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Influence of weeding regimes and Cypercot on flea beetles (*Podagrica* spp) populations and yield of okra (*Abelmoschus esculentus* L. Moench)

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ABSTRACT

The combination of regular weeding and appropriate insecticide application was effective against the insect pest. Influence of weeding frequencies and cypercot (a combination of cypermethrin 250 g/L + dimethoate 150 g/L) concentrations were assessed on infestation and damage caused by okra flea beetle (*Podagrica* spp) on okra during 2020 and 2021 cropping seasons. The experiment was a split-plot design with weeding frequencies (0, 1, 2 and 3 weedings) as the main plots and five cypercot applications (0.0, 0.5, 1.5 and 2.0 L/ha) as the subplots on a plot size of 4.0 m × 5.0 m replicated three times. The results showed that okra plants weeded three times and applied with cypercot at 1.5 L/ha and 2.0 L/ha were effective in reducing *Podagrica* spp infestation and damage during the study period. The combination of these control methods was found to be appropriate in the control of the pest and good for enhancing okra productivity in the area. This study recommended three weeding combined with the application of cypercot at 1.5 L/ha for the optimum production of okra in the study area.

Keywords: Okra, *Podagrica* spp, cypercot, concentration, frequency.

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INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is an important vegetable crop and is now widely cultivated in different parts of the world (Anaso, 2008). India is the world's largest producer of okra followed by Nigeria and Sudan. It is grown on about 2 million hectares (Anaso and Lale, 2002; Schippers, 2002). It is grown both in the tropical and subtropical regions of the world (Anitha, 2007; FAO, 2012).

Okra plays an important role in the human diet by supplying fats, proteins, carbohydrates, vitamins and minerals (Degri et al., 2017; Dilruba et al., 2009). Okra is grown for its nutritional and economic value (Alao et al., 2011; Chopra et al., 2013). In Nigeria, Okra is mainly grown for its leaves, fibres, and immature pods which are used for consumption and commercial purposes (Anaso, 2008). Okra cultivation is gaining popularity because of its high demand and economic return, being driven by both youths and women enterprises (Anaso and Lale, 2002; Anaso, 2008; FAO, 2012). Okra mucilage is suitable for industrial and medicinal applications. Okra mucilage is usually used for glass paper production and also for confectionary use (Kumar et al., 2010). Okra has also formed medical applications as a plasma replacement or blood volume expander (Kumar et al., 2010).

Despite the economic and nutritional values of okra, its production in Nigeria is hampered by insect pests and weeds. It is susceptible to a large range of insect pests, weeds and diseases at various growth stages of the crop (Alegbejo et al., 2008; Fasunwon and Banjo, 2010).

In the tropics, weeds are a major menace of okra because they interfere with its production (Youdeowei, 2004; Some and Samon, 2009; Lado and Hussaini, 2010; Kumar, 2014). Weeds interference may reduce plant vigour, delay development and growth, or suppression of specific characters but the ultimate effect of weed and insect pests is the reduction of crop yield and marketability (Iremiren, 1988; Capinera, 2005; Kumar et al., 2010). Weeds reduce crop yield by interfering with crop growth through competition with crops for sunlight, water, nutrients and space (Lado and Hussaini, 2010; Takim and Uddin II, 2010). It has also been found that weeds provide a favorable environment for insect pests and disease pathogens (Alegbejo et al., 2008; Anaso, 2008; Lado and Hussaini 2010; Fasunwon and Banjo, 2010). According to Youdeowei (2004), Kumar et al. (2010) and Yusuf et al. (2015), weeding that gives poorer weeds and control increases the density and diversity of weeds and consequently insect pest populations within the habitat. Also, the correct insecticide choice and application rate that is effective and less toxic to humans, animals and the environment in the field is recommendable (Youdeowei, 2004). Weeding frequencies and insecticide applications is one of the integrated pest control methods that proved to be sustainable and effective (Anaso and Lale, 2002; Anaso, 2008; Kumar et al., 2010). Although previous studies showed that regular weeding is very vital in weed and pest control, little is known about the impact of weeding frequency and Cypercot applications on okra growth and yield in the field. Therefore, the present study was conducted to evaluate the influence of weeding frequency and cypercot applications on flea beetle (*Podagrica* spp) populations and okra yields in the field.

