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Tolerance of *egusi*-melon [*Citrillus colocynthis* (L.) schrad] and susceptibility of weeds to Primextra doses

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ABSTRACT
Objective: The study was to evaluate melon tolerance and weeds susceptibility to Primextra {Primextra-Gold 660g/L (atrazine (370g/l) + S-metolachlor (290 g/l SC)}.
Methodology and results: The Field studies were conducted in 2013 and 2014 planting seasons at Faculty of Agriculture Farm, University of Port Harcourt, Rivers State, (latitude 04^{o} 54 538'N, and longitude 006^{o} 55 329'E; 17m above sea level), Nigeria. Seven rates of primextra (0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.98 kg ai ha^{-1}), applied as pre-emergence were compared with a untreated control (no primextra).The 8 treatments were fitted into a Randomized Complete Block Design, replicated three times. Melon was planted 3 seeds per hole at a spacing of 1m ×0.5m (20,000plants/ha). Result from this study showed that both melon and weeds were susceptible to all Primextra rates but melon tolerated low doses of Primextra in the range of 0.25 – 0.75 kg ai//ha than higher rates. Weeds were more susceptible to higher Primextra rates between 1.0 and 1.98 g ai/ha. Susceptibility of weeds to Primextra rates of 0.25 – 0.75 kg ai /ha and 1.0 – 1.98 kg ai/ha accounted for about 76.2 % and 74 % weed control efficiency respectively. Results also showed that melon tolerated Primextra doses of 0.25 to 0.75 kg ai /ha and thus reached a mean ground cover of ≥ 40 % to ≥ 80 % when compared to the untreated plot. Melon fruit yield from the Primextra treated plots had about 23.5% (1659 Kg/ha) yield advantage over the untreated control plot (1269kg/ha). Mean fruit yield with the herbicide rates were as follows: 1959.5 kg/ha (0.25- 0.75 kg ai/ha); 1430 kg/ha (1.0 – 1.98 kg ai/ha) and 974.5kg/ha (1.50 -1.98 kg ai/ha). Susceptibility of weeds to Primextra increased as application dose increased. The implication of this result is that melon may find a tolerable dose of Primextra-Gold for integration in maize-melon cropping systems.
Conclusion and application of results: Farmers can intercrop either simultaneously egusi-melon with maize or relay egusi-melon into maize and use primextra for pre-emergence weed control, at a dose not greater than 0.25-0.75 kg ai/ha for good yield and acceptable weed control. This can be applied in maize-melon cropping systems with melon either simultaneously or in relayed intercropping to reduce the effect manual weeding on melon especially during flowering and fruiting.
Keywords: PrimextraGold, melon, Tolerance, weed

INTRODUCTION

Melon, which was formerly known scientifically as *Colocynthis citrullus* (L.) and now classified as Citrillus colocynthis (L) Schrad, is a member of the cucurbitaceae. It is an herbaceous annual vegetable with trailing hairy vines, which bear tendrils and lobed leaves on long petioles (Okigbo, 1976). It is commonly called *colocynth,* bitter apple, bitter cucumber, egusi or vine of Sodom. Egusi melon (*Colocynthis citrullus L.)* is an important crop in Nigeria and most other Africa countries, where it has been in cultivation for many centuries (Cobley, 1975) and from where it has probably been introduced to Asia, Iran and Ukraine (Shippers, 2000). It thrives in hot regions with rich light soil and can tolerate periods of low rainfall. It is a highly drought tolerant annual cucurbit and is widely distributed in parts of West Africa (Akpambang *et al*., 2008). It is especially very common within the moist savannah and forest vegetation belts stretching west to Central Africa (Ekpo *et al.,* 2010). It is rarely cultivated as sole crop in traditional cropping system where it provides some weed suppression effect when intercropped with other crops. It is also cultivated for its seeds, which are prepared into condiments used in preparing soup and various dishes (Olaniyi, 2008; NAERLS-PCU 2005). The egusi-melon seed is rich in dietary oil (53.1%), high in protein (33.8%), and containing higher levels of most amino acids than soya bean (*Glycine max)* (Nwokolo and Sim, 1987). Melon is grown across the country, but with higher intensity of cultivation in Kogi state (211,600ha). There was large increase in land area put to melon production in 2004 and 2005 (NAERLS-PCU, 2005). In southern Nigeria, egusi melon is usually grown mixed with other crops such as cassava and maize by most famers who practice mixed cropping (Ekpo *et al*., 2010). In such crop combinations egusi melon is regarded as a minor crop receiving less attention from the farmers. The rural women mostly grow it, but in recent times, it has become a commercial crop that is no longer gender bias. Apart from being used as food, melon also has the potential to improve nutrition, enhance food security, foster rural development and support sustainable land management. As a popular vegetable crop that is in Nigeria it can be cultivated as sole crop or in an intercrop with other crops (Udoh *et al*., 2005). It is very useful economic crop for both local consumption and industrial use. Vegetable oil is extracted from the seed, which is rich in linoleic, oleic, stearic acids and rich in fat and protein, while the ground seed is used to prepare various food delicacies such as cake and soup (Lagoke *et al*., 1983). Melon performs best when grown singly, but it will give adequate yield when intercropped with other crops. In the southern part of Nigeria, the popular intercropping pattern includes the following: maize/melon/cassava, maize/yam/cassava, maize/melon/yam/ cassava, maize/melon, and melon/yam. However, in recent times the combination of melon/maize has become dominant, because they are both short duration and season crops, which provide food and generate income to the farmers early in the season. There has been increased demand for egusi-melon in Nigeria, where it is cultivated in over an area of 200,000 ha (NAERLS-PCU, 2005) with an estimated production of about 347,000 ton per annum (Olufemi and Ayodeji, 2006). The major problem limiting productivity and increased land use for melon cropping system in the southern part of Nigeria are weeds. The drudgery associated with controlling weeds manually makes it more costly besides being inefficient. Though, melon as a live mulch has been reported to smother weeds (Akobundu, 1987), but as a short season crop, its weed smothering ability is limited, because the cover duration will not sustain the smothering effect against late emerging weeds (Udensi *et al*., 1999). Weeding melon is a problem in that it will disturb the growth of the vines, especially if they are already bearing flower heads. Melons, and generally the cucurbits have limited number of available herbicides for weed control because of its susceptibility to herbicide injury. Few herbicides can be applied pre-emergence that melon can tolerate. Farmers who intercrop maize and melon, and use Primextra for pre-emergence weed control have been doing a lot of serial dilution, to see how they can reduce the effect of Primextra on melon.

