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Research paper

Chemical Weed Control in Okra (*Abelmeschus esculentus* L. Moench) in Dongola Locality-Northern State-Sudan

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ABSTRACT

The herbicides experiment was conducted for two consecutive summer seasons (2014, 2015) at Altraa village, Sharg Elneel Unit, Dongola Locality, Northern State – Sudan, located within latitude 16° and 22° N and longitude 20° and 32° E., to determine fresh pod yield loss due to weed competition and to evaluate and compare the effects of Fusilade applied as post-emergence at 0.7, 1.1, 1.3 and 1.5 l/fed and glyphosate applied pre-emergence at 0.3, 0.4, 0.5 and 0.6 l/fed and applied post-emergence at the same rates. Results obtained from this experiment indicated that, unrestricted weed growth significantly reduced fresh pod yield (kg/fed) by 67.40% in both summer seasons. Results also showed that, Fusilade herbicide was the best in controlling Graminae weeds while Glyphosate herbicide was the best in controlling broad-leaved weeds in both summer seasons. Further, among the two herbicides treatments the best weed control was achieved by Glyphosate which applied post-emergence at 0.6 l/fed while Fusilade at 1.5l/fed treatment applied post-emergence gave higher fresh pod yield in both summer seasons. The use of the two herbicides treatments reduced significantly weed biomass (g/m^2).

Keywords: Broad-leaved weeds, Graminae, herbicides, weed free

المكافحة الكيميائية للحشائش في البامية (*Abelmeschus esculentus* (L.) Moench)

بمحلية دنقلا-الولاية الشمالية-السودان

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أجريت تجربة مبيدات الحشائش لموسمين صيفيين متعاقبين 2014 و 2015م بقرية الترعة– وحدة شرق النيل– محلية دنقلا – الولاية الشمالية – السودان، الواقعة بين خطى عرض'2 16^0 شمال وخطى طول '20 32^0 شرق لتحديد الفقد في إنتاجية القرون الرطبة الناجم من منافسة الحشائش ولتقييم ومقارنة تأثيرات الفيوزيليد المستخدم بعد الانبثاق بمعدل 0.7، 1.1، 1.3 و1,5 لتر للفدان والجلايفوسيت المستخدم قبل الانبثاق بمعدل 0.3، 0.4، 0.5، و0.6 لتر للفدان وبعد الانبثاق بنفس المعدلات. أشارت النتائج المتحصلة من هذه التجربة إلى أن النمو غير المحدود للحشائش قلل معنوياً إنتاجية القرون الرطبة (كجم /فدان) ب 67.40% في الموسمين الصيفين. أوضحت النتائج المتحصلة من هذه التجربة أن مبيد الحشائش فيوزيليد كان أفضل في مكافحة الحشائش النجيلية بينما مبيد الحشائش جلايفوسيت كان أفضل في مكافحة الحشائش عريضة الأوراق في الموسمين الصيفيين. أيضاً أوضحت النتائج المتحصلة من هذه التجربة أن من بين معاملات مبيدي الحشائش، جلايفوسيت المستعمل بعد الانبثاق بمعدل 0.6 لتر/فدان أنجز أفضل مكافحة للحشائش بينما فيوزيليد المستعمل بعد الانبثاق بمعدل 1.5 لتر/فدان أعطى اعلى إنتاجية للقرون الرطبة في الموسمين الصيفيين. استخدام معاملات مبيدي الحشائش قلل معنوياً الوزن الجاف للحشائش بالجم في المتر المربع.

كلمات مفتاحية: الحشائش ذات الاوراق العريضة، النجيليات، مبيدات حشائش، خالية من الحشائش

Introduction

Okra (*Abelmeschus e*sculentus (L) Moench), sometimes called Gumbo, is a tall, handsome, tropical annual plant with a much branched coarse stem that grows to a height of three feet and produce large-petaled flowers and long slender, pointed seed pods (Victor, 1973). It is one of the most important and popular vegetables grown in the Sudan and the world. It is a member of the plant family Malvaceae cultivated in Sudan, it is ranking third after onion and tomato with annual average area and yield of 58014 feddans and 291376 tons, respectively. It grows well under irrigation and rain-fed area, in most parts of the country (Ahmmed, 2007 and Ali, 2012). It is grown mainly for its green pods which are used as vegetable, fresh canned cooked with meat (Weika) making a favorable and popular dish by most Sudanese (Umrogaiga and Tagalia), or conserved by drying and grinding into powder. The leaves are also cooked in many areas. It is a typical food in combination with sorghum bread (Kisra). The seeds, roasted and ground to powder are used as a substitute of coffee. Okra is used principally in soups and stews. It is grown in the tropical and subtropical area, almost in all parts of the country. It's main producing countries are India, Nigeria, Pakistan and Ghiana, where India at the top with a total production of 3,550,000 metric tons (FAO, 2004). The world production of okra as fresh fruit vegetable is estimated at 6 million tons per hectare (Lyagba *et al.*, 2012).

