Preliminary Study of Effect of Herbicide Rotation on Growth and Yield of Roselle (*Hibiscus sabdariffa* L.) in the Alley of Citrus Trees

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Abstract
A field trial was conducted at National Horticultural Research Institute, Ibadan, to conduct a preliminaryinvestigation of theeffect of herbicide rotation on growth and yield of roselle in the alley of citrus trees in the orchard. Treatments included paraquat, glyphosate, metolachlor + hoeing, metolachlor + glyphosate and no weeding ascontrol.The spacing for roselle was 60cmx 30cm,the spacing for citrus was 5mx5m, while the plot size was 6m x 3m. Data collected includes growth attribute of citrus, roselle growth and yield at 1m,2m and 3m away from citrus tree and weed biomass. The experimental design was Randomized Complete Block Design (RCBD) in 4 replications. The data collected were subjected to analysis of variance (ANOVA) using SAS analysis and means were separated using Duncan Multiple Range Test (DMRT) at $p \leq 0.05$. Results revealed that significantly higher fruit yield (17.7) and calyx dry weight (19.8g) was recorded from glyphosate treated plots at 1m away from the citrus tree. No significant difference was observed on number of fruit and calyx dry weight at 3m away from the citrus tree. Tallest citrus tree (260.7 cm) was recorded from plots treated with metolachlor+glyphosate. The check(No weeding plots) recorded significantly wider collar diameter (9.8 cm) and scion diameter (7.6 cm). Significantly least weed biomass of 15.0 g/m^{2}was recorded from paraquat treated plots.

Keywords: *- Weed biomass, Herbicide, Calyx, Weed interference, Roselle yield*.

INTRODUCTION

Citrus (*Citrus spp*) is one of the most important fruit trees grown for fresh consumption and as raw materials for marmalade and juice production in the tropics and sub tropics (Adewale *et al*., 1996; Olaniyan *et al*., 2001; Alamu *et al*., 2011). Sweet orange (*Citrus sinensis* Osbeck Cv Agege 1) is the most widely grown type of citrus fruit, by far, it account for around 55% of the citrus area and over 60% of production. Its importance is due to the high vitamin C content in the fruit, high industrial potential for manufacturing concentrates, fruit juice, squash marmalades, essential oils and flavouring purposes (Davies and Albrigo, 1994; Futch and Singh 1998; FAO 2008).

Intercropping tree crops with staple food crops before canopy closure is a common practice by farmers (Andor and Ofosu-Budu, 2012). The cropping system of citrus vary with the agro-ecology, in the southwestern zone of Nigeria, citrus is grown as a home compound crop with other crops, it serves for home consumption and in year of heavy bearing, surplus fruit are sold for cash (Olaniyan 2001). In the southwestern zone, citrus is interplanted with *Theobroma cacao* (Cocoa), *Cola spp*. (Kola) and *Musa paradisiaca* (Plantain) to generate extra income (Amih, 1985; Aiyelaagbe *et al.,* 2001). In the middle belt, identified to be the largest citrus producing area in Nigeria, the farmers intercrop the alley of citrus orchard with *Vigna unguiculata* (Cowpea), *Glycine max* (Soybean) and sometime *Manihot esculenta* (Cassava).(Aiyelaagbe,2001)

Citrus is grown at a recommended spacing of 7m x 7m and this makes it possible and convenient to utilize the alleys for growing other crops especially at the juvenile stage. The attendant cultural operation in maintaining sole citrus are usually capital intensive during the early stages, due to the wide spacing with no monetary returns in the first five years of orchard establishment

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(Olaniyan 2001).In southern part of Nigeria, a number of crops have been found to be compatible with citrus such as cowpea, okra, watermelon, amaranths and maize (NIHORT, 2000).

The intercropping systems being practiced for citrus presently puts citrus as the minor crop in the system, the compatibility of the companion crop with citrus is therefore not of much concern. The compatibility of the different intercrop needs to be carefully studied to justify their inclusion in citrus orchard alleys. Inclusion of the intercrops (fruit vegetables and spice crops) will encourage farmers to maintain the young citrus plants, serve as a source of income to the farmers.

Weeds have been reported to significantly contribute to direct yield losses of crops by competing for water, nutrients, light, space and/or carbondioxide. Akobundu (1987) reported that 50 to 80 % crop yield loss is caused by weeds, probably due mainly to delay in weeding. In addition to competition for limited growth resources, it has also been generally observed that weeds also act as reservoirs or alternate hosts for insects, diseases and nematodes (Singh and Sharma, 2010). The main problems limiting production and expansion of roselle pointed out by El-Awad, (2001) are, scarcityand reliability of rainfall, limited research and agricultural extension services, poor cultural practices,inadequate weed control and harvest problems. Hoe weeding is still by far the most widely practiced culturalweed control technique in field crop production throughout the tropics because of the prohibitive costs ofherbicides and fear of toxic residue coupled with the lack of knowledge about their use.(Ibrahim *etal*,2011)

Although the most desirable strategy is to proactively use annual herbicide rotations, sequential applications, or tank mixtures before resistance evolves, that requires growers to apply multiple herbicides even if weed densities are low. The objective of thisstudy was to investigate the effect of herbicide rotation on growth, yield and yield's components of *Hibiscussabdariffa* in the alley of citrus trees.

MATERIALS AND METHODS

The experimental site was National Horticultural Research Institute (NIHORT) Ibadan. Ibadan the Oyo state capital is located with the coordinates of 07º24, 36.88N, 00351'16.05''E with 213 meters above sea level. Ibadan lies in the derived savannah ecological zone of Nigeria. The treatments consisted of paraquat, glyphosate, metolachlor + hoeing, metolachlor + glyphosate and no weeding as control. Roselle seeds were planted in the alley of citrus trees at 60cm x 30 cm spacing, citrus spacing was 5m x 5 m, while the plot size was 6m x 3m.Data collected includes growth attributes of citrus trees, roselle growth and yield attributes at 1m, 2m and 3m distance away from citrus tree and weed biomass. The experimental design wasRandomized Complete Block Design (RCBD) in four replications. The data collected were subjected to analysis of variance (ANOVA) using SAS analysis and means were separated by Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSIONS

Table 1 shows the roselle fruit yield at 1m, 2m, and 3m distances away from the citrus trees. Significantly ($P<0.05$) highest number of fruit was recorded from plots treated with glyphosate at 1m spacing, while the least number of fruit was recorded from the check(no weeding plots). At 2m and 3m distance away from citrus trees, highest number of fruit (20.0and 30.0) was also recorded from glyphosate treated plots but not significantly different from other treatments (Table 1). The result on calyx dry weight shows that significantly

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($p<0.05$) higher fruit weight (17.8 and 19.8 g/m^2) was also recorded from plots treated withglyphosate at 1m and 2m distance respectively. However at 3m distanceaway from citrus trees, highest calyx dry weight was recorded from paraquat treated plots and closely followed by glyphosate and metolachlor + hoeing plots. These were not significantly different from other treatments and the weedy check 1 (no weeding). Tallest plant (260.7cm) was recorded from plots treated with metolachlor + glyphosate, but was not significantly different from other treatments. A significantly wider diameter (9.8cm) was recorded from the weedy check (no weeding) but was not significantly different from herbicide rotated plots. Similar trend was also observed for scion diameter (7.6cm) in no weeding plots. The canopy spreads as observed also revealed that no weeding plots and metolachlor + glyphosate plots recorded highest canopy spreads at CS 1 and CS 2, these were not significantly different from other treatment except paraquat treated plots at CS 1 (Table2).The response of roselle in citrus alley viewed at different distances, confirms the report of the preliminary study of Oyedele *et al.* (2015). Highest calyx yield was produced at 3 m distance from the citrus tree, which was not significantly different from the yield obtained from other treatments, this confirms the result of the earlier work of Olaniyan and Fagbayide (2005), who reported that intercropping did not hinder the optimum growth and yield of citrus and companion crops. The least dry weight of 15.0g/m^2 was recorded from paraquat treated plots, this was significantly lower when compared with other treatments except no weeding plots. While significantly ($P<0.05$) highest weed dry weight was recorded from metolachlor + glyphosate plots (Table 2).This result may also be attributed to vigorous plant with loss competition for light, nutrients, and free space in weed from environment (Ahmed and Salahudeen, 2010).

CONCLUSION

In this study, there was similarity in the efficacy of the two herbicides and its rotation; this shows that the efficacy was more influenced by the nature of their active ingredients. The rotation of the herbicide and combination with hoeing enhanced the yield of roselle and growth of the citrus trees. Also, the highest calyx yield observed at 3m away from the citrus is an indication of non-tolerance of roselle plant to shade.

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Table 1. Effect of herbicide rotation on number of fruit and calyx dry weight of roselle in citrus alley

	Roselle Fruit Yield			Calyx Dry Weight		
Treatments	**1m**	**2m**	**3m**	**1m**	**2m**	**3m**
Paraquat	8.3bc	19.3a	29.0a	6.5c	16.4ab	22.0a
Glyphosate	17.7a	20.0a	30.0a	17.8a	19.8a	21.1a
Metolachlor+ hoeing	13.3ab	17.7a	27.7a	13.7ab	11.3b	21.1a
Metolachlor+ glyphosate	8.7bc	23.7a	26.7a	8.3ab	12.8ab	15.2a
No weeding	5.3c	17.7a	19.6a	9.6bc	16.1ab	16.3a

Means followed by the same letter(s) in the same column are not significantly different from each other.

Table 2. Effect of herbicide rotation on growth attributes of citrus trees and weed dry weight

	Citrus growth attributes					
Treatments	PH	CD	SD	CS 1	CS 2	Weed dry weight (g/m^2)
Paraquat	228.3a	6.4b	4.3b	144.3b	180.3a	15.0c
Glyphosate	198.0a	6.7b	4.3b	207.3ab	196.7a	39.0a
Metolachlor+ hoeing	243.7a	7.3ab	5.0b	240.0a	173.7a	37.3ab
Metolachlor+ glyphosate	260.7a	8.4ab	6.1ab	277.0a	266.7a	53.7a
No weeding	240.3a	9.8a	7.6a	277.7a	196.3a	20.0bc

Means followed by the same letter(s) in the same column are not significantly different from each other
PH –Plant Height , CD – Collar Diameter, CS – Canopy Spread

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