However, this has caused more problems instead of solving the problem, and they have incurred losses due to wrong doses and dilution rates. The dilemma here is that wrong choice of herbicide doses can be detrimental, as too little can engineer resistant weeds that may compete with the crop while too high a dose could be phytotoxic to crop Chikoye *et al*., 2005; Chikoye *et al*., 2006). Farmers have recorded substantial yield losses with the use of Primextra at higher rates and at the commercially label rate recommended for sole maize (3-4L//ha). Primextra is popular, because it is available and accessible for the majority of farmers who grow and sell green maize intercrop with either melon or yam for income early in the growing season. Other herbicides available are mostly selective and are not compatible with the cropping systems. Rates used in melon intercrop have not been determined on sole melon to evaluate weed control efficacy and possible injury to melon. Therefore, little or no information is available on how egusi-melon can react to different rates of Primextra-Gold. Hence, the objective of the current study was to evaluate the tolerance of egusi-melon and susceptibility of weeds to selected Primextra doses.

MATERIALS AND METHODS

Experimental site description: The study was carried out at the Faculty of Agriculture Research and Teaching Farm, University of Port Harcourt, Port Harcourt, Nigeria between 2013 (April, 15th to July 30th, first planting season) and 2014 (September 18th to December, 20th , second planting season). The experimental site is located at latitude 04° 54´ 538'N and longitude 006° 55´ 329'E and at an altitude of 17 meters above sea level.

Experimental Procedure: The experimental site was slashed, tilled and levelled manually using cutlass, hoe and shovel. Soil samples were collected at a depth of 15cm diagonally across the plot using soil auger. They were bulked together thoroughly mixed, and a sub sample was taken to the laboratory for chemical analysis. Data were also collected on relevant weather information throughout the period of the study. The experiment was laid out as a randomized complete block design (RCBD), with three replications. The plot size was 3m by 3m, with 8 treatments. The eight treatments consisted of seven doses of Primextra [Primextra-Gold 660g ai/L (atrazine (370g ai/l) + S-metolachlor (290 g/l SC)] that were compared with untreated control.

1. Primextra Gold at 0.25kg ai/ha
2. Primextra Gold at 0.50kg ai/ha
3. Primextra Gold at 0.75kg ai/ha
4. Primextra Gold at 1.00kg ai/ha
5. Primextra Gold at 1.25kg ai/ha
6. Primextra Gold at 1.50kg ai/ha
7. Primextra Gold at 1.98kg ai/ha (Recommended rate for sole maize)
8. Untreated control (Not weeded - after land preparation)

The herbicide treatments were applied immediately after planting with a hand pump CP 15 knapsack sprayer fitted with a red jet nozzle and calibrated to deliver spray volume of 200L/ha. Melon was planted at a plant spacing of 0.75m x 0.5m with 3 seeds per hill and thinned to one seedling per hill to reflect the specified population of 26,666 plants/ha.

Data collection: For melon, data were collected on the following: melon emergence, melon height, flowering, mortality rate, melon ground cover rate, melon vine weight, fruit number and fruit yield. On weeds, data were collected on weed density, weed biomass and weed ground cover. Melon emergence was taken by counting the total number of seed hills that emerged per plot. Melon seedling height was done by measuring all plants on a four linear meter randomly per plot and the averaged represented the data value per treatment. Both measurements were taken at 2 WAP. The tolerance of melon to the Primextra-Gold doses was expressed as growth inhibition rate (GIR) calculated according to the following formula:

$$\text{Growth inhibition rate (GIR)(\%)} = 1 - \left\{\frac{\text{Mean emergence of treatment}}{\text{Mean emergence of untreated control}}\right\} \text{X } 100\ \%$$ (Song *et al*., 2006)

Melon vine and weed ground cover were determined using line-intercept method used in vegetation cover assessment (Martin and Paddy, 1994) at 10 WAP. Flowering percentage was taken by counting flowers in two diagonal transects of the plot using 50cm by 50cm quadrat with five sub division measuring 10cm by 10cm each, in using the quadrat flower heads that fall within the 10cm space square was counted, and expressed as the percentage of the total 10cm square points per quadrant to represent percentage flowering. Vine weight was assessed by cutting the entire vine per plot and taking the weight. Fruit number was determined by counting, and fruit weight was determined by gathering all the fruits and weighing them right on the field. Melon yield was assessed using the fruit only as the seed could not be extracted. Data on weed density and biomass were assessed from 3 quadrat measuring 25cm by 25cm at 4, 8 and 12 WAP (harvest), by clipping the weeds at ground level using secateurs. The weed samples were oven dried at 80°C for 48 hours and weighed using a weighing balance (MP 2001 electronic balance, SHP0100511374).

Statistical Data Analysis: Analysis of Variance (ANOVA) was done using general linear model procedure (PROC GLM) of SAS 9.2 (SAS Institute Inc., 1999). Means were separated using LSD at 5% level of probability procedures (Gomez and Gomez, 1984). ANOVA of the data revealed treatment x year interactions. These factors prevented the pooling of data across years. Therefore, they are presented for each year.

RESULTS

Physical and chemical properties of the soil at the experimental site and weather data: The soil was sandy loam with a pH of 4.96 which is acidic by all standard, the total organic carbon was moderate, available potassium was adequate and the nitrogen value was low (Table 1). Weather information from the Geography department of University of Port Harcourt presented in Figure 1 shows rainfall, relative humidity and temperature distribution during the seasons of the study.