MATERIALS AND METHODS

Experimental site

The experiments were conducted at the Department of Agronomy Teaching and Research farm, Federal University of Kashere, Gombe State, Nigeria under rain-fed conditions during the 2020 and 2021 cropping seasons. Kashere is located in the Sudan savanna ecological zone of Nigeria within latitude 09°69' N and 11°56' E of the equator, and altitude of 431 m above sea level, the mean annual rainfall is between 800 and 1200 mm; annual minimum and maximum temperature of 20 to 40°C, respectively. The duration of the rainy season ranges from 120 to 160 days usually from May to October (GSADP, 2013).

Sources of experimental materials

The synthetic insecticide (cypercot, a combination of cypermethrin 250 g/L = dimethoate 150 g/L) and the NGAE – 96-1 variety of Okra seeds were purchased from Gombe State Agricultural Development Programme (GSADP) farm input store at Bogo, Gombe. Compound fertilizer N.P.K 15:15:15 was purchased from Gombe's main market.

Experimental design and layout

The experimental field was laid out in split plots organized in a randomized complete block design (RCBD) replicated three times. The main plots were assigned to the weeding frequencies (zero weeding; one weeding at 3 weeks after sowing (WAS); two weedings at 3 and 6 WAS; three weeding at 3, 6 and 9 WAS while the subplots were the five cypercot application rate (0:0; 0.5; 1.0; 1.5 and 2.0 L/ha). Each main plot size was 4.0 m × 5.0m (20 m²) separated by a 1.5 m wide border margin and an alley of 2.0 m to allow for operations, data collection and observation.

Experimental procedures and agronomic practices

The selected experimental field was cleared of debris, ploughed, harrowed and ridged when rainfall has established. The field was then mapped out into plots and blocks using a plastic measuring tape of 100 m long and pegs according to experimental design.

Improved okra seeds were treated with Apron Star 42WS (Imidacloprid 20% + Metalaxyl – M 20% + Tebuconzole 2%). The seed dressing was done at the rate of one sachet per kg seed before sowing in the field in order to ensure good seed germination, seedling establishment and protection against soil pathogens. The seeds were sown at the rate of 3-4 seeds per hole on the prepared plots. The intra-row spacing was 30 cm while inter-row spacing was 45 cm and sowing depth was 2.5 cm (GSADP, 2013).

Weeding was done based on the weeding frequencies designed for the study (zero weeding as control, one weeding at 3 WAS, two weeding at 3 and 6 WAS; three weeding at 3, 6 and 9 WAS). Okra seedlings were thinned to two plants per stand after 3WAS. Compound fertilizer NPK 15:15:15 was applied at the rate of 60 kg/ha at 3 weeks after seed emergence.

Insecticide application

The different insecticide applications were done at the rate of 0.0 L/ha (Control); 0.5, 1.0, 1.5 and 2.0 L/ha on the plants in the different treatments using 16 litres knapsack sprayer at a one-week interval.

Data collection

The following parameters were collected and analyzed. Number of flea beetles for the two years, number of leaves per plant, number of leaves damaged per plant n(umber of leaves having feeding) holes plant height (measuring from the plant base to the plant apex); undamaged fruits (fruits without feeding holes); percentage damaged fruits weight, percentage undamaged fruit and fruit yield were collect and recorded.

Data analysis

The data collected were subjected to analysis of variance (ANOVA) and the treatment means were separated at a 5% level of probability using the least significance difference (LSD).

RESULTS

The results of the effects of weeding frequency and cypercot application on the number of *Podagrica SPP* are shown in Table 1. It showed that the *Podagrica* spp number was significantly ($P < 0.05$) higher on zero weeding (control) treatment while it is lower on two and three weedings in both years. The results also showed that *Podagrica* SPP populations were lowest on 2.0L/ha treated plots but highest on 0.0 L/ha (control) treated plants. There was no significant difference in the interaction between weeding frequencies and cypercot applications.

Table 2 shows that there was a significant difference

Table 1. Effects of weeding frequency and cypercot application on P*odagrica* spp population in the 2020 and 2021 cropping seasons.

Treatment	Number of *Podagrica* spp/plant	
	2020	2021
Weeding frequency (WF)		
Zero weeding (Control)	7.12	7.10
One weeding	4.02	4.05
Two weedings	1.41	1.39
Three weedings	1.20	1.33
SE±	3.11	3.08
Cypercot applications (CA)		
0.0 L/ha	7.06	7.09
0.5 L/ha	6.11	6.01
1.0 L/ha	4.61	4.58
1.5 L/ha	1.24	1.26
2.0 L/ha	1.09	1.07
SE±	5.51	5.49
Interactions (WF × CA)	NS	NS

Table 2. Effects of weeding frequency and cypercot application in the number of leaves, damage leaves and undamaged leaves in 2020 and 2021 cropping seasons.

