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Full Length Research Paper

A study of the effect of variety and spacing on in sect pest infestations and growth of Amaranthus (*Amaranthus* spp.) in Alau Dam, Maiduguri, Nigeria

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Amaranthus species are important vegetable crop cultivated and consumed daily in Nigeria and many countries of the world. Unfortunately, insect pests are a major setback for commercial production and for the purpose of food security in the country. The experiment was conducted at Alau Dam in 2010 and 2011 cropping seasons to investigate the effect of variety and spacing on these insect pests infestation and their subsequent growth performance. The results showed that *Amaranthus cruentus* was attacked more than the remaining three species and 20cm × 20cm plant spacing was found to be also the most effective in reducing insect pest infestations. *A. caudatus* and *A. cruentus* were also found to perform better by having more number of leaves of leaves/plant, more number of branches/plant and high heights and fresh weight/plot. Therefore vegetable farmers should use insect pest resistant varieties and good agricultural practices like the recommended crop spacing for the purpose of pest management and good crop performance.

Key words: Amaranthus, leaf beetle, variety spacing infestation growth, Alau Dam.

INTRODUCTION

Amaranths (*Amaranthus* spp.) are herbaceous annual plant belonging to the family Amaranthaceae with green or red or brown leaves and branched flower stalks (heads) bearing small seeds. It is known to be a native of tropical America, but it is now very widely distributed throughout the tropics (Stalknecht and Schulz-Schaeffer, 1993; Palada and Chang, 2003).

Amaranth can be grown under a variety of conditions both humid and arid. It grows from sea level to 2400 m altitude. Normally, it grows rapidly at high temperature and it generally thrives within a temperature range of 22-30°C. Amaranth is grown during both wet and dry season, though irrigation is normally required for dry season crops since the rate of transpiration by the leaves is high. Frequent applications of water are required, related to the stage of growth of the crop and the moisture-retaining capacity of the soil. It can however, tolerated periods of drought after the plant has become established. Amaranth can be grown on a wide range of soils but, it grows best in loam or silt-loam soils with good water holding capacity (AVRDC, 2003). Amaranth can tolerate a soil pH of 4.5 to 8 (Fayemi, 1999).

Furthermore, Amaranth can be used as a high protein grain or as a leafy vegetable. The seeds are eaten as a cereal grain. They are ground into flour, popped like popcorn or cooked into porridge. The seeds can be germinated into nutritious sprouts (AVRDC, 2003).

The Amaranth leaves are cooked alone or combined with other local vegetables such as pumpkin. The leaves are rich in calcium phosphorus, folic acid, potassium, iron and vitamins A, B and C but fairly low in carbohydrate (AVRDC, 2003; Okpara et al., 2013). The crop is

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commonly used as leafy vegetable and is a cheap vegetable for the common man (Fayemi 1999; Makus, 1990). Amaranths are recommended as a good food with medicinal properties for pregnant women, children lactating mothers and patients with constipation, fever, haemorrhage and anaemia (Quinton, 2006). It was reported to contain twice the amount of calcium that fresh milk contains per unit of serving. It enhances mental hormones and helps lower cholesterol levels significantly in the blood (AVRDC, 2003).

Amaranths are susceptible to damage by foliar insect pests and diseases such as aphids (*Aphis* spp.), leaf worms (*Spodoptera* spp.), leaf rollers (*Sylepta derogota*), leaf miners (*Liriomyza* spp.), spider mites (*Tetranychus* spp.), stem boring weevils (*Hypolixus haereus*), bugs (*Asparia armigera*) (Richard, 1989; Okunlola et al., 2008) and flea beetles (*Podagrica* spp.).

Aphids are major pest of Amaranths causing leaves to curl and become unattractive to consumers and customers. They feed by sucking plant sap. Small aphid population may be relatively harmless, but heavily infested Amaranth plants usually have wrinkled leaves, stunted growth and deformed seeds. Amaranth plants, particularly young plants, may dry out and die. Heavy attack on older Amaranth plants may cause crop loss by decreasing flower and seed viability (Okunlola et al., 2008; Youdeowei, 2004; Geoff et al., 2007).

Bugs can cause severe damage to flowering head and seeds and particularly damaging to grain Amaranth when present in large numbers during critical seed fill stage. They are usually of minor importance in vegetable Amaranth (Youdeowei, 2004).

Leaf worms or cutworms attack young seedlings. The caterpillar emerges from the soil at night, encircle the plant with its body and cut through the stem of young plants just above ground level or below ground level causing plant wilt and death (Richard, 1989; Kirby and Dill, 2004). Leafrollers larvae feed on the lower surface of the leaves folded and covered with webs or rolled and spun together (Booth, 1983; Imam et al., 2010; Geoff et al., 2007).

Leafminer larvae make long, slender, white mines (tunnels) in leaves. Severe mined leaves many turn yellow and drop. Severely attacked seedlings are stunted and may eventually die (Sorensen, 1995; Rodriquez, 1997; Sparles and Liu, 2001; Degri, et al., 2007; Degri et al., 2012).