Table 1: Physical and chemical properties of the soil at the experimental site

	Value	
Soil parameters	**2013**	**2014**
% silt	**3.0**	**6.0**
% Clay	**6.80**	**5.20**
% Sand	**90.2**	**88.8**
pH	**5.62**	**4.30**
Organic carbon (%)	**1.053**	**1.911**
Available- P(ppm)	**18.67**	**8.66**
Total Nitrogen (%)	**0.068**	**0.096**
Exchangeable acidity (cmol/kg)	**0.74**	**0.800**
K (cmol/kg)	**0.980**	**1.835**
Na (cmol/kg)	**1.511**	**2.135**
Ca (cmol/kg)	**0.359**	**1.932**
Mg (cmol/kg)	**1.305**	**0.639**
ECEC (cmol/kg)	**4.875**	**4.875**

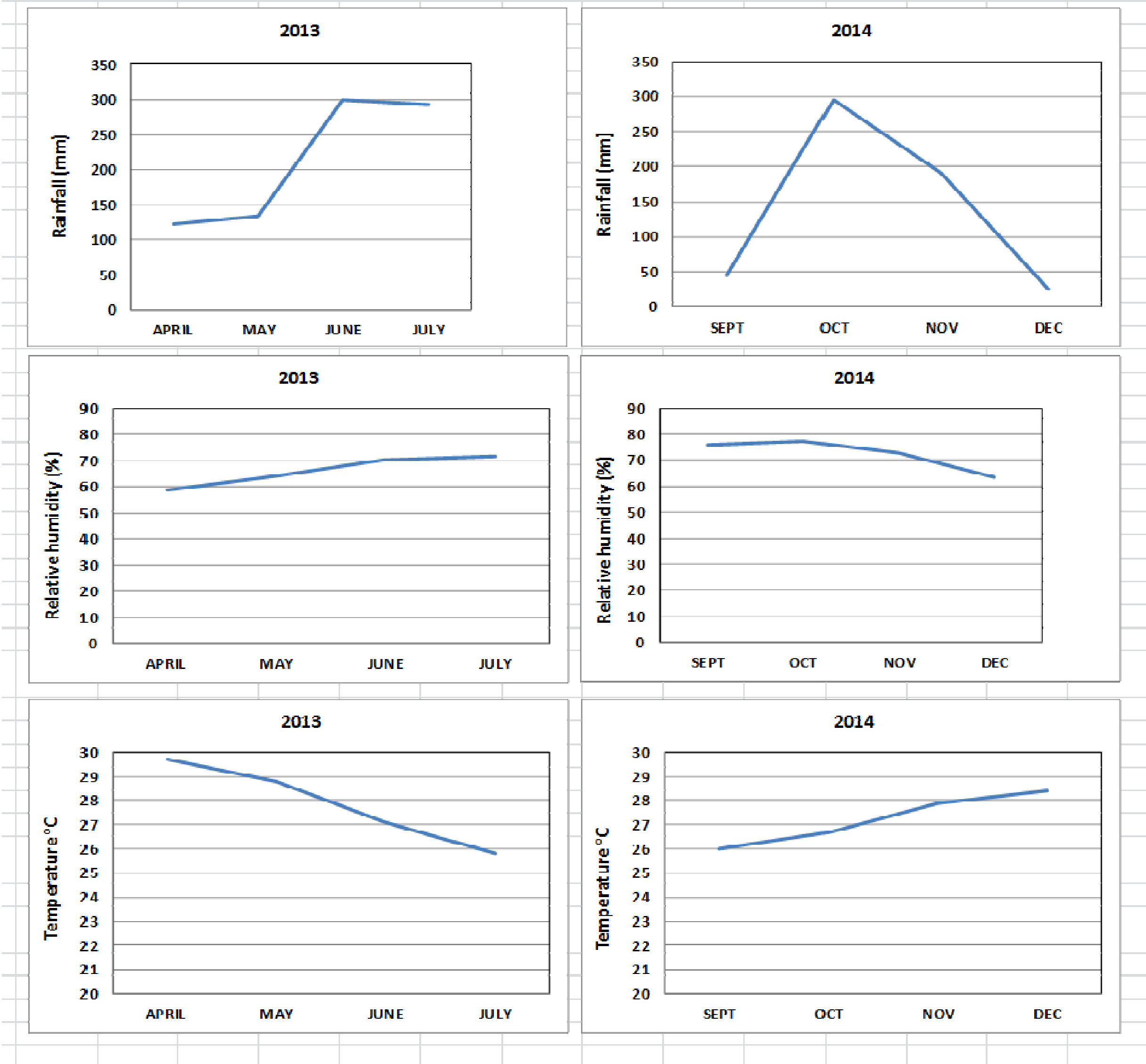

Figure1: Rainfall, relative humidity and mean temperature distribution at Abuja campus of University of Port Harcourt site of the experiments in 2013 season (April to July) and 2014 season (September to December) Source of weather data: Geography Department , University of Port Harcourt, 2013 and 2014)

Effect of treatment on melon seed emergence and seedling height*:* The highest melon emergence was recorded with the control plot, and the lowest with Primextra at 1.98 kg ai/ha in both years (Table 2). In 2013, the control treatment did not differ significantly in melon emergence compared to Primextra rate at 0.25 kg ai/ha and 1.50 kg ai/ha. However, Primextra at 0.25 kg ai/ha, had similar effect on melon emergence when compared to the other rates, except for Primextra rates of 1.0 kg ai/ha and 1.98 kg ai/ha. Effect of Primextra doses on melon emergence was variable in 2013, and did not follow a specific pattern such as increasing dose with decreasing emergence or otherwise. The same pattern of melon seed emergence observed in 2013 was repeated in 2014. Weeded control did not differ significantly from Primextra doses of 0.25 – 0.75 kg ai/ha and 1.25- 1.50 kg ai/ha. The Primextra doses did not differ in their effect on melon seed emergence except Primextra at 1.98 kg ai/ha, which had significantly lower emergence compared to Primextra at 0.25 kg ai/ha (Table 2). In both years melon seedling height were significantly taller in weeded control plots than in Primextra treated plots. The Primextra doses though had a variable effect on melon seedling height but there was no distinct dose superiority effect.