Treatment	Mean number of leaves/plant		Damaged leave		Undamaged leave	
	2020	2021	2020	2021	2020	2021
Weeding frequency (WF)						
0	10.05	10.02	4.62	5.48	5.43	4.54
1	10.33	10.31	4.33	4.31	6.00	6.01
2	10.67	10.66	2.45	2.51	8.22	8.15
3	11.48	11.52	1.61	1.59	9.87	9.93
SE±	0.95	0.81	2.11	2.13	3.91	3.15
Cypercot application (CA) (L/ha)						
0.0	10.11	10.09	5.84	5.88	4.27	4.21
0.5	10.19	10.17	5.42	5.40	4.77	4.77
1.0	10.41	10.43	4.11	4.09	6.30	6.34
1.5	11.78	11.80	2.83	2.81	8.95	8.99
2.5	11.82	11.85	2.33	2.37	9.49	9.48
SE±	0.72	0.79	2.88	2.96	4.31	5.28
Interactions (WF × CA)	NS	NS	NS	NS	NS	NS

between the weeding frequencies and cypercot application rates. Okra plants weeded three times and cypercot applied at 2.0 L/ha produced more leaves because of low flea beetles attack, improved growth and the leaves were not damaged much compared to okra plants that were not weeded and treated with cypercot. The table further indicated that okra plants that were not weeded (zero weeding) and not treated with cypercot (0.0L/ha) had their leaves damaged most by the flea beetles (*Podagrica* spp) while the eaves of okra plants weeded three times and sprayed with cypercot at 2.0 L/ha there leaves were not damaged much during the two cropping seasons.

Results presented in Table 3 showed that okra plants in three weeded plots grow taller than the other weeding frequencies. Okra plants that were not weeded (control)

Table 3. Effects of weeding frequency and cypercot application rates on okra plant height in 2020 and 2021 cropping seasons.

Treatment	Mean plant height (cm)	
	2020	2021
Weeding frequency (WF)		
0	101.02	98.61
1	121.11	121.17
2	133.69	133.63
3	153.61	155.07
SE±	52.60	56.46
Cypercot application (CA) rates (L/ha)		
0.0	84.87	85.11
0.5	109.11	108.97
1.0	121.92	121.91
1.5	154.41	153.68
2.0	154.52	154.40
SE±	70.11	69.30
Interactions (WF × CA)	NS	NS

had shorter okra plants.

When cypercot applications were compared, the results showed that untreated (0.0L/ha) okra plants were shorter than the others while those okra plants that were treated with 1.5 and 2.0 L/ha produced taller plants (Table 3).

There were significantly more okra fruits per plant on three weeded plots followed by two weedings while zero weeding (unweeded) plots had the least number of okra fruits per plant (Table 3). When damaged okra fruit was compared, three weedings had lower damaged fruit while unweeded plots had higher damaged fruits. Three weeding plots had more undamaged fruit compared to unweeded plots that had a lower number of undamaged okra fruits. The application of cypertcot showed that okra plants sprayed with 1.5 and 2.0 L/ha had more number of okra fruit and undamaged okra fruits but lower damaged okra fruits (Table 4). Plots that received zero (0.0 L/ha) treatments and a lower rate of the insecticide had a lower number of fruits per plant and lower undamaged fruit but higher damaged fruits.

Table 4. Effects of weeding frequency and cypercot applications on okra (fruits, damaged and undamaged fruits in 2020 and 2021 cropping seasons.

Treatment	No. of fruit/plant		Damaged fruit		Undamaged fruit	
	2020	2021	2020	2021	2020	2021
Weeding frequency (WF)						
0	7.16	7.58	4.11	4.09	3.50	3.49
1	10.11	10.13	3.37	3.37	6.74	6.76
2	18.22	18.18	3.09	3.11	15.13	15.07
3	18.22	20.20	2.02	2.02	16.22	18.28
SE±	9.65	12.72	2.11	2.07	12.72	14.79
Cypercot application (CA) (L/ha)						
0.0	6.18	6.17	4.17	4.14	2.01	2.03
0.5	6.31	6.38	3.91	3.89	2.40	2.49
1.0	10.72	10.69	3.13	3.15	7.59	7.54
1.5	18.31	18.30	1.66	1.56	16.65	16.74
2.0	18.55	18.49	1.33	1.34	17.22	17.15
SE±	12.37	12.32	2.84	2.80	15.21	15.12
Interactions (WF × CA)	NS	NS	NS	NS	NS	NS

Table 5. Effects of Weeding frequency and cypercot applications on percentage damaged fruit weight and fruit yield in 2020 and 2021 cropping seasons.