One of the main problems that affect yield and quality of okra vegetable is weed interference and their competition with the crop. Weeds in okra must be controlled (Imoloame, 2013). In developing countries manual weeding is the most common method of weed control but in many instances the available labor is unable to remove weeds from vast areas of land during critical periods, thus, the use of herbicides is a necessity (Elamin, 1991; Abdel Rasoul, 1998 and Abdel Marouf, 2004). Herbicides play a major role in controlling weeds in crop production. They constitute a new and highly efficient technique for controlling weeds, increasing yield, improving quality and reducing labor in crop production (Yousif, 2002 and Abdel Marouf, 2004).

In Sudan okra vegetable received little attention with inadequate information is especially in area of weed control. Thus, this study was conducted to assess the magnitude of fresh pod yield losses in okra due to weed infestation and to evaluate the

efficacy of a pre and post-emergence herbicides namely, Glyphosate and Fusilade on weed control, tolerance and yield of okra.

Materials and Methods

An experiment was conducted during two consecutive summer seasons of the years 2014 and 2015 at Altra - Dongola locality-Northern State-Sudan. The area is located within latitudes 16° and 22° N, and longitude 20° and 32° E. (Osman, 2004). Dongola locality is a true desert and characterized by extremely high temperatures and radiation in summer, low temperature in winter, scarce rainfall and high wind speed. The mean maximum and minimum temperatures are 36.8 and 19.5°C, respectively. The climate is hyper arid with a vapor pressure of only 10.8 mb and a relative humidity of less than 20% (Osman, 2004). The soil in the experimental site is a sandy clay loam, with 57.34% sand, 19.83% silt and 22.50% clay (Damirgi and Al-agidi, 1982). The herbicides treatments were: phloaziaphop-p-putyle as Fusilade (150g) Ec, applied post-emergence at 0.7, 1.1, 1.3 and 1.5 litre/fed. (1 fed= 0.42ha); Glyphosate as Touchdown 41% Ec, applied pre-emergence at 0.3, 0.4, 0.5 and 0.6 litre/fed, and post-emergence at 0.3, 0.4, 0.5 and 0.6 litre /fed.

Weedy and weed-free treatments were included for comparison. Pre-emergence herbicides were applied, immediately after sowing, with a knapsack sprayer at a volume rate of 80 liters per feddan, application of the pre-emergence herbicides was followed by irrigation while the post-emergence herbicides were applied at 4 weeks after crop sowing. Treatments were arranged in a randomized block design with four replications. In each season the experimental site was ploughed, harrowed, leveled and divided into 3x3.5 m plots. Each plot was made of five rows. Okra, variety Khartuomia was planted by hand in rows on flat, three seeds/hole in rows 70 cm a part and 25 cm between holes, on 23 February for both summer seasons. The seedlings were later thinned to two plants per hole, to give a population of approximately 48000 plants per feddan. Nitrogen fertilizer, as urea, was applied at a rate of 2 N (80lb of nitrogen/fed (halve the dose after 2 weeks from sowing and the other halve after 4 weeks from the first dose). In the weed free treatment, weeds were removed frequently by repeated hand weeding to keep the crop free from weeds up to harvest. However, in the weedy treatment, weeds were left

to grow, unrestrictedly, with the crop until harvest. Visual observations of phytotoxicity of the herbicides treatments on the crop were assessed periodically. However, Glyphosate treatments which applied post - emergence at 0.4, 0.5 and 0.6 l/fed were toxic to the okra crop.

The effect of treatments on weeds was assessed by counting the individual weed species at 4 weeks after herbicides application. This was done by randomly placing 1x1m quadrate in each plot. Weeds inside each quadrate were identified and individual weed species counted. The percentage control of grassy and broad-leaved weeds, as compared with the un-weeded control, for each treatment was calculated. Weed species and their dry weights were also determined at ten weeks after sowing. Ten plants were randomly selected from the three inner rows in each plot to determine plant height (cm), number of branches/plant, number of leaves/plant, leaf area index and shoot dry weight (g)/plant. At each picking, ten plants were randomly selected in each plot to determine mean number of pods/plant and mean fresh pod yield (kg/fed). Two rows in each plot were left unpicked until harvest, ten plants were randomly selected in each plot from those rows left unpicked, their pods were cut and threshed in bulk to determine number of seeds/pod and 100 seed weight (g) (Baada, 1995).

