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GROWTH CHARACTERS OF SWEET PEPPER (*Capsicum annuum* L.) CULTIVARS AS INFLUENCED BY WEEDING AND SPRAYING REGIMES USING NEEM LEAF EXTRACT IN THE SUDAN SAVANNA OF NIGERIA

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ABSTRACT

Three field trials were conducted in 2016/2017, 2017/2018 and 2018/2019 dry seasons at Zakirai, Gabasawa Local Government, Kano State to study the growth of sweet pepper cultivars as influenced by weeding and spraying using neem leaf extract in the sudan savanna, Nigeria. The experiment consisted of four cultivars of sweet pepper (*Dan Alko*, California Wonder, *Dan Damasak* and Yolo Wonder), three hoe weeding (Weedy check, 3 and 6 weeks after transplanting) and four spraying regimes (0,4,6 and 8 weeks after transplanting) which were factorially combined and laid out in a split plot design and replicated three times. Data were collected on plant height, number of leaves, number of branches, crop growth rate, and total dry matter. The result of the study shows that 2017/2018 dry season had significantly increased plant height, number of branches and leaves, as compared to the corresponding seasons. *Dan Alko* and *Dan Damasak* produced significantly higher mean value of crop growth rate and total dry matter both at 12 WAT. It also revealed that weeding regimes at 6WAT gave highest number of branched at 12WAT. The use of neem leaf extract was found to be effective on number of leaves only at 4WAT.

Key words: Cultivars; Sweet Pepper; Neem leaf extract; Weeding; Seasons.

INTRODUCTION

Sweet pepper (*Capsicum annuum* L), also called bell pepper belongs to the family *Solanaceae* (Olarewaju and Showemino, 2006; Kabura *et al.*, 2008). It is an important vegetable crop all over the world, which ranks third in world vegetable cycle after tomato and onion (Peet, 2006). The crop has a wide range of uses as a spice in the preparation of soup and stew when cooked with tomatoes and onions. It can be used as a condiment and extensively for flavouring, sauces and in canned products. They are also used for confectionary products like bread, meat pie, and burger. It has low calorie, but the nutritive value is high in vitamin A and C (Alabi, 2006). It was also discovered to be a good source of medicinal preparation of black vomit, gout and paralysis (Khan *et al.*, 2010). The leaves and fruits are antiseptic, diaphoretic, irritant, and antirheumatic. It is used externally in the treatment of sprains, unbroken chilblains, and neuralgia (Schery, 1999). The crop can be grown on many kinds of soils ranging from fine sands through clay loams and silt loams, but sandy loams and loams are preferred (Jaliya and Sani, 2010).

Many pepper cultivars are available which ripen to color's of green, red, orange, or yellow. Fresh market cultivars have thick and succulent walls and should be firm and bright in appearance (Bosland and Votava, 2000). Cultivars for processing have fruit that are firm, flat (with two locules), smooth, thick fleshed, bluntly pointed and about 150 mm long and 40 mm wide at the shoulders (Bosland, 1992). Despite the economic importance of sweet pepper its production has been very low due to many constraints. The prominent among which are diseases, insect pests, low yielding local varieties and poor weed management (Jaliya and Sani, 2010). Although the crop is widely cultivated throughout the year, yields obtained by peasant farmers are often very low (Adigun, 2001). Weeds are some of the constraints in sweet pepper production which can substantially reduce yields without obvious sign of damage (Terry, 1983). Weeds are a serious negative factor for crop production, that may result in great losses in crop yield. Such losses may arise mainly from the direct competition between crops and the weeds for light, water, space and nutrients or indirectly from harbouring insects and disease-causing organisms (Ghulam and Mir 2006). Among the insects that attacks sweet pepper are cutworms (Agrotis spp) false codling month, whiteflies, aphids and moderately susceptible to rook-knot nematode (*Meloidogyne* spp). Aphids and whiteflies are the major insect pests attacking peppers and other vegetable crops grown throughout Nigeria, they attack the crop both in nursery and main field (Degri and Yoriyo, 2010). Identifying weeding and spraying regimes to control weed and insects will certainly help to increase growth and yield of sweet pepper and increased its availability throughout the year. In line with these, this experiment was conducted to determine the response of sweet pepper to different weeding regimes and to evaluate the efficacy of neem leaf extract spray in the management of insects on sweet pepper.