Table 2: Effect of treatment on melon emergence, height at 2 WAP

	Melon emergence (No.m^{-2})		**Melon seedling height (cm plant^{-1})**	
Treatment	**2013**	**2014**	**2013**	**2014**
Primextra-Gold 0.25 kg ai/ha	**20833**	**24241**	**1.47**	**3.24**
Primextra-Gold 0.50 kg ai/ha	**19167**	**18519**	**2.02**	**2.88**
Primextra-Gold 0.75 kg ai/ha	**18333**	**18148**	**0.70**	**3.16**
Primextra-Gold 1.00 kg ai/ha	**13333**	**12963**	**1.20**	**2.53**
Primextra-Gold 1.25 kg ai/ha	**17500**	**10370**	**0.94**	**3.29**
Primextra-Gold 1.50 kg ai/ha	**20000**	**11852**	**1.09**	**2.63**
Primextra-Gold 1.98kg ai/ha	**7500**	**5556^{b}**	**0.84**	**1.50**
Untreated control	**26667**	**19666**	**3.08**	**5.09**
LSD (@5%)	**7052.9**	**12204**	**0.989**	**1.07**

Means in a column followed by the same alphabet are not significantly different at 5% level of probability according to LSD Test

Inhibition effect of Primextra–Gold on egusi-melon: Melon showed a significantly different response to the Primextra-Gold rates in the planting seasons of both years. In 2013 planting season, rates between 0.25 kg ai/ha and 0.75 kg ai/ha caused growth inhibition of about 22 % to 50 %, while rates between 1.0 kg ai/ha and 1.50 kg ai/ha resulted in growth inhibition of about 45% to 60% on the average (Figure 2). The commercially recommended rate of Primextra-Gold, 1.98 kg ai/ha for weed control in sole maize, caused up to 80 % growth inhibition of melon (Figure 2). There was a similar trend of growth inhibition with respect to Primextra-Gold doses in 2014, were the lower rates between 0.25 kg ai/ha to 0.75 kg ai/ha caused melon growth inhibition rates of about 21% to 42%. Similarly rates between 1.00 kg ai/ha and 1.50 kg ai/ha in 2014 resulted in growth inhibition of between 48% and 60% and the recommended commercial rate for sole maize, 1.98 kg ai/ha caused melon growth inhibition rates of ≥ 70% (Figure 2).The untreated control in 2014, planting season recorded about 15% melon growth inhibition, which was the evidence of weed competition, as corroborated by the amount of weed biomass recorded in this treatment in 2014.

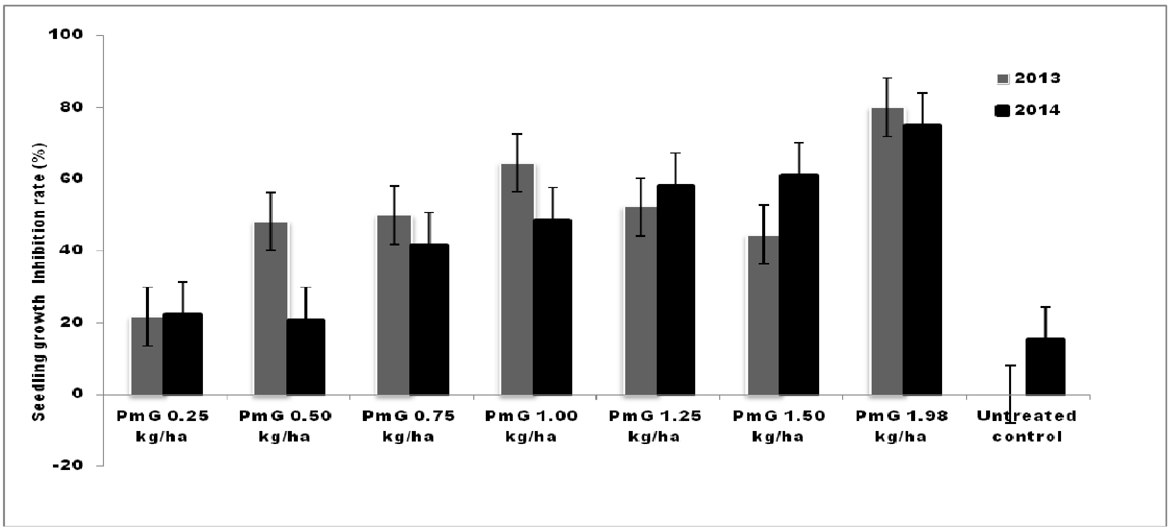

Figure 2: Inhibition effect of Primextra-Gold (PmG) doses on Egusi- melon at 2 WAP in 2013 and 2014 planting seasons