Yield data were analyzed by the analysis of variance, and means were separated by the Duncan's Multiple Rang Test. Combined analysis was done for the data of the two seasons.

Results and Discussion

Visual observations showed that, Glyphosate treatments which applied post- emergence at 0.4, 0.5 and 0.6 l/fed were toxic to the okra crop. Okra plants were attacked by aphids in both summer seasons which controlled by Folimat. The infection by aphids was heavy in the first summer season. The weed flora in the experimental site consisted of grassy and broad-leaved weeds. In both summer seasons broad-leaved weeds were predominant. The same result was found by Mohamed and Elamin (2012). The dominant weed species were:

The combined analysis of both summer seasons, showed that, Fusilade treatments at 0.7, 1.1, 1.3 and 1.5 l.a.i/fed significantly decreased weed biomass (g/m^2)

as compared to the weedy full season treatment (Table 1). Fusilade herbicide was the best between the two herbicides used which gave the lowest dry weight of weeds. These findings are in line with those obtained by Bhalla and Parmar (1986) and Bhalla and Parmar (1982).

The predominant weed species in the experimental site

Chenopodium album (L.), *Malva parviflora* (L), *Convolvulus arvensis* (L.), *Amaranthus graecizanth parviflora*, *Sorghum arundinaceum, Gynandropsis gynandra* (L.) *Briq, Sinapis arvensis* (L.), *Tribulus terrestris* (L.), *Datura stramonium* (L.), *Cynodon dactylon* (L.) *Pers, Cyperus rotundus* (L.), *Eruca sativa*, *Portulaca oleracea* (L.), *Dactyloctenium aegyptium* (L.) *Beauv*., *Sporobolus pyramidatus* (Lam.) *Hitchc., Sonchus oleraceus* (L). *Hyoscyamus reticulates, Echinochloa colona* (L.) *Link, Tephrosia apollinea* (Del.), *Cassia italica* (Mill.) *Lam. Ex Steud, Calotropis procera* (Ait.) *Ait. f., Aerva javanica (Burm. f.), Rhynchosia memnonia (Del.) cooke and Lotus arabicus* (L).

The mean readings of both summer seasons confirmed that, Fusilade treatment which applied post-emergence at 0.7, 1.1, 1.3 and 1.5 l.a.i/fed achieved excellent control of Graminae weeds. However, Glyphosate treatments which applied pre-emergence at 0.3, 0.4, 0.5 and 0.6 l.a.i/fed gave moderate control of Graminae weeds while Glyphosate treatments at the same mentioned rates which applied post-emergence gave poor control of Graminae weeds (Table 1). Fusilade herbicide was the best between the two herbicides used which achieved effective control of Graminae weeds.

The mean results of both summer seasons indicated that, Fusilade treatments which applied post- emergence at 0.7, 1.1, 1.3 and 1.5 l/fed did not achieve any control of broad-leaved weeds. However, glyphosate treatments which applied pre and post-emergence gave poor to good control of broad leaved weeds, respectively (Table 1). Glyphosate was the best between the two herbicides used. Glyphosate herbicide at the rate of 0.6 l.a.i/fed was the best treatment among the treatments of the two herbicides used which achieved good control of broad leaved weeds while Fusilade treatment at 1.5 l.a.i./fed was the best between the treatments of the two herbicides used which gave the best fresh pod yield (kg/fed). Similar results were found by Covindra *et al*. (1982);

Tiwari *et al*. (1985); Kumar and Charanjit (1986) and Ramachandra-Boopathi *et al*. (1992).