MATERIALS AND METHODS

EXPERIMENTAL SITE

The experiment was conducted during the 2016/2017, 2017/2018 and 2018/2019 dry seasons at Zakirai (12° 60' N; 8° 53' 0" E) Gabasawa Local Government Area, Kano State**.** The location is in the Sudan savanna agro ecological zone of Nigeria. A weight sample of neem leaf was analyzed using liquid chromatography (LC) tandem mass spectrophotometer (MS) to determine the bioactive compound in the neem (Table 1).

TREATMENTS AND EXPERIMENTAL DESIGN

The treatments consisted of four cultivars of sweet pepper (California Wonder, *Dan Alko, Dan Damasak*, and Yolo Wonder), three hoe weeding (Weedy check, 3 and 6 WAT) and four spraying regimes (0, 4, 6 and 8 WAT). These were laid out in a spilt-plot design and replicated three times. The gross plot size was 3 x 2.4m (7.2m^2), while the net plot size was 1.2 x 3m.

SEED SOURCE AND DESCRIPTION OF THE CULTIVARS

The improved seeds (Califonia and Yolo Wonder) were sourced from Premier Seeds while the local were sourced from yankaba Market, Hadejia road, Kano. California Wonder and Yolo Wonder, are blocky shaped and have a primary colour that is usually green but may be yellow or purple. The secondary mature colour is usually red, with 75 to 80 days from transplanting to maturity. They are hardy, strong, and vigorous plants with short nodes. The varieties have a yield potential of up to 15-20t ha^{-1}. *Dan Alko* and *Dan Damasak* are oblong shaped peppers. They are hardy and vigorous bushy plants with semi determinate growth habit. The varieties take longer days to mature (80 to 85 days) and have a yield potential of 5-10t ha^{-1}.

DATA COLLECTION

Data were collected through random sampling of five tagged plants from each net plot. Observation and measurement of growth characters were done at intervals of four weeks beginning from 4WAT and ended at 12WAT.

Plant height (cm): This was taken by measuring the height from the ground level to the main shoot apex of 5 randomly selected and tagged plants and the average thereafter recorded.

Number of branches per plant: Number of primary and secondary branches of five randomly selected tagged plants and the average was recorded.

Number of leaves per plant: The number of leaves per plant were determine by counting number of leaves from five selected and tagged plants and the mean recorded from each plot.

Total dry matter (g): The dry matter produced per plant was determined by uprooting five randomly selected plants and oven dried to a constant weight at 70^o C. The weights of the dried samples were taken using an electric weighing scale (Toledo SB 8001 mono block-model), recorded 4WAT, 8WAT, and12WAT.

Crop growth rate (CGR): The crop growth rate expresses the dry matter increment of plant material per unit area of ground per unit time. It was computed as suggested by Watson (1958) and recorded on per plant basis.

DATA ANALYSES Data generated were subjected to analyses of variance using General statistics computer software 17th edition. The treatment means were compared using student Newman-Keuls Test (SNK).

RESULTS AND DISCUSSION

Table 1, bioactive compounds of neem plant revealed the presence of Salannin azadirachtin (22.4%), Gedunin (18%), hydroquinone (4.4%), luteolin-7-sulfate (13.8%), nimbolide (17.5%, nimbinine (18.2%), and Glutamine (5.5%). This had detected seven peaks their retention time of 11.6, 13.2,1.7, 1.7, 1.9, 13.2 and 1.3. The peak separation was 1.0. The organic chemical compounds were identified and characterized based on their molecular weight.

Plant height

The results of plant height of sweet pepper as affected by variety, weeding and spray regime during the period of the experiment is presented in Table 2. This indicated that plant height differed significantly across all the sampling periods and in all the seasons of the study. Significantly taller plants were observed in 2017 while the shorter plants were recorded in 2016. The result further indicated that plant height of pepper was not significantly influenced by variety, weeding and spraying.

Table 1. Bioactive Compounds of Neem plant used during the period of the experiment.

S/N	Proposed Compound	Molecular formula	Percentage in extraction	Candidate Mass	Retention Time
1	Salannin A.	$C_3H_{44}O_9$	22.4	597.2	11.6
2	Gedunin	$C_{28}H_{34}O_7$	18.2	458.3	13.2
3	Hydroquinone	$C_6H_6O_2$	4.4	116.3	1.7
4	Luteolin 7 sulfate	$C_5H_0O_9S$	13.8	367.4	1.7
5	Nimbolide	$C_{27}H_{30}O_7$	17.5	467.2	1.9
6	Nimbinine	$C_{28}H_{34}O_7$	18.2	483.4	13.2
7	Glutamine	$C_5H_{10}N_2O_3$	5.5	146.1	1.3

Table 2: Plant height (cm) of sweet pepper as affected by variety, weeding and spray during 2016, 2017 and 2018 dry seasons at Zakirai.

