.15414/afz.2019.22.03.90-100

The type of seed beds and weed control methods play significant role in determining sustainability in vegetable production. Field experiment was conducted during 2015 growing season to determine the effects of three seed bed types such as: raised bed (RB), flat bed (FB), ridged bed (RB) in combination with four weed control methods such as: hoe weeding (T_1), hand weeding (T_2), use of *Panicum maximum* as live mulch (T_3) and zero weeding (T_4) on the vegetative performance of long cayenne pepper (*Capsicum frutesens* L.) The experiment was arranged as split plot fitted into Randomized Complete Block Design (RCBD) with three replications. The growth parameters measured were the plant height (cm); number of leaves, numbers of branches, stem girth (cm), leaf area (cm^2), weed density (m^{-2}) and weed biomass (kg/ha). The result revealed that the seed bed types and the weed control methods had significant effect on the parameters measured. However, raised bed and hoe weeding (RBT1) enhanced all the parameters measured more than other treatment combinations by recording the highest mean value in all character and also proved to be more effective in reducing weed biomass than other weed control treatment combinations. It was concluded that sowing on raised bed and using hoe weeding as a means of controlling weeds should be recommended for effective performance of pepper for optimum growth.

Keywords: seed bed, weed control, Long cayenne pepper

1 Introduction

Long Cayenne Pepper (*Capsicum frutesens* L.) belongs to the family Solanaceae. It is one of the most important vegetables that is consumed worldwide after tomatoes and onions (Akinfasoye et al.2006) and was believed to have been introduced to Africa and Asia by Columbus from the new world (Alabi, 2006). It is best to start the seed in a good and warm environment.The progress faster that way because the seed of pepper is slow to germinate,taking up to 12–21 days or longer (NAERLS, 2006; Awalu and Mohamman, 2009). Although much of the greater part of the total hectarage of pepper is grown from transplant. Seeds can be sown directly in the open field, principally in some of the warmest part of the country (NAERLS, 2006). 10–12 seed can be planted at 45–50 cm apart on rows, 75 cm apart between rows (Grubben and Tahir, 2014). Cayenne pepper are usually a tapering group, 10–25 cm long, generally skinny, mostly red coloured, often with a curved tip and some what ripped skin, wich hang from bush as opposed to growing upright (Idowu et al., 2012).

Pepper production has increased in recent years in Nigeria and other sub-humid and semi-arid tropics as a result of its nutritional values. Ashenafi and Tekalign (2014) reported, that pepper contributes substantially to the Nigerian diet, accounting about 40 percent of the total vegetables consumed per day. It is a good source of vitamins A, C, E, B_1, B_2 and D (Auwalu and Muhamman, 2009). Also obtained from pepper are potassium, phosphorus and calcium (Idowu et al., 2012). USDA (2001) and Business day (2007) reported, that exportation of pepper in Nigeria has once been reported as a lucrative business, Nigeria being the largest producer of pepper in the world accounting for about 50 percent G.D.P of Africans production. Ashenafi and Tekalign (2014) and Gungula and Bayoso (2005) reported that in addition to pepper being easy to grow, it is easily processed and packaged for export. The cash income potentials being derived

***Corresponding Author:** Angela Amao, Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, Ogbomoso, Nigeria, Telephone (+234) 8034462397; e-mail: akinangy@gmail.com

from it makes it suitable for use in poverty reduction and food security improvement programs. Although pepper is widely grown in Nigeria, yields obtained by farmers are often very low. This could be attributed to production constraints in pepper cultivation such as unpredictable climatic condition, weed infestation and improper seed bed preparation (Grubben and Tahir, 2004).

In crop production system prior to seedlings emergence, good seed bed preparation is one of the most important approaches to soil amendment and improvement (Samuel and Ajav, 2010). Zaragoza (2002) equally reported seed bed preparation as an effective step for increasing space, efficiency and yield of vegetable crops. Weed control is one of the most serious concerns of both commercial and subsistence pepper growers (Fitzroy, 2011). Weed found growing in pepper field compete with the crop for light, moisture, air, water, space, and nutrient. This competition decreases plant vigour, quality and yield. Peter et al. (2014) and Mark (2014) reported, that pepper plant unlike other vegetable crops like tomatoes and lettuce, has shallow root system which makes it more vulnerable to weed competition and this is detrimental to its establishment and growth.

Generally, plants require an environment where nutrients and other resources that support its growth and development are in abundance and they do best when their roots are able to extract these resources (Adigun, 2001). Zaragoza (2002) equally reported, that vegetables grown on seed beds do better because those soils are usually light and loosed with good tilt which makes root penetration easy. This helps in nutrient absorption in plants and thus improves crop emergence and growth.