Table (1): Effects of herbicides treatments on Graminae, broad leaved percentage weeds control and weed biomass during summer seasons (2014- 2015, combined)

Treatments	Herbicide rate kg a.i/fed	Percentage Graminae weed control	Percentage broad-leaved weed control	Weed biomass (g/m^2)
Fusilade post	0.7	89.39	0	47c
Fusilade post	1.1	92.18	0	41.5c
Fusilade post	1.3	92.21	0	45.5c
Fusilade post	1.5	91.39	0	43c
Glyphosate pre	0.3	53.36	18.98	71ab
Glyphosate pre	0.4	59.65	30.80	96.5a
Glyphosate pre	0.5	64.88	9.99	56bc
Glyphosate pre	0.6	63.69	21.33	71ab
Glyphosate post	0.3	45.07	46.52	74ab
Glyphosate post	0.4	33.73	52.84	75ab
Glyphosate post	0.5	44.79	54.1	61.25c
Glyphosate post	0.6	48.84	64.63	66ab
Weed free full	-	100	100	89.5ab
Weedy full	-	0.00	0	-
C.V%	-	-	0	44.79%
S.E%	-	-	0	15.0704

Treatment means in the same column with the same letters are not significantly different at p (0.05) according to Duncan's Multiple Range Test.

a.i = Active ingredient.

The combined analysis of both summer seasons (Table 2) showed that, Fusilade herbicide treatments at 0.7, 1.3 and 1.5l.a.i/fed and the weed free full season treatment significantly increased plant height (cm) as compared to the weedy full season treatment. These treatments of Fusilade herbicide gave plant height (cm) comparable to that obtained in the weed free full season treatment. Further, all herbicides treatments and the weed free full season treatment did not significantly increased number of branches/plant as compared to the weedy full season treatment. Furthermore, Fusilade herbicide treatments at 0.7, 1.1 and 1.5 l.a.i/fed and the weed free full season treatment significantly increased number of leaves/plant and leaf area index/m^2 as compared to the weedy full season treatment.

The combined analysis of both seasons showed that, the weed free full season treatment only significantly increased shoot dry weight (g/plant) as compared to the weedy full season treatment (Table 2). Similarly, Ramachandra-Boopathi *et al*. (1992) indicated that, okra growth

components were positively affected by herbicides treatments, growth components were significantly increased in treated plots as compared to the weedy full season treatment.

Table (2): Effects of herbicides treatments on okra vegetable growth components during summer seasons (2014, 2015, combined)

Treatments	Herbicide rate kg a.i/fed	Plant height (cm)	Number of branches/ plant	Number of leaves/ plant	Leaf area index (m^2)	Shoot dry weight (g)/plant
Fusilade post	0.7	86.8 ab	1.9abc	26.1 bc	8.8 bc	25.1 bc
Fusilade post	1.1	83.5 abc	2.4ab	26.5 bc	8.5 bc	32.0 bc
Fusilade post	1.3	86.4 ab	2.1abc	24.6 bcd	9.3 b	30.4 5bc
Fusilade post	1.5	84.7 ab	2.0abc	28.3 b	8.3 bc	39.4 ab
Glyphosate pre	0.3	65.0 de	1.8abc	18.5 e	5.8 cdef	21.2 bc
Glyphosate pre	0.4	80.8 bc	1.8abc	19.3 de	5.5 cdef	26.6 bc
Glyphosate pre	0.5	63.1 de	1.6bc	15.6 e	4.8 def	20.9 bc
Glyphosate pre	0.6	74.8 bcd	1.9abc	20.9 cde	7.0 bcde	27.0 bc
Glyphosate post	0.3	66.6 de	1.6bc	18.3 e	4.5 def	38.8 ab
Glyphosate post	0.4	62.6 de	1.6abc	17.4 e	4.3 ef	16.4 c
Glyphosate post	0.5	58.9 e	1.4c	17.4 e	3.8 ef	15.0 c
Glyphosate post	0.6	63.3 de	1.9abc	17.5 e	2.5 f	18.5 bc
Weed free	-	97.3 a	2.6a	43.3 a	16.8 a	55.4 a
Weedy	-	70.3 cde	1.9abc	20.de	7.8 bcd	24.6 bc
C.V%		17.28%	41.%	23.4%	30.0%	65.4 %
S.E%		6.4	0.3985	2.6	1.0 1	9.1

Means followed by the same letter (s) within each column do not differ significantly at p (0.05)
a.i = Active ingredient.

The combined analysis of both summer seasons showed that, the weed free full season treatment only significantly increased number of pods/plant and number of seeds/pod as compared to the weedy full season treatment (Table 3). Further, results indicated that, all herbicides treatments and the weed free full season treatment did not significantly increased 100 seed weight (g) as compared to the weedy full season treatment.

Further, the Fusilade treatments at 1.3 and 1.5 l.a.i/fed and the weed free full season treatment significantly increased fresh pod yield (kg/fed) as compared to the weedy