Effect of treatment on weed density and biomass: At 4 WAT in the planting seasons of both years the control treatment had a significantly (*P*=0.0099) higher weed density compared to the Primextra treated plots (Table 3). The Primextra doses though had variable effect on weed density at 4 WAT did not differ significantly from each other in lowering weed density. However, higher doses of Primextra had reduced weed density, with 1.98 kg ai/ha having the lowest. Averaged over the Primextra doses and compared with the control the Primextra doses reduced weed density by 83% in 2013 and 43% in 2014 planting seasons (Table 3). The trend was similar at 8 WAT in the planting seasons of both years with the Primextra rates significantly reducing weed density compared to the control. The Primextra doses did not differ significantly on their effect in reducing weed density in the planting seasons of both years at 8 WAT except in 2014 where Primextra at 1.98 kg ai/ha had a significantly lower weed density compared to 0.25 kg ai/ha (Table 3). Primextra dose at 0.25 kg ai/ha, which had the highest weed density in both years at 8 WAT, reduced weed density by 83% and 29% when compared to the control in 2013 and 2014 respectively. At 12 WAT in 2013 there was no significant treatment effect on weed density (*P*=0.6667). However, at the same period in 2014, the Primextra doses significantly (*P*=0.0001) reduced weed density when compared with the control. Primextra doses did not differ on their effect on weed density. At 4 WAT in the planting seasons of both years, all Primextra doses were significantly superior to the control treatment in reducing weed biomass. All the Primextra doses had similar efficacy in reducing weed biomass in 2013, planting season (Table 4). However, in 2014, planting season all Primextra doses except 1.25 kg ai/ha were significantly superior to 0.25 kg ai/ha in reducing weed biomass. The effect of Primextra doses caused about 56.3 % weed biomass reduction during the 2013 planting season compared to the control. While similar effect in 2014 planting season accounted for about 85.4 % weed biomass reduction. Biomass reduction at 8 WAT followed similar trend in the planting seasons of both years. In the planting seasons of both years, Primextra doses significantly reduced weed biomass (Table 4). When compared to the control without Primextra. Averaged over Primextra doses and compared to the control, weed biomass reduction was about 50.5 % and 50.7% in 2013 and 2014 planting seasons respectively. At 12 WAT in the planting season of both years, treatment did not differ significantly in their effect on weed biomass. The weeded control and the Primextra doses had similar effect on weed biomass (*P*>0.05) (Table 4).

Table 3: Effect of treatments on weed density

Treatments	Weed density no./m^2					
	2013			2014		
	4 WAP	8 WAP	12 WAP	4 WAP	8 WAP	12 WAP
PrimextraGold-0.25 kg ai/ha	0 (1.00)	3 (1.55)	32 (5.65)	26 (5.11)	17(4.19)	11(3.32)
PrimextraGold-0.50 kg ai/ha	5 (1.74)	0 (1.00)	29 (5.38)	1 7 (4.18)	12(3.52)	9(3.11)
PrimextraGold-0.75 kg ai/ha	0 (1.00)	0 (1.00)	39 (6.30)	17 (4.19)	15(3.97)	9(3.02)
PrimextraGold-1.00 kg ai/ha	0 (1.00)	0 (1.00)	33 (5.77)	19 (4.41)	16(4.02)	11(3.41)
PrimextraGold-1.25 kg ai/ha	0 (1.00)	0 (1.00)	37 (6.09)	15 (3.92)	16(4.06	11(3.37)
PrimextraGold-1.50 kg ai/ha	0 (1.00)	0 (1.00)	32.(5.68)	14 (3.74)	13(3.57)	9(3.08)
PrimextraGold-1.98kg ai/ha	0 (1.00)	0 (1.00)	35.3(5.97)	10 (3.24)	11(3.38)	8(2.94)
Untreated control	44 (6.27)	56 (7.05)	41.3(6.44)	51 (7.18)	46(6.78)	20(4.49)
LSD (@5%)	**22.6(2.05)**	**1.58**	**1.87(1.27)**	**6.96(0.88)**	**6.23(0.75)**	**4.12(0.53)**

Means in the same column followed by the same alphabet are not significantly different at 5% level of probability according to LSD Test. Figures in parenthesis are square root transformed means $(x+0.5)^{½}$

Table 4: Effect of treatments on weed biomass

Treatments	Weed biomass gram/m^2					
	2013			2014		
	4 WAP	8 WAP	12 WAP	4 WAP	8 WAP	12 WAP
PrimextraGold-0.25 kg ai/ha	0.00	0.00	2.67	24.18	96.53	39.64
PrimextraGold-0.50 kg ai/ha	0.53	0.00	4.13	4.44	55.28	52.98
PrimextraGold-0.75 kg ai/ha	0.00	0.00	3.03	6.93	63.29	26.84
PrimextraGold-1.00 kg ai/ha	0.000	0.00	3.60	5.69	63.31	118.58
PrimextraGold-1.25 kg ai/ha	0.00	0.00	4.73	10.84	62.40	52.27
PrimextraGold-1.50 kg ai/ha	0.00	0.00	3.47	3.20	29.87	19.38
PrimextraGold-1.98kg ai/ha	0.00	0.73	3.41	2.84	53.33	62.40
Untreated control	4.49	3.47	3.43	335.28[a]	213.69	164.27
LSD (@5%)	**1.49**	**1.17**	**1.622**	**25.44**	**71.43**	**78.66**

Means in the same column followed by the same alphabet are not significantly different at 5% level of probability according to LSD Test

Effect of treatment on melon and weed ground cover: In the planting seasons of both years melon ground cover was generally low, however, percentage ground cover was higher in 2013 planting season than in 2014 planting season (Table 5). In 2013, the highest melon ground cover of 34% was recorded with the control treatment and this was significantly different from the rest of the treatments (*P*=0.0001) (Table 5). Primextra doses of 0.25 and 0.50 kg ai/ha recorded between 18 and 20% ground cover respectively, while Primextra doses of between 0.75 and 1.98 kg ai/ha recorded between 5 and 11% ground cover (Table 5). The trend was variable in 2014 planting season, as all Primextra doses except dose of 1,50 and 1.98 kg ai/ha recorded higher melon ground cover than the control but the differences were not significant (*P*=0.2473). Primextra doses 1.50 – 1.98 kg ai/ha reduced melon ground in 2014 planting season by 96% and 95% when compared to the mean effect of 0.25 – 1.25 kg ai/ha doses and the control treatment respectively. Averaged over the years, treatment effect on melon ground cover was as follows: control plot (21.2%0)> 0.25 kg ai/ha (18.2%) > 0.5 kg ai/ha (17.1%) >0.75 kg ai/ha (10.5%) >1.0 - 1.25 kg ai/ha (9.7%) > 1.50 – 1.98 kg ai/ha (3.0%) (Table 5). In the planting seasons of both years, weed ground cover was significantly higher in the control treatment than in the Primextra treated plots (*P* < 0.05) (Table 5). Control plots in 2013 planting season, had a significantly (*P*=0.0075) higher weed ground cover than the Primextra treatments. The Primextra doses did not differ significantly on their effect in reducing weed ground cover, however Primextra dose of 0.25 kg ai/ha had the highest weed ground cover among the herbicide treatments. Weed ground cover in 2014 planting season was significantly (*P<0.0001*) lower in the plot that received 1.98 kg ai/ha of Primextra than in plots treated with Primextra rates between 0.25 – 1.00 kg ai/ha (Table 5). There were no significant weed ground cover differences among Primextra doses of between 1.25 and 1.98 kg ai/ha. Primextra doses of between 0.25 and 1.00 kg ai/ha had similar effect on weed cover but 1.25 kg ai/ha was superior to 0.25 kg ai/ha in lowering weed ground cover (Table 5).