Spider mite feeding on Amaranth plants may cause reduction in plant growth, flowering and number of seeds. Damage is most severe when mites attack young plants particularly during the dry season (Richard, 1989; Okunlola et al., 2008), stem boring weevils feed on the leaves but the larvae (grubs) bore into roots and stems, causing rotting, wilting, lodging and disposition to diseases thus increasing crop loss (Sorensen, 1995). The control of these insect pests attacking Amaranths using insecticides are available in many literatures but there is lack of information regarding the use of cultural practices, such as, use of resistant variety and the correct spacing on leaf beetle infestations and growth of Amaranth in the study area, thus the aim of the present study.

MATERIALS AND METHODS

The experiment was conducted at Alau Dam, Maiduguri (11° 51'N and 13° 15'E at elevation of 319m above sea level 12.008GPS) between November 3rd, 2010 and February 8th, 2011 dry season. The soil of the study area is sandy-loam. The experimental field was cleared of debris, ploughed, harrowed, well-levelled and prepared nursery bed of 25 cm high for seedling production.

The experiment consisted of four Amaranth varieties (*Amaranthus candatus* L., *A. cruentus*, *A. viridus and A. hybridus*) and four spacing (20cm × 10cm, 20cm × 15cm, 20cm × 20cm and 20cm × 25cm) laid out in a split-plot design and replicated four times. The net plot sizes were 1.0m × 2.0m.

The four Amaranth seeds were obtained from Borno State Agricultural Development Programme (BOSADP) input shop located in the ministry of Agriculture Maiduguri.

The Amaranth seeds were sown by broadcasting the seeds uniformly at the rate of 0.8g/m^2. The seeds were mixed with sand at a ratio of 1 g seed to 100 g sand in order to obtain a uniform stand. The seeds were covered lightly with a layer of rice hills (mulch) immediately after broadcasting as recommended by AVRDC (2003). The beds were watered daily in the evening to provide good moisture for good seed germination. The seedlings emerged after five days and they were properly watered every day in the late afternoon (5.00 pm - 6.00 pm) to maintain vigorous plant growth.

The Amaranth seedlings at 4 weeks after sowing (4 WAS), were pulled and lifted with rooted ball intact and transplanted in the experimental plots in the late afternoon (6.00 pm) on a cool day to minimize transplant shock.

Holes of 10 cm deep were dug on the bed at 20cm × 10cm, 20cm × 15cm, 20cm × 20cm and 20cm × 25cm. Each transplant was placed in its hole and the roots were covered with soil lightly firm. The seedlings were irrigated immediately after transplanting to establish good root to soil contact. The seedlings were watered everyday in the evening to ensure a good stand and maintain vigorous plant growth. Over watering was avoided to minimize disease development and nutrient leaching.

Seedbeds were mulched with rice hills to suppress weeds and the experimental field was cleared of weeds to allow Amaranth transplants to grow vigorous and establish a canopy that can shade out emerging weeds.

Harvesting of Amaranth was done at a plant height of 30 cm at the 6th week after transplanting (WAT) at once during early morning to reduce water loss and were tied in separate bundles per plot and then weighed using Jen

Table 1. Effects of variety and spacing on mean insect pest populations of Amaranths.

Treatment	**Mean no. of insect pests/plant**		
Variety (V)	***Spodoptera* spp.**	***Sylepta* spp.**	***Liriomyza***
Amaranthus caudatus	2.00	2.50	8.75
A. cruentus	3.17	3.92	9.92
A. hybridus	0.67	1.17	3.67
A. viridus	0.17	0.92	3.42
SE ±	0.26	0.36	0.67
LSD(0.05)	0.54	0.73	1.36
Spacing (cm) (S)			
20x10	7.83	3.25	5.00
20x15	7.50	3.25	3.08
20x20	4.92	1.92	0.75
20x25	5.50	2.00	1.58
SE ±	0.67	0.45	0. 45
LSD (0.05)	1.36	0.92	0. 92
Interactions			
V*S	NS	NS	NS

way top loading weighing balance (model 2000) with a capacity of 5 kg and the data recorded. During the experiment, data were collected on the number of insect pests/plant on the leaves between 6.00 pm - 7.00 pm when the insect pests have not gone to hiding.

At full growth of Amaranths, when they have started flowering, the number of leaves per plant were counted and recorded, the number of branches per plant were counted and recorded, and the randomly sampled plant height were measured using a plastic measuring tape in centimetres and recorded.

The Amaranths were harvested fresh by cutting their sterns together with their leaves and branches and tied in bundles. The bundles harvested from each plots were then weighed and recorded.

The data collected from the parameters studied were subjected to analysis of variance (ANOVA) and their individual treatment means compared using least significant difference (LSD) at 5% level of probability according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The populations of insect pest of Amaranth observed attacking the leaves are presented in Table 1. The results showed that *A. cruentus* suffered more insect pests attack than the remaining *Amaranthus* species. *A. viridus* had significantly ($p<0.05$) the lowest insect pests attack during the study period in the study area.