Weed control is vital to achieving good crop performance and effective weed control strategies are limited for *Capsicum* producers. Over a long period, there was no herbicides registered for broad leaf weed in Nigeria (Shaikia et al., 2004). Also, proper soil management practices like good seed bed preparation is useful for improving soil condition for enhancement of crop growth (Zaragoza, 2002). Incidentally, many farmers do not give desired attention to the manner in which they prepare their seed beds and the best method of controlling weeds. To increase the performance of pepper, proper seed bed management preparation and weed control practice becomes an important option. Therefore, this research was designed with the objective of determining the appropriate seed bed types and weed control methods that is suitable for the establishment and growth of long cayenne pepper.

2 Material and methods

2.1 Experimental site

The experiment was carried out at the National Horticultural Research Institute (NIHORT) Vegetable Experimental Field in Ibadan (Lat, 7° 22° N, Long 3° 50° E). The study area is in the tropical wet and dry climate with a bio modal rainfall pattern having long rainy season which usually start in late March to September and to early November after a short dry spell in August. The average minimum and maximum temperature from 21 to 37 °C, with an annual rainfall of about 1,250–1,500 mm and average relative humidity of about 70%.

2.2 Nursery operation

Long cayenne pepper seedlings were raised in seed boxes each measuring 1 × 1 m (L × B) and 1 × 1 m height. The nursery boxes were filled with sterilized top soil, seeds were sown by broadcasting, watered and monitored for six weeks before transplanting to the permanent beds.

2.3 Pre – weed sampling

Weed samples were harvested within the net plot area before planting to know the predominant weeds on the experimental field, using 0.25 × 0.25 m quadrate which was placed thrice at random arrangement and the weeds within the quadrate were identified and recorded.

2.4 Land preparation and plot layout

The experimental field was cleared of its vegetation, debris were burnt, the field was ploughed and then the bed types and ridges were constructed. The experimental field was divided into 12 plots that comprised the 3 seed bed types: raised beds, ridge beds and flat beds that constituted the main plots while the weeding treatments (hoe weeding, hand weeding, live mulch and zero weeding) were randomly assigned to the beds as sub-plots and these treatments were replicated thrice giving a sum total of 48 plots. Each bed size was 2 × 2 m with 1 m gap between the beds. The blocks were spaced out 1 m apart with 1.5 m dimensions of the beds to ease movement during farming operation and the total land area was 227.5 m2.

2.5 Treatments and experimental design

The experiment was arranged as split plot fitted into Randomized Complete Block Design (RCBD) with three replications. The three seed bed types were allotted to the main plots while the four weed control methods were allotted to the sub-plots. The three seed bed treatments were: Raised Beds (RB), Flat Bed (FB), Ridge Bed (R). The four weed control methods were: T_1 – Hoe weeding, T_2 – Hand weeding, T_3, – Use of live much (*Panicum maximum*) and T_4 – Zero weeding.

2.6 Planting and cultural practices

At 6 weeks after sowing, one seedling was planted per hole at a spacing of 50 × 50 cm and 20 plants were planted per seed beds giving a total plant population of 1,440 plants per ha. The weeding treatment was carried out at 4, 6 and 8 weeks after transplanting prior to each weeding at 2 weeks interval except mulching which was maintained throughout the study period and zero weeding where retained throughout the experiment. Data were collected on the fresh weight of the weed samples harvested from each of the 3 randomly selected net plots and recorded. The weeds were later oven-dried, weighed and the average weight of the biomass was determined.

2.7 Data collection and statistical analysis

The experiment was arranged as split plot fitted into Randomized Complete Block Design (RCBD) with three replications. Data collection on the growth characteristics of pepper commeranced at 4 WAP and was done forthnightly. The growth assesment of the test crop was made from 4 randomly selected tagged plants from the certral row of each plot. The recorded data were compiled and statistically analyzed via Analysis of Variance with Statistical Analysis Software (SAS) package, and the significant means were separated by least significant difference (LSD) at 5% level of significance (Gomez and Gomez, 1984).

3 Results and discussion

3.1 Effect of seedbed types and weed control methods on growth parameters of pepper plant height

The main and interactive effect of seedbed types and weed control methods on the pepper plant height is presented in Table 1. Seed bed types had no significant effect on pepper plant height except at 4 weeks after transplanting (WATP) with significantly (p <0.05) higher plant height value recorded in ridge seed bed type (22.24 cm) which was closely related to the value recorded in raise bed type (21.35 cm), while the least value was recorded in the flat bed type (19.20 cm).

Weed control methods had significant (p <0.05) effect on plant height of pepper throughout the study period. At 4, 6 and 8 weeks after transplanting (WATP), significantly (p <0.05) higher value of pepper plant height was recorded in hoe weeded plot (23.24 cm, 35.97 cm and 43.00 cm) compared with the values recorded in hand weeded plot (21.08 cm, 31.10 cm and 34.40 cm) while the least value were recorded in zero weeded plots (16.62 cm, 24.27 cm and 31.20 cm).