Table 5. Effect of treatments on melon and weed ground cover at 10 WAP

Herbicide treatments	**2013**		**2014**	
	Melon cover	**Weed cover**	**Melon cover**	**Weed cover**
	------------------------------------(%)---			
Primextra -Gold -0.25 kg ai/ha	22.6 (4.62)	3.66 (1.94)	13.75 (3.69)	16.67 (4.14)
Primextra- Gold 0.50 kg ai/ha	18.33 (4.33)	3.00 (1.72)	15.83 (3.46)	13.33 (3.70)
Primextra -Gold 0.75 kg ai/ha	11.33 (3.43)	2.00 (1.47)	9.58 (3.12)	13.33 (3.71)
Primextra- Gold 1.00 kg ai/ha	10.30 (3.28)	0.33 (0.88)	9.17 (2.66)	14.17 (3.82)
Primextra Gold 1.25 kg ai/ha	9.00 (3.03)	1.66 (1.25)	10.42 (2.98)	8.73 (3.04)
Primextra-Gold 1.50 kg ai/ha	5.60 (2.43)	0.66 (0.99)	0.83 (1.05)	7.50 (2.69)
Primextra- Gold 1.98kg ai/ha	6.30 (2.61)	1.00 (1.17)	0.00 (0.71)	2.92 (1.89)
Untreated control	34.0 (5.86)	8.33 (2.93)	8.33 (2.86)	76.67 (8.78)
LSD (@5%)	9.10 (**0.899**)	3.66 (0.974)	**13.84** (2.29)	**6.91** (0.869)

Means followed by the same alphabet are not significantly different at 5% level of probability according to LSD Test. Figures in parentheses are arcsine transformed means

Effect of treatments on melon flowering: At 5 WAP in 2013 planting season, melon flowering was significantly reduced (≥ 95 %) by the Primextra when averaged over doses and compared to the untreated control (Table 6). All the Primextra doses had similar effect in inhibiting melon flowering, but doses range of 0.25 – 0.5 kg ai/ha had occasional flowering cover (Table 6). However, at 10 WAT in 2013 planting season, flowering in the control plot was higher than all Primextra doses except 1.25 kg ai/ha. All the Primextra doses had similar effect on flowering rate at 10WAT in 2013 planting season. Similarly @ 5WAT in 2014 planting season, Primextra rates of 1.50 to 1.98 kg ai/ha significantly reduced melon flowering compared to doses between 0.25 and 0.50 kg ai/ha. Control plot and Primextra doses of 0.25, 0.5, 0.75 and 1.0 kg ai/ha were not different in flowering rate (Table 6). Also at 5 WAT in 2014 planting season, control plots, Primextra dose at 0.75 – 1.98 kg ai/ha did not differ significantly in their effect on flowering. At 10 WAT in 2014 planting season, Primextra dose at 0.25 kg ai/ha had the highest number of flowering heads among all the treatments, and this was significantly higher than the rest of the Primextra doses, but not significantly different from the control (Table 6). Primextra doses of between 0.50 and 1.25 kg ai/ha had some flowering heads compared to doses between 1.50 and 1.98 kg ai/ha with little or no flower heads but the differences were not significant.

Table 6: Effect of Primextra doses on melon flowering at 5 and 10 WAP

	2013		**2014**	
Herbicide treatments	**5WAP**	**10 WAP**	**5WAP**	**10 WAP**
Primextra -Gold 0.25 kg ai/ha	**2.33 (1.24)**	**3.0 (1.41)**	**8.88 (2.97)**	**9.55 (3.03)**
Primextra- Gold 0.50 kg ai/ha	**2.33 (1.15)**	**0.30 (0.33)**	**7.99 (2.29)**	**4.22 (1.86)**
Primextra -Gold 0.75 kg ai/ha	**0.00 (0.00)**	**1.6 (1.049)**	**3.11 (1.37)**	**3.33 (1.77)**
Primextra –Gold 1.00 kg ai/ha	**0.33 (0.33)**	**2.33 (1.24)**	**2.67 (1.29)**	**2.89 (1.68)**
Primextra- Gold 1.25 kg ai/ha	**0.00 (0.00)**	**4.66 (2.16)**	**2.22 (1.09)**	**1.77 (1.09)**
Primextra –Gold 1.50 kg ai/ha	**0.00 (0.00)**	**1.66 (1.05)**	**0 (0.00)**	**0 (0.00)**
Primextra -Gold 1.98kg ai/ha	**0.00 (0.00)**	**1.33 (0.94)**	**0 (0.00**	**0 (0.00)**
Untreated control	**15.6 (3.86)**	**4.66 (2.09)**	**5.33 (2.29)**	**5.33 (2.26)**
LSD (@5%)	**5.52(1.27)**	**2.85 (1.45)**	**5.88 (1.88)**	**5.87 (1.16)**

Means followed by the same alphabet are not significantly different at 5% level of probability according to LSD Test. Figures in parentheses are arcsine transformed means