Treatment	Sampling Period (WAT)		
	4	8	12
Variety (V)			
California Wonder	16.93	22.47	30.63
Dan Alko	18.19	26.16	32.45
Dan Damasak	18.23	24.94	31.18
Yolo Wonder	16.87	22.64	32.45
SE±	0.880	0.989	0.503
Weeding (W)			
Weedy check	17.71	24.24	31.34
3 WAT	17.62	23.93	31.12
6 WAT	17.34	23.99	31.22
SE±	0.237	0.272	0.308
Spray (S)			
Control	17.61	23.93	31.18
4 WAT	17.47	23.65	31.14
6 WAT	17.93	24.34	31.36
8 WAT	17.21	24.28	31.22
SE±	0.274	0.314	0.356

This might be as a result of temperature variation during the period of the experiment (Appendix 1). Similar results with respect to temperature influence on plant physiology and growth was reported by Khanduri *et al.* (2008) who noted that high temperature influences many aspects of plant physiology and growth which may lead to sitgnificant increase or decrease in crop productivity.

Number of branches

Significant effect of season was recorded for number of branches per plant of pepper in the study (Table 3). This showed that more branches were recorded in 2017 in all the sampling periods. This could be attributed to high temperature recorded in season (Appendix 1). Similarly, weeding has significant effect on the number of branches of pepper only at 12WAT. More number of branches were recorded from plots weeded at 6WAT which was also at par with the weedy check. While those weeded at 3WAT had the lesser number of branches. The results of the study also indicated that number of branches in pepper was not significantly affected by variety and spraying regimes throughout the sampling periods. Increase in the number of branches could be because the environmental resources were available to support the growth of the crop instead of the weeds or the weeding done that might have increased the number of branches thus exposing the plants for better photosynthetic opportunity. This was, in agreement with the findings of Alabi (2006).

Number of Leaves

Number of leaves of sweet pepper were significantly affected by season in all the sampling periods (Table 4). There were larger number of leaves of pepper in 2017 than all the seasons. 2016 season bears the least number of leaves. This indicated the effect of temperature on crop growth rate as reported by Khanduri et al. (2008) who noted that high temperature increases crop rate while lower temperature decreases it. Spray had significant effect on number of leaves of pepper only at 4WAT. This shows that, number of leaves increases when spraying regimes were done at 4,6 and 8WAT.This indicated the neem extact might have contain some bioactive which stimulate the production of more leaves (Table 1). The results indicated that, variety and weeding regimes did not significantly affect number of leaves of sweet pepper. This might have been due to the fact that the extract was efficient enough to control insects since the plant was at an initial stage of growth. This is in accordance with the work done by Edith and Confidence (2016) who compared carbon and furan and neem leaf extract on insect pest of cowpea. They found that the plants treated with extract of Azadirachtin indica gave the best result in all growth parameters (plant height, number of leaves and number of pods).

Total dry matter

Significant effect of season on total dry matter was observed in all the sampling periods in this study (Table 5). The results showed that 2016 crops had the highest dry matter of sweet pepper both at 8 and 12WAT. Likewise, variety significantly influenced total dry matter of pepper only at 12WAT. This showed that *Dan Alko* and *Dan Damasak* produced the highest dry matter while California Wonder and Yolo Wonder recorded the lowest. It was observed that, weeding and spraying regimes did not significantly affect total dry matter of sweet pepper in this study. The significant increase in dry matter might be due to extensive vegetative growth and development of the thick stem which resulted in higher production of biomass as compared to growth and stem morphology of California and Yolo wonder variety. Similar results with respect to higher dry matter of local cultivars of pepper was reported by Amare et al. (2013).

Crop growth rate

Significant ($p<0.001$) on crop growth rate of pepper (Table 6). This revealed that crop growth rate was higher in 2016 at both the sampling periods.

Table 3: Number of branches of sweet pepper as affected by variety, weeding and spray during 2016, 2017 and 2018 dry seasons at Zakirai.