Spacing Amaranths at 20cm × 10cm apart was observed to suffered serious insect pest attack followed closely by 20cm × 15cm. Spacing the crop at 20cm × 20cm apart had the lowest insect pests attack. The highest insect pest populations recorded under *A. cruentus* could be due to their crop physiology and taste which attracted more insect pests to feed on it (Richard, 1989; Rodriquez, 1997; Youdeowei, 2004; Geoff et al., 2007). Charles et al. (2009) reported that some *Amaranthus* species have quick establishment, drought tolerated, high biomass production, and resistance to pests and diseases. As reported, *A. cruentus* suffered more insect pest attack in Brazil than other *Amaranthus* spp. studied. Imam et al. (2010) reported that *A. cruentus* suffer more from Hemiptera, Lepidoptera and Orthoptera than other Amaranthaceae.

The highest insect pest populations recorded under Amaranths spaced at 20cm×10cm and 20cm × 15cm could be due to the close canopy these spacing had, which encouraged the feeding activity of the insect pests (Makus, 1990). AVRDC (2003) reported that closely spaced vegetables and horticultural crops suffer more from insect pests attack due to the conducive environment which they provide for the insect and consequently a favourable and productive shelter for the insect pests and thus make it easier for the pest to find its food near on the host plant (Sorensen, 1995; Hein, 2003). There was no significant difference between insect pest population infestations on variety and spacing.

Table 2 showed that *A. caudatus* produced the highest number of leaves, branches and were taller than other Amaranths crops, while *A. viridus* had the lowest number of leaves, branches and were shorter than others. This implies that *A. caudatus* resisted the attack of the leaf worm, leaf roller and the leaf miner than the other Amaranths during the study period (Richard, 1989; Charles et al., 2009). *A. viridus* had the lowest number of leaves/plant, branches and were shorter than other Amaranths because it suffered from the insect pest attack

Table 2. Effects of variety and spacing on number of leaves/plant, branches/plant and height of Amaranths.

Treatment Variety (V)	No. of leaves/plant	No. of branches/plant	Mean plant height(cm)
A.caudatus	62.50	12.26	60.73
A.cruentus	46.52	10.72	50.43
A.hybridus	33.49	9.81	47.10
A.viridus	26.03	9.56	33.83
SE ±	11.10	0.22	4.66
LSD(0.05)	35.31	0.44	11.40
Spacing (cm) (S)			
20x10	33.17	6.67	33.50
20x15	47.60	9.83	47.35
20x20	60.03	10.75	60.38
20x25	50.47	13.17	56.49
SE ±	4.45	0.44	0.33
LSD(0.05)	10.89	0.89	0.81
Interactions			
V*S	NS	NS	NS

Table 3. Effects of variety and spacing on fresh harvest weight of Amaranths/plot.

Treatment Variety(V)	Mean fresh weight of Amaranth/plot(kg)
A.caudatus	36.81
A.cruentus	29.87
A.hyridus	26.67
A.viridus	23.83
SE ±	0.99
LSD(0.05)	2.44
Spacing (cm)(S)	
20x10	23.80
20x15	26.10
20x20	36.63
20x25	29.30
SE ±	0.99
LSD(0.05)	1.40
Interactions	
V*S	NS

more than Amaranths (Okunlola et al., 2008). Richard (1989) reported that insect pest feeding on grain Amaranth plants usually causes stunted growth and crop loss in the field.

Crop spacing is very important in crop growth and performance. Well-spaced crops were found to grow well and yield much better than close-spaced crops (Fayemi, 1999). Sparles and Liu (2001) reported that closely spaced vegetables do not grow well due to overcrowding, nutrient deficiency and insect pests attack. Amaranths crops spaced at 20cm × 10cm and 20cm × 15cm apart had lower number of leaves branches and short sterns because insect pests fed on them and their population did not allow the crops to grow vigorously and there was high competition on nutrients (Palada and Chang, 2003; Okpara et al., 2013).

Table 3 showed that *A. caudatus* had significantly the highest mean fresh weight per plot than the three other varieties. *A. viridus* had the lowest fresh weight. Close spaced Amaranths had lowest fresh weight, while wide spaced Amaranths had highest fresh weight per plot. This result indicate that *A. caudatus* grew and performed best than other (Okpara et al., 2013) wide spaced Amaranths insect pest attack (Charles et al., 2009; Okunlola et al., 2008). The higher growth of the Amaranths and consequent high fresh weight recorded in 20 × 20 might be due to the adequate space provided to the crops which helped the crops to grow vigorously and tolerated the attack of the insect pests (Booth, 1983; Palada and Chang, 2003).

Conclusion

The present study showed that *Amaranthus* species suffer various insect pests attack. *A. cruentus* was found to be attacked by the insect pests than the other three species during the same period of crop spacing. It was also shown that 20cm × 20cm had the lowest insect pest attack and consequently had the best crop performance during the study period. The reason for higher insect pest infestation recorded under *A. cruentus* and higher performance than *A. hybridus* and *A. viridus* could be further investigated in the study area in order attain concrete information which could be of great use to vegetable farmers as well as to researchers.

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