Effect of treatments on melon fruit and vine yield: In 2013 planting season, mean fruit number per hectare was significantly (*P*=0.0021) higher in the control plots compared to all the Primextra doses. Although the Primextra doses had variable effect on melon fruit number, but the doses did not differ significantly from each other (Table 7). However, in 2014 planting season, fruit number followed a definite pattern that was different from that of 2013 planting season. Primextra doses of 0.25 – 0.50 kg ai/ha in 2014 planting season, had a significantly (*P*=0.0003) higher fruit number than the rest of the treatments (Table 7). All the other Primextra doses except 1.98 kg ai/ha had higher fruit number than the control treatment, but the differences were not significant (*P* > 0.05). Melon fruit yield in 2013 planting season did not differ significantly among treatments. Primextra at 0.5 kg ai/ha recorded the highest fruit weight of 2.3 tons/ha followed by the control plot with about 2.0 tons/ha, and the least fruit weight was from the plot treated with 1.98 kg ai/ha (1.5 tons/ha) (Table 7). In 2014 planting season, except for 1.98 kg ai/ha, melon fruit yield did not differ significantly among treatments with the highest fruit weight of about 2.5 tons/ha recorded with Primextra at 1.0 kg ai/ha (Table 7). Primextra at 1.98 kg ai/ha did not produce any fruits in 2014 planting season. Except for Primextra at 1.98 kg ai/ha, mean fruit weight was higher in Primextra treated plots averaging 1519 kg/ha than in the control plot (370 kg/ha) in 2014 planting season. The Primextra doses did not differ significantly in their effect on melon fruit weight, except for 1.98 kg ai/ha, which had no fruit. Averaged over the Primextra doses melon fruit yield was 1.3 tons/ha and 1.5 tons/ha in 2013 and 2014 planting seasons respectively, while fruit yield in control plot was 2.2 tons/ha and 0.37 ton/ha in the respective planting seasons of each year. Averaged over the years and Primextra doses melon fruit yield had about 23.5 % (1659.4 kg/ha) yield advantage over the control plot (1269 kg/ha) (Table 7). Similarly, averaged over the years Primextra rates of 0.25 – 0.75 kg ai/ha had an average fruit yield of 1.95 tons /ha, 1.0 – 1.98 kg ai /ha had an average fruit yield of 1.43 tons /ha and Primextra rates of 1.50 – 1.98 kg ai/ha had an average fruit yield of 974 kg/ha (Table 7). In 2013, there was no significant vine weight differences between the control and the Primextra treatments, but vine weight were higher in control plot and Primextra doses of 0.25 – 1.0 kg ai/ha than in Primextra dose of 1.25 – 1.98 kg ai/ha (Table 7). The highest vine weight was recorded with 0.5 kg ai/ha Primextra (9.9 tons/ha) and the lowest with Primextra at 1.25 kg ai/ha (6.3 tons/ha) while the control plot recorded about 8.6 tons/ha of vines (Table 7). Similarly, in 2014 planting season, treatments did not exert any significant effect on vine yield except Primextra dose of 1.98 kg ai/ha, which significantly had no vine yield. Highest vine yield was recorded with Primextra dose at 0.5 kg ai/ha with about 185 tons/ha of vine. Primextra doses between 0.25 -0.75 kg ai/ha in 2014 had between 14.3% and 40% vine yield advantage over the control plot (Table 7).

Table 7: Effect of treatments on melon fruit and vine weight

	2013			**2014**		
Treatment	**Fruit (No.ha-1)**	**Vine weight (kg ha^{-1})**	**Fruit weight (kg ha^{-1})**	**Fruit** (No.**ha**$^{-1}$)	**Vine weight** (kg **ha**$^{-1}$)	**Fruit weight (kg ha^{-1})**
Primextra Gold -0.25 kg ai/ha	4167	9808	1583	19630	129629	2444
Primextra Gold 0.50 kg ai/ha	10000	7608	2333	15556	185185	2370
Primextra Gold 0.75 kg ai/ha	8254	7500	2214	6296	166666	815
Primextra Gold 1.00 kg ai/ha	4167	8208	1833	7407	92593	2519
Primextra Gold 1.25 kg ai/ha	11667	6250	1667	4074	37037	1556
Primextra Gold 1.50 kg ai/ha	3333	6958	1472	2222	74074	926
Primextra Gold 1.98kg ai/ha	6667	6400	1500	0	0	0
Untreated control	30833	8583	2167	3333	111111	370
LSD (@5%)	**11239**	**3104**	**2387.8**	**6900.7**	**152171**	**2180.5**

Means in the same column followed by the same alphabet are not significantly different at 5% level of probability according to LSD Test