Treatment	% Damaged fruit		Mean fruit yield (kg/ha)	
	2020	2021	2020	2021
Weeding frequency (WF)				
0	54.00	53.96	318.70	315.98
1	33.33	33.27	489.87	478.90
2	16.96	17.11	641.66	641.68
3	11.17	9.95	677.78	678.54
SE±	42.83	44.01	35.80	36.56
Cypercot application (CA) (L/ha)				
0.0	7.48	67.10	314.09	309.67
0.5	61.96	60.97	411.61	413.14
1.0	29.20	29.47	644.41	641.92
1.5	9.07	8.52	673.11	676.45
2.0	7.17	7.25	675.34	676.31
SE±	60.31	59.85	36.12	36.66
Interactions (WF × CA)	NS	NS	NS	NS

A higher percentage of okra fruits were damaged in unweeded (zero weeding) and untreated (0.0 L/ha) plots during the study period (Table 5). On the other hand, unweeded (zero weeding) and untreated (0.0 L/ha) plots had lower fruit yields compared to plots weeded three times and sprayed with cypercot at 2.0 L/ha. The interaction between weeding frequencies and insecticide applications showed no significant difference in both cropping seasons in the study area.

DISCUSSION

Weeding frequencies and the use of the right concentration of insecticide are the two most important components of integrated pest management for the control of flea beetles (*Podagrica* SPP) in the field (Mustapha et al., 2001). These two methods help to control both the weeds and the pest (Degri et al., 2017). Weed control and pest control are both good practices for improving okra growth and yield performance (Capinera, 2005; Degri et al., 2017). Weed removal improved the growth performance of okra because competition ability of weeds and harbouring flea beetle (*Podagrica* spp) were reduced in the regularly weeded plots than the unweeded plots (Iremiren, 1988; Youdeowei, 2004; Anaso, 2008; Yusuf et al., 2015). Total removal of weeds in the three weeded plots could have effectively reduced competition between the weeds and crop and made more assimilates available to support okra growth and development, and consequently its yield (Degri et al., 2017). That could be the reason okra plant height and fruit yield was significantly higher in two and three weeded plots: this is in agreement with the findings of Takum and Uddin (2010) who reported that regularly weeded plots had higher yield compared to unweeded and one-weeded plots.

These results showed that okra plant growth, fruit number, fruit yield can also be improved and leave and fruit can be improved by choosing the right insecticide and applying it appropriately. Cypercot applied at 1.5 and 2.0 L/ha were found to be more effective in reducing flea beetle population, okra leaves damage, fruit damage and improving okra plant height number of fruits and fruit yield than 0.5 and 1.0 L/ha. This implies that cypercot applied at 1.5 and 2.0 L/ha was the appropriate concentrations for flea beetles (*Podagrica* spp) control in the area. Okra plants treated with cypercot at 0.5 and 1.0 L/ha were less effective in the control of *Podagrica* spp during the study. This indicates that this insecticide applied at these concentrations was not appropriate enough to manage the infestation and damage of the insect pest. Anitha (2007) reported that the application of insecticides at the recommended rates will give the needed control of insect pests while concentration will not be effective against the pest and may even cause pest resistance and resurgence.

Among the five concentrations of cypercot, it was found that okra treated with 1.5 and 2.0 L/ha had reduced leave and fruit damage, improved okra plant growth performance and fruit yield during the study period. This indicates that cypercot applied at these two concentrations were the appropriate concentrations for optimum okra fruit production in the study area. The interactions of the weeding frequencies and cypercot applications showed that there were no significant differences between them. This means that these two control methods are equally important in the control of this insect pest in okra production in the area.

CONCLUSION

This present study showed that okra flea beetles (*Podagrica* SPP) are a major insect pest of okra as earlier reported by Anaso and Lale (2002). It is a major constraint to okra production in the area. The practice of regular weeding combined with appropriate cypercot application rates was found to be effective against okra flea beetles infestation and damage. The combination of these two practices was found to have reduced flea beetles population; leaves damaged and okra fruit damage. It was also found that okra leaves, plant height, fruit number and fruit yield have improved during the study. This indicates that regular weeding and appropriate insecticide application rates on okra have remarkably enhanced okra productivity in the area.

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