Treatment	Sampling Period (WAT)		
	4	8	12
Variety (V)			
California W	2.926	5.037	6.787
DanAlko	3.269	5.167	6.843
Dandamasak	2.454	5.324	6.667
Yolo Wonder	2.907	5.065	6.676
SE±	0.1591	0.1941	0.1561
Weeding (W)			
Weedy check	3.208	5.104	6.771ab
3 WAT	3.194	5.049	6.465b
6 WAT	3.014	5.292	6.993a
SE±	0.0918	0.0904	0.1114
Spray (S)			
Control	2.991	5.213	6.787
4 WAT	3.139	5.194	6.926
6 WAT	3.194	5.102	6.583
8 WAT	3.231	5.083	6.676
SE±	0.1060	0.1044	0.1286

Table 4: Number of leaves of sweet pepper as affected by variety, weeding and spray during 2016, 2017 and 2018 dry seasons at Zakirai.

Treatment	Sampling Period (WAT)		
	4	8	12
Variety (V)			
California W	20.19	38.65	48.22
DanAlko	23.55	40.44	48.92
Dandamasak	23.73	39.72	47.61
Yolo Wonder	20.59	38.99	47.70
SE±	0.941	1.135	1.039
Weeding (W)			
Weedy check	22.37	39.70	48.19
3 WAT	22.06	38.70	46.85
6 WAT	21.62	39.94	49.31
SE±	0.436	0.511	0.625
Spray (S)			
Control	21.22b	39.36	48.59
4 WAT	21.48a	39.86	48.69
6 WAT	22.31a	38.80	46.69
8 WAT	23.06a	39.78	48.47
SE±	0.503	0.590	0.722

Table 5: Total Dry Matter (g) of sweet pepper as affected by variety, weeding and spray during 2016, 2017 and 2018 dry seasons at Zakirai.

Treatment	Sampling Period (WAT)		
	4	8	12
Variety (V)			
California W	3.490	13.60	19.71b
DanAlko	3.598	14.30	22.22a
Dandamasak	3.627	14.19	21.61a
Yolo Wonder	3.378	14.30	20.00b
SE±	0.0828	0.447	0.275
Weeding (W)			
Weedy check	3.471	13.79	20.77
3 WAT	3.599	13.82	20.70
6 WAT	3.500	14.08	21.18
SE±	0.0936	0.242	0.253
Spray (S)			
Control	3.512	13.98	21.07
4 WAT	3.388	13.45	20.57
6 WAT	3.528	14.11	20.94
8 WAT	3.665	14.05	20.94
SE±	0.1081	0.279	0.292

Table 6: Crop growth rate (gwk^{-1}) of sweet pepper as affected by variety, weeding and spray during 2016, 2017 and 2018 dry seasons at Zakirai.

Treatment	Sampling Period (WAT)	
	8	12
Variety (V)		
California W	12.73	16.31b
DanAlko	13.40	18.65a
Dandamasak	13.28	18.06a
Yolo Wonder	12.65	16.62b
SE±	0.447	0.195
Weeding (W)		
Weedy check	12.92	17.32
3 WAT	12.92	17.24
6 WAT	13.20	17.66
SE±	0.235	0.226
Spray (S)		
Control	13.10	17.58
4 WAT	12.60	17.21
6 WAT	13.22	17.42
8 WAT	13.13	17.43
SE±	0.272	0.261

Variety had significant effect on crop growth rate of pepper only at 12WAT. This showed that higher crop growth was recorded in *Dan Alko* and *Dan Damasak* while the parameter was lower from California Wonder and Yolo Wonder varieties. This could have been as a result of the genetic makeup of the crop, or the local varieties could have the ability to adapt favorably to local growing conditions with the improved varieties easily succumbing to the vagaries of the weather and other abiotic and challenges of yield which was in agreement with the findings of Quartey et al. (2014).

CONCLUSION

The results of the study revealed that, 2017/2018 season had significant increase in plant height, number of branches, number of leaves and total dry matter than corresponding seasons. *Dan Alko* and *Dan Damasak* were superior in crop growth rates and total dry matter. Weeding done twice increased number of branches of sweet pepper. The result also indicated that spraying regimes done increase, number of leaves in the study area.

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Appendix 1: Metrological Data Records 2016/2017, 2017/2018 and 2018/2019 Dry Seasons.

Month	2016/2017		2017/2018		2018/2019	
	Relative Humidity	Temperature	Relative Humidity	Temperature	Relative Humidity	Temperature
November	27.13	30.50	30.1	35.32	28.21	32.89
December	21.81	21.16	20.43	27.02	22.43	23.43
January	18.34	24.36	17.2	27.57	18.34	25.16
February	17.00	30.75	16.3	34.28	19.44	31.21
March	20.22	32.01	19.3	35.1	20.16	31.56

Source: Gabasawa Local Government Weather Station