There was interactive effect of seedbed types and weed control methods on pepper plant height throughout the study periods. At 4, 6 and 8 weeks after transplanting (WATP), significantly (p <0.05) higher plant height values (24.80 cm, 36.40 cm and 44.67 cm) were recorded in raised bed hoe weeded plot closely followed by raised bed live mulch plots (22.84 cm, 34.43 cm and 43.40 cm) while the least value were recorded in flat bed zero weeded plot (14.10 cm, 21.00 cm and 27.43 cm).

3.2 Number of leaves

The main and interactive effect of seed bed types and weed control methods on the number of leaves of pepper is as presented in Table 2. Seed bed types influenced the number of leaves of pepper throughout the study period with significantly (p <0.05) higher values of number of leaves of pepper recorded in raised bed type (12.61, 25.55 and 35.00) compared with the values recorded in ridge bed type (12.39, 21.88 and 31.98) for 4, 6 and 8 (WATP) respectively, while the least values were recorded in flat bed type (9.94, 17.26 and 26.07).

Weed control methods had significant (p <0.05) effect on the number of leaves of pepper throughout the study period. At 4, 6 and 8 (WATP), hoe weeded plots recorded significantly (p <0.05) higher values of number of leaves (13.37, 23.53 and 32.49), closely followed by the values recorded in live mulch plots (12.43, 22.86 and 32.00) while the least values were recorded in zero weeded plots (10.25, 18.94 and 28.00).

There were interactive effects of seed bed types and weed control methods on the number of leaves of pepper throughout the study period. At 4, 6 and 8 (WATP) significantly (p <0.05) higher number of leaves of pepper was recorded in raised bed hoe weeded plot (14.60, 28.80 and 37.90) compared with the values recorded in raised bed hand weeded plots (12.08, 25.90 and 35.63) and ridge hoe weeded plots (14.25, 23.67 and 33.13) while the least value was observed in flat bed zero weeded plot (8.32, 15.53 and 24.00).

3.3 Stemgirth

The main and interactive effect of seed bed types weed and control methods on stem girth of pepper is as presented in Table 3. Seed bed types had significant effect on stem girth of pepper throughout the study period. Significantly (p <0.05) higher stem girth values (1.66 cm, 2.56 cm and 3.49 cm) were recorded in ridge bed type respectively while flat bed recorded the least values (1.44 cm, 2.30 cm and 3.28 cm).

Weed control method also had significant effect on stem girth of pepper throughout the period of study. At 4, 6 and 8 (WATP), significantly higher stem girth values were recorded in hoe weeded plots (1.79 cm, 2.91 cm and 3.70 cm) compared with the value recorded in live mulched plot (1.65 cm, 2.71 cm and 2.51 cm) while the

Table 1 The interactive effect of seed bed types and weed control methods on pepper plant height (cm)

Seed bed type	Weed control methods				Seed bed type mean
Plant height at 4 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	24.80	21.04	22.84	18.41	21.35
Flat bed	22.40	19.93	20.38	14.10	19.20
Ridge	24.22	22.27	23.22	17.68	22.24
Weed control method mean	23.24	21.08	22.67	16.62	
LSD bed (B)	2.27				
LSD weed control method (W)	2.62			6	
LSD B × W	4.53				
Plant height at 6 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	36.40	31.10	34.43	26.33	32.01
Flat bed	35.37	28.87	29.47	21.00	28.67
Ridge	36.13	33.57	34.80	25.47	32.49
Weed control method mean	35.97	31.10	32.90	24.27	
LSD bed (B)	3.28				
LSD weed control method (W)	3.78				
LSD B × W	6.55				
Plant height at 8 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	44.67	34.07	43.40	27.13	37.30
Flat bed	41.47	37.23	40.47	27.43	36.80
Ridge	42.80	38.70	40.70	31.67	38.50
Weed control method mean	43.00	34.40	41.50	31.20	
LSD bed (B)	5.72				
LSD weed control method (W)	6.00				
LSD B × W	11.44				

least values were recorded in zero weeded plots (1.33 cm, 2.10 cm and 3.57 cm) respectively.

The main and interactive effect of seed bed types and weed control methods on pepper stem girth at 4, 6 and 8 after transplanting (WATP) was significant throughout the study period with significantly (p <0.05) higher values recorded in raise bed hoe weeded plot (1.79 cm, 2.91 cm and 3.70 cm) closely followed by ridge hoe weeded plot (1.74 cm, 2.84 cm and 3.60 cm) and raised bed live mulch treated plot (1.65 cm, 2.71 cm and 3.51 cm) respectively while the least values was recorded in flat bed zero weeded plots (1.41 cm, 1.92 cm and 3.78 cm).

3.4 Pepper branches

Table 4 presents the main and interactive effect of seed bed types and weed control methods on pepper branches. Seed bed types had significant effect on the number of branches of pepper throughout the study period with significantly (p <0.05) higher value of number of pepper branches recorded in raised bed type (1.88, 4.02 and 5.90) at 4, 6 and 8 (WATP), respectively compared with the value recorded in the ridge bed type (1.57, 3.12 and 4.92) while the least values were recorded in flat bed type (1.18, 2.57 and 3.27).

Weed control methods had significant effect on the number of pepper branch throughout the study period with significantly (p <0.05) higher value of pepper branches recorded in the hoe weeded plots (2.03, 4.02 and 6.20) respectively followed by the values of number of pepper branches recorded in hand weeded plot (1.41, 3.14 and 5.00) and live mulch plots (1.60, 3.46 and 5.29)

Table 2 The interactive effect of seed bed types and weed control methods on the number of leaves of pepper

Seed bed type	Weed control methods				Seed bed type mean
Number of leaves at 4 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	14.60	12.08	12.52	11.60	12.61
Flat bed	11.25	9.43	10.75	8.32	9.94
Ridge	14.25	12.03	14.09	10.83	12.39
Weed control method mean	13.37	11.18	12.43	10.25	
LSD bed (B)	2.87				
LSD weed control method (W)	11.65				
LSD B × W	2.87				
Number of leaves at 6 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	28.80	25.90	26.13	21.37	25.55
Flat bed	18.13	15.33	20.03	15.53	17.76
Ridge	23.67	21.30	22.63	19.93	21.88
Weed control method mean	23.53	20.92	22.86	18.94	
LSD bed (B)	2.66				
LSD weed control method (W)	3.08				
LSD B × W	5.33				
Number of leaves at 8 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	37.90	35.63	36.13	29.73	35.00
Flat bed	26.40	24.94	28.93	24.00	26.07
Ridge	33.13	31.63	33.43	29.73	31.98
Weed control method mean	32.49	30.76	32.00	28.00	
LSD bed (B)	3.74				
LSD weed control method (W)	4.32				
LSD B × W	7.48				

respectively, while the least values were recorded in zero weeded plots (1.14, 2.19 and 3.62).

There was interactive effect of seed bed types and weed control methods had on the number of branches of pepper throughout the study period. At 4, 6 and 8 WATP, significantly higher values of number of branches of pepper were recorded in raised bed hoe weeded plots (2.67, 5.27 and 7.77) respectively, compared with the values recorded in raised bed live mulch plots (1.88, 4.63 and 6.53) while the least values were observed in flat bed zero weeded plots (1.03, 2.03 and 3.27).

3.5 Pepper leaf area

The main and interactive effect of seed bed types and weed control methods on the leaf area of pepper plot is as presented in Table 5. Seed bed types had significant effect on the leave area of pepper except at 6 weeks after transplanting. At 4 and 8 weeks after planting, significantly (WATP) (p <0.05) higher leave area values were recorded in raised bed type (5.11 cm^2, 7.99 cm^2, 10.51 cm^2) closely followed by the values recorded in ridge bed type (4.48 cm^2, 7.96 cm^2, 10.08 cm^2) while the least value was recorded in the flat bed type (4.40 cm^2, 7.60 cm^2, 9.59 cm^2).

Weed control methods equally had significant effect on the leave area of pepper throughout the study period at 4, 6 and 8 (WATP) after transplanting respectively, with significantly (p <0.05) higher leave area values recorded in hoe weeded plots (5.67 cm^2, 9.09 cm^2 and 11.11 cm^2) closely followed by the values recorded in the live mulch plots (5.29 cm^2, 8.33cm^2 and 10.19 cm^2) respectively,

Table 3 The interactive effect of seed bed types and weed control methods on the stem girth

Stem girth (cm)	Weed control methods				Seed bed type mean
Stem girth at 4 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	1.79	1.51	1.65	1.41	1.66
Flat bed	1.69	1.43	1.53	1.00	1.44
Ridge	1.74	1.64	1.72	1.49	1.58
Weed control method mean	1.74	1.53	1.64	1.33	
LSD bed (B)	0.14				
LSD weed control method (W)	0.17				
LSD B × W	0.29				
Stem girth at 6 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	2.91	2.69	2.71	1.92	2.56
Flat bed	2.49	2.23	2.34	2.13	2.30
Ridge	2.84	2.38	2.50	2.25	2.50
Weed control method mean	2.75	2.48	2.47	2.10	
LSD bed (B)	0.15				
LSD weed control method (W)	0.17				
LSD B × W	0.29				
Stem girth at 8 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	3.70	3.43	3.57	3.78	3.49
Flat bed	3.48	3.29	3.31	3.08	3.28
Ridge	3.60	3.38	3.51	3.26	3.36
Weed control method mean	3.58	3.37	3.50	3.04	
LSD bed (B)	0.22				
LSD weed control method (W)	0.25				
LSD B × W	0.44				

while the least value was recorded in the zero weeded plot (3.53 cm^2, 6.45 cm^2 and 8.09 cm^2).

There was interactive effect of seed bed types and weed control methods on pepper leave area throughout the study period with significantly (p <0.05) higher leave area values recorded in raised bed hoe weeded at 4, 6 and 8 (WATP) after planting (10.13 cm^2, 12.72 cm^2 and 20.20 cm^2), while the least value was recorded in flat bed zero weeded plot (2.79 cm^2, 5.95 cm^2, and 7.42 cm^2).

3.6 Weed density in pepper plots

Seed bed types had no significant effect on the weed density value were recorded in pepper plots except at 8 weeks after transplanting with significantly (p <0.05) higher weed density values recorded in flat bed (18.83 m^{-2}) which was at pare with the value recorded in ridge bed type (17.17 m^{-2}) while the least value was recorded in raised seed bed type (16.83 m^{-2}). Weed control methods had significant effect on weed density values recorded in pepper plot throughout the study period. Significantly (p <0.05) higher weed density values were recorded in zero weeded (22.45 m^{-2}, 18.56 m^{-2} and 14.67 m^{-2}) compared with the values obtained in live mulched plot (12.67 m^{-2}, 14.11 m^{-2} and 15.89 m^{-2}) while the least value was recorded in the hoe weeded plots (11.67 m^{-2}, 12.33 and 13.78 m^{-2}) (Table 6).

There was interactive effect of seed bed types and weed control methods on weed density values recorded in pepper plot throughout the study period with significantly (p <0.05) higher weed density value recorded in flat bed zero weeded plots (12.72 m^{-2}, 20.00 m^{-2} and

Table 4 The interactive effect of seed bed types and weed control methods on the number of branches

Pepper branches	Weed control methods				Seed bed type mean
Pepper branches at 4 weeks after planting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	2.67	1.77	1.88	1.30	1.88
Flat bed	1.33	1.10	1.27	1.03	1.18
Ridge	2.10	1.33	1.77	1.10	1.57
Weed control method mean	2.03	1.41	1.60	1.14	
LSD bed (B)	0.53				
LSD weed control method (W)	0.62				
LSD B × W	1.07				
Pepper branches at 6 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	5.27	3.97	4.63	2.20	4.02
Flat bed	3.40	2.13	2.73	2.03	2.57
Ridge	3.80	2.67	3.67	2.33	3.12
Weed control method mean	4.02	3.14	3.46	2.19	
LSD bed (B)	1.02				
LSD weed control method (W)	1.18				
LSD B × W	2.03				
Pepper branches at 8 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	7.77	5.3	6.53	3.67	5.90
Flat bed	5.07	4.07	4.67	3.27	3.27
Ridge	5.77	4.40	5.57	3.93	4.92
Weed control method mean	6.20	5.00	5.29	3.62	
LSD bed (B)	1.10				
LSD weed control method (W)	1.23				
LSD B × W	2.20				

27.30 m^{-2}) while the least values were recorded on raised bed hoe weeded plots (7.29 m^{-2},11.00 m^{-2} and 13.33 m^{-2}).

3.7 Weed biomass in pepper plot

The main effect of seed bed types and weed control methods on weed biomass value in pepper plot is as presented in Table 7. Seed bed types had no significant effect on the weed biomass in pepper plots except at 8 weeks after transplanting with significantly higher weed biomass value (0.48 kg/ha) recorded in flat bed seed bed types closely followed by the values recorded in the ridge bed type (0.46 kg/ha) while the least value was recorded in the raised bed type (0.34 kg/ha).

Weed control methods had significant effect on the weed biomass values recorded in pepper plots throughout the study period. Significantly (p <0.05) higher weed biomass values were recorded in the zero weeded plots (0.26 kg/ha, 0.60 kg/haand 0.68 kg/ha) while the least values were observed in the hoe weeded plots (0.10 kg/ha, 0.14 kg/haand 0.16 kg/ha).

There was interactive effect of seedbed types and control methods on weed biomass values recorded in pepper plot throughout the study period. At 4, 6 and 8 weeks after transplanting (WATP), significantly (p <0.05) higher weed biomass values were recorded in flat bed zero weeded plots (0.20 kg/ha, 0.67 kg/ha and 0.90 kg/ha), followed by flatbed hand weed plots (0.25 kg/ha, 0.57 kg/ha and 0.77 kg/ha) while the least values were observed in raised bed hoe weeded plot (0.10 kg/ha, 0.13 kg/ha and 0.12 kg/ha), respectively.

Table 5 The main interactive effect of seed bed types and weed control methods on Pepper leaf area (cm^2)

Seed bed type	Weed control methods				Seed bed type mean
Leaf area of pepper at 4 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	10.13	8.99	9.17	8.36	5.11
Ridge	8.00	7.60	7.63	7.67	4.84
Flat bed	5.13	3.53	4.13	2.97	4.40
Weed control method mean	5.67	4.47	5.29	3.58	
LSD bed (B)	0.50				
LSD weed control method (W)	0.57				
LSD B × W	0.98				
Leaf area at 6 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	12.72	11.05	12.12	10.45	7.99
Ridge	9.80	6.89	6.63	6.27	7.96
Flat bed	7.43	6.45	6.75	5.95	7.60
Weed control method mean	9.09	7.53	8.33	6.45	
LSD bed (B)	0.61				
LSD weed control method (W)	0.70				
LSD B × W	1.15				
Leaf area at 8 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	20.20	11.07	16.37	10.00	10.51
Ridge	10.42	9.77	10.34	9.70	10.08
Flat bed	9.70	8.09	9.55	7.42	9.59
Weed control method mean	11.11	10.11	10.19	8.09	
LSD bed (B)	0.80				
LSD weed control method (W)	0.95				
LSD B × W	1.56				

The effect of different seed bed types and weed control method affected the performance of pepper. The flat bed produced shorter plants while there was significant increase in the growth characteristics of pepper plant in the raised bed. This may be attributed to the deeper ploughing obtained on raised bed that allowed for proper intake of nutrient by the pepper plant. Similar observation was made by Zaragoza (2002), who reported that raised beds provides fine tilt for proper growth and development of pepper.

In a similar manner, there was significant effect of weed control methods on the seed bed types on the growth of pepper. Raised bed hoe weeded plots produced the highest number of leaves, highest number of branch, plant height, stem girt and leaf area than other treatments. Flatbed zero weed plot resulted into significantly weaker plant while raised bed hoe weed plot produced vigorously healthy plants compared to other treatment combinations. This may be as a result of its ability to control weeds more efficiently than other methods Achieved result agree well with the previous of work of Mustapha (2014), who reported better vegetative performance of sweet pepper on raised bed then flat bed. This result may also be attributed to the volume of soil accumulated under raised bed that allowed for accessibility to nutrients and other resources needed for better growth and development of pepper in those plots. This is in line with the work of Imoloame (2014); Adigun et al. (2018) and Kanton et al. (2000) who reported better performance of sorghum in raised then flat bed and highest performance of soya bean complimented with hoe weeding under different weed control methods.

Table 6 The main and interactive effect of seed bed types and weed control methods on the weed density (m^{-2}) pepper plots

Seed bed type	Weed control methods				Seed bed type mean
Weed population in at 4 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	7.29	8.45	8.40	9.60	12.92
Ridge	9.70	10.34	9.77	10.42	13.08
Flat bed	10.45	12.13	11.05	12.72	13.17
Weed control method mean	11.67	13.22	12.67	14.67	
LSD bed (B)	1.35				
LSD weed control method (W)	1.40				
LSD B × W	3.12				
Weed population at 6 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	11.00	14.67	11.67	13.33	11.67
Ridge	14.33	15.00	14.67	15.67	15.58
Flat bed	15.67	18.60	16.00	20.00	15.75
Weed control method mean	12.33	15.67	14.11	18.56	
LSD bed (B)	1.95				
LSD weed control method (W)	2.30				
LSD B × W	3.80				
Weed population at 8 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	13.33	14.44	13.67	14.67	16.83
Ridge	16.33	17.67	16.67	18.67	17.17
Flat bed	18.68	20.67	19.30	27.30	18.83
Weed control method mean	13.78	18.33	15.89	22.45	
LSD bed (B)	2.65				
LSD weed control method (W)	2.83				
LSD B × W	4.65				

This result also reveals the effectiveness of the hoe weeding method to significantly reduce the weed cover thereby minimizing weed competition with the pepper plant thereby leading to proper assimilation of nutrients, and accessibilities of sunlight and moisture for proper growth. The flat bed zero weeded plots had the lowest number of leaves and number of branches. This observation was due to the competition of the crops with the weeds for growth resources since the weeds were allowed to grow unchecked. This implies that the plant could not produce more leaves to conserve the available nutrients and moisture for the critical stages. The same factor could be responsible for the reduction in the stem girth and leaf area recorded in the flat bed zero weeded plots. This result is in conformity with the findings of Kanton et al. (2000), who recorded highest value of growth of sorghum in raised bed than flat beds.

The efficiency of weed control methods and the seed bed type adopted in this study can be deduced from the weed density (m^{-2}) and the weed biomass (kg/ha). The highest weed density (m^{-2}) and weed biomass (kg/ha) in the flat bed zero weeded plots may be attributed to the open soil surfaces and niches available for weeds for free aggressive growth. Timely eradication of weeds in the raised bed hoe weeded plots and the availability of growth resources for use by crops under this treatment resulted better performance and growth of crops in those plots. This agreed well with the findings of Kanton et al. (2000), Abidkhan et al. (2012), Madukwe et al. (2012)

Table 7 The main and interactive effect of seed bed types and weed control methods on weed biomass in pepper plots (kg/ha)

Seed bed type	Weed control methods				Seed bed type mean
Weed biomass at 4 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	0.10	0.10	0.10	0.11	0.16
Ridge	0.12	0.16	0.14	0.16	0.17
Flat bed	0.20	0.25	0.23	0.30	0.17
Weed control					
Method mean	0.10	0.17	0.13	0.26	
LSD bed (B)	0.02				
LSD weed control method (W)	0.02				
LSD B × W	0.04				
Weed biomass at 6 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	0.13	0.16	0.16	0.17	0.30
Ridge	0.22	0.33	0.23	0.33	0.34
Flat bed	0.33	0.57	0.47	0.67	0.37
Weed control					
Method mean	0.14	0.30	0.22	0.60	
LSD bed (B)	0.24				
LSD weed control method (W)	1.17				
LSD B × W	0.24				
Weed biomass at 8 weeks after transplanting					
	Hoe	Hand	Mulch	Zero weeding	
Raised bed	0.12	0.17	0.12	0.20	0.34
Ridge	0.30	0.38	0.30	0.67	0.46
Flat bed	0.67	0.77	0.67	0.90	0.48
Weed control					
Method mean	0.16	0.33	0.24	0.68	
LSD bed (B)	0.15				
LSD weed control method (W)	0.14				
LSD B × W	0.27				

and Imoloame (2014) who reported that growing crops on seed beds and supplementing chemical control weed treatment with hoe weeding at intervals helped to reduce crop-weed competition and provide almost crop weed free environment and improved crops vigour.

5 Conclusion

On the basis of this result, it can be concluded that sowing of pepper on raised seed bed was superior to sowing on flat bed on the vegetative parameters. Raised bed hoe weeding methods reduced weed cover more than other treatments. Meanwhile, raised bed hoe weeding treatments out measured other treatment combinations in terms of plant height, number of leaves, number of branches per plants, stem girth and leaf area of pepper plant. The maximum reduction of weed density and weed biomass observed in raised bed and hoe weeding was not only effective in providing long season control of weeds but has promoted better vegetative growth and performance of pepper

6 References

ABIDKHAN M.S., ZAHID, H. and ABDUL MATEEN, K. (2012) Effect of different weed control methods on weeds and yield of

chili (*Capsicum annuum* L.). In *Pakistan Journal of Weed Science*, vol. 18, no. 1, pp. 71–78.

ADIGUN, J.A. (2001) Influence of intra-row spacing and chemical weed control on the growth and yield of Chili pepper (*Capsicum frutesens* L.) in the Nigerian Northern Guinea Savanna. In *Nigerian Journal of Horticulture Science*, vol. 5, pp. 67–73.

ADIGUN, J.A. et al. (2018) Impact of nitrogen levels and weed control methods on growth and yield of okra (*Abelmoschus esculentus* L.) in Nigerian forest zone. In *International Journal of Agriculture*, vol. 20, no. 2, pp. 1–11.

AKINFASOYE, I.A., D.J. NMYAN, R.M. and TAHIRU. (2006) Effect of harvesting frequency on the duration, yield and quality of pepper. In *Proceeding of 24th Conference of Horticulture Society of Nigeria*. 17–22 September 2006, Gombe, Nigeria.

ALABI, D.A. (2006) Effects of fertilizer Phosphorus and poultry droppings treatments on growth and nutrient components of pepper (*Capsicum annuum* L.). In *African Journal of Biology and Environment*, no. 5, pp. 671–677.

ASHENAFI, W. and TEKALIGN, T. (2014) Yield and yield components of pepper (*Capsicum annuum* L.) as influenced by stage and intensity of productive organs. In *Journal of Biology, Agriculture and Healthcare*, vol. 4, no. 15, pp. 114–120.

AUWALU, B. M. and MUHAMMAN, M.A. (2009) Seedling performance of sweet pepper (*Capsicum annuum* L.) as influenced by growth media and fertilizer sources in Northern Guinea Savanna Zone of Nigeria. Bayero University Kano. In *Nigerian Journal of Biology and Environmental Science*, vol. 6, no. 3, pp. 109–112.

BELEL, M.D., SAIDU M.S. and SAJO A.A. (2011) Effect of Land Preparation and Weeding Regime on the Yield of Sweet Pepper (*Capsicum annuum* L.) in Mubi, Adamawa State. In *Journal of Agronomy*, vol. 10, no. 2, pp. 62–67. doi: https://doi.org/10.3923/ja.2011.62.67

BULLOCK, Fitzroy D. (2011) Weed control in peppers. In *Agricultural and Natural Resources*, Fact Sheet ANR-5, 4 p.

GOMEZ A.K. and GOMEZ A.A. (1984) *Statistical Procedure for Agricultural Research*. New York: John Willey and Sons.

GRUBBEN GJH and EL TAHIR IM (2014) *Capsicum annuum* L. In Grubben, G.J.H and Denton, O.A. (eds). *PROTA (Plant Resources of Tropical Africa/Ressources végétales de l'Afrique tropicale*). PROTA Foundation: Wageningen, pp. 154–163.

GUNGULA D.T. and BOYASO I. (2005) The Influence of nutrients and growth media on the nursery performance of sweet pepper seedlings. In *Journal of Sustainable Development in Agriculture and Environment*, vol. 1, no. 1, pp. 104–112.

IDOWU-AGIDA O. O, E.I NWAGUMA and ADEOYE I.B. (2010) Cost implication of wet and dry season pepper production in Ibadan, Southwestern Nigeria. In *Agric. Biol. J. N. Am.*, vol. 1, no. 4, pp. 495–500.

IDOWU-AGIDA O.O., OGUNNIYAN D.J. and AJAYI, E.O. (2012) Flowering and fruiting behaviour of long cayenne pepper (*Capsicum frutescens* L.). In *International Journal of Plant Breeding and Genetics*, vol. 6, no. 4, pp. 228–237.

IMOLOAME, E.O. (2014) The effect(s) of difference weed control methods on weed infestation, growth and yield of soya beans (*Glycine max* L, Merril) in the Southern Guinea Savanna of Nigeria. In *Journal of Agricultural Research*, vol. 14, no. 2, pp.129–143.

KANTON, R.A.L. et al. (2000) Influence of tillage systems and seedbed types on sorghum yields and economics in Northern Ghana. In *Journal of Soil and Tillage Research*, vol. 55, no. 1–2, pp. 79–85.

KHANTUN, M.J., BEGUM M. and HOSAAIN, M.M. (2016) Effects of tillage method and weeding regime on soil weed bank status and yield performance of wheat. In *Progressive Agriculture*, vol. 27, no. 1, pp. 9–19. doi: https://doi.org/10.3329/pa.v27i1.27528

MADUKWUE, D.K., H.C. OGBUECH AND M.O. ONUH. (2012). Effects of Weed Control Methods on the Growth and Yield of Cowpea (*Vigna unguiculata* (L.) Walp) under Rain-Fed Conditions of Owerri. In *American-Eurasian J. Agric. & Environ. Sci.,* vol. 12, no. 11, pp. 1426–1430. doi: https://doi.org/10.5829/idosi.aejaes.2012.12.11.1791

MONSOOR K.K et al. (2008) Enhancement of wheat and yield components by controlling weeds with deep tillage practices under irrigated clay loam soil conditions. In *Pakistan Journal of Biology and Environment Science*, vol. 6, no. 3, pp.109–112.

PETER, D. and NATHAN, B. (2014) *Weed management principles in commercial vegetable production.* HS717, UF/IFAS Extension. 6 p.

SAMUEL, T.M. and AJAV E.A. (2010) Optimum tillage systems for pepper production in an Alfisol of South-Western Nigeria. In *Academic Journal*, vol. 5, no. 19, pp. 2647–2652.

SCHONBECK, Mark. (2014) *Weed Management Strategies for Organic Tomato, Pepper, and Eggplant in the Southern United States* [online]. Retrieved 2019-10-10 from http://hightunnels.org/weed-management-strategies-for-organic-tomato-pepper-and-eggplant-in-the-southern-united-states/

SHAIKIA, M.A. et al. (2004) Assessment of weed complex in spring potato fields of mix cropping system under irrigated conditions of Faisalabad District. In *Pakistan Journal of Weed Science* Research, vol. 10, no. 1–2, pp. 63–72.

TEI, F. et al. (2002) Weeds and weed management in carrots – a review. *Proceedings in the 12th EWRS Symposium,* 24–27 June 2002, Wageningen, pp. 13–15.

UNITED States Department for Agriculture (USDA) (2001) Economic Research Services. USDA Agric. Outlook. USA.