DISCUSSION

Melon emergence in both seasons of 2013 and 2014 was variable with the treatments. On the average the lower rates of Primextra-Gold 0.25 kg ai/ha(0.38 L/ha) to 0.75 kg ai/ha (1.14 L/ha) had emergence consistent with the effect of rates in both planting seasons of 2013 and 2014, and this was ≥ 50 % in 2013 season and ≥ 70 % in 2014 season when compared with the untreated control (Table 2). The higher rates of Primextra-Gold 1.0 kg ai/ha (1.5 L/ha) to 1.98 kg ai/ha (3 L/ha) had emergence which was not consistent with effect of rates in both seasons of 2013 and 2014, and this averaged 40 % in 2013 season and 29 % in 2014 in season when compared with the untreated control (Table 2). With the observed rate of emergence with the lower rates of Primextra-Gold 0.25 kg ai/ha (0.38 L/ha) to 0.75 kg ai/ha (1.14 L/ha), it is clear *egusi*-melon tolerated this dose range of Primextra-Gold. Primextra-Gold at 0.25 kg ai/ha had emergence rate that was comparable to the untreated control in both seasons of 2013 and 2014 being evidence that, that rate may be less phytotoxic for potential integration in cropping systems involving melon. Melon seedling height exhibited the same pattern observed with emergence, indicating tolerance with rates 0.25 kg ai/ha to 0.75 kg ai /ha. Various researchers working on melons have reported different tolerance level of melons to herbicides, as well as decrease in the tolerant level of melons as herbicide rates doubled (Sosnokie *et al*., 2004). Weed density was generally lower in 2013 planting season than in 2014 planting season between 4 and 8 WAP. This may be due to weed seed bank diversity or weed flora differences of the sites where the experiment was conducted, as well as the different planting seasons. This may also be linked to the infestation size of the different sites, previous cultural and weed management practices as well as local environmental conditions of the sites during the trial. The prevalent climatic conditions of the two trials were different, and this may affect have a great influence on the result. This similar observation and probable reasons are widely reported in literature (Udensi *et al*., 2015; Davis *et al*., 2005; Cardina *et al*., 2002; Menalled *et. al*., 2001). Weed dry matter followed the trend observed with weed density in both years. This is also a reflection of weed flora differences as mentioned above, in addition to some late emerging weeds that were not controlled. Since weed dry matter increased between 4 WAT and 12 WAT by a value ≥ 90 % in both seasons to a level where some treated plots had dry matter similarity with the untreated control (Table 4), it may have been that, weeds that were poorly or initially not controlled by these rates, as well as late emerging weeds had caused the increases. Similarly, attributes and results on weed control have been reported (Udensi *et al.,* 2015; Chikoye *et al*., 2005). It is also possible that at 4 WAT some of the weeds that escaped control either due to weed seed dormancy or any other physiological changes germinated after the herbicides efficacy had reduced. Sosnoskie *et al*., 2014, reported that pre-emergence herbicides are only active against newly germinated seedlings that are emerging from or through the chemical barrier. Apart from treatment effect, melon establishment was poor in both seasons of 2013 and 2014 due to late planting, hence the poor ground cover and even 100% melon ground cover was not possible. In planting seasons of both years, melon ground cover was better with the untreated control and the lower rates of Primextra-Gold 0.25 kg ai/ha up to 1.0 kg ai/ha. There is evidence that the higher rates of Primextra affected the melon ground cover. The melon ground cover recorded with the untreated control is evidence that there was inhibition of growth of melon by higher rates. Similarly, the melon and weed ground cover recorded with the lower rates of the herbicides and the untreated controls indicated that there were both melon tolerance, weed control achievement by the low rates, as well as the evidence of growth inhibition of melon by the higher rates, and weed competition effect. Thus, the low melon ground cover in the untreated control may in addition be attributed to weed completion effect with the melon. This corroborated the work of Masiunas and Weller (1989), that uncontrollable weed can compete and restrict the growth of muskmelon. The higher weed coverage and lower melon ground cover in the untreated control in 2014 planting season compared to the melon and weed ground cover with the lower herbicides rates is also an indication that weed competition was the restricting factor for melon growth in the untreated control. Similarly, the lower weed ground cover with the herbicide rates in comparison with the untreated control is an indication of the efficacy these herbicides even at low rates. The high weed ground cover observed in 2014 season compared to 2013 season also may be due to insufficient weed control as a result of little rainfall during the period of this trial (September to December, 2014). Rainfall however, must be adequate to achieve acceptable weed control, as insufficient rain limits herbicide movement in the soil, resulting in poor weed control (Monaco and Skroch, 1980). Primextra dose had a variable effect on fruit number in 2013 planting season, which did not reflect a systematic herbicide dose response in terms of reduced fruit number with higher doses of herbicide. However, in 2014 planting season, there was a definite pattern of increased dose response by melon. Our result if aggregated over the planting seasons of both years, will agree with Boyhan *et al.*, 1995 that melon fruit number reduced with increased rate of herbicide application; and if considered by the season each year, fruit number in 2013 may conflict with their result. However, it is possible that variety and herbicide type as well as local environment and season of planting may influence result. The absence of fruits in some of the herbicide treatments is consistent with the stand and cover reduction observed in some of the treatments. The low fruit yield observed in the untreated control plot irrespective of high vine weight may be due to weeds that emerged after the vine, which were not weeded. This result agrees with the respective results of Timothy *et al.*, 2000 and Menges *et al.*, 1973). In the planting seasons of both years melon fruit weight reduced with increasing Primextra rate, indicating reduced tolerance at increased herbicide dose. This result corroborates the of Boyhan *et al.*, 1995 that melon fruit weight reduced with increasing rate of the herbicide Clomazone. The variability and inconsistency in herbicide dose effect on melon in 2013 season may be due to high rainfall during the trial, which was between April and August, in 2013 as against 2014 trial, which was between September and December 2014. Similar variability in response to herbicide by watermelon is reported (Timothy *et al.*, 2000). Though we observed that for all herbicide rates there were initial bleaching and stunting, however, which was transient to a greater extent especially for the lower rates 0.25 kg ai/ha to 1.25 kg ai/ha. Similar results with other melon families had been reported with other herbicides (Timothy *et al.*, 2000). Melon tolerated Primextra doses of 0.25 – 1.25 kg ai/ha more than 1.50 – 1.98 kg ai/ha doses. However, tolerance level or sensitivity of melon to herbicides may vary with particular melon family (Cucurbitaceae) and dosage. Sosnoskie *et al.*, 2014, reported that cantaloupe in the same melon family tolerated Pendimethalin, Metolachlor, and others not mentioned, but were injured by Linuron and up to 100% crop loss when the rates were doubled. Song *et al.*, 2006, reported that sensitivity or tolerance of cucurbits might vary with cultivar. It is also known that cucurbits are injured by herbicides (Kupatt *et al.*, 1983; Monaco and Skroch, 1980) and, the susceptibility to the herbicides may vary depending on the species (Umeda and Ken, 2002; Bottenberg and Masiunas, 1997; Barth *et al.*, 1995; Frost *et al.*, 1983).

CONCLUSION

This study observed that melon could tolerate certain rates of Primextra-Gold, after the initial injury; and Primextra-Gold rates between 0.25 kg ai/ha to 1.00 kg ai /ha may be tolerable to seeded melon. The implication of this result is that melon may find a tolerable dose of Primextra-Gold for integration in maize-melon cropping systems. This level of tolerance if consistent over a wide range of ecologies in the seasons can be used in cultivation practice especially in an intercrop with maize or other crops of great tolerance or labelled for Primextra-Gold use. This is because weed control in melon is difficult due to the nature of vine coverage of the crop, which can prohibit mechanical cultivation, as well as the unavailability of safe and selective herbicides, particularly for the control of broadleaf species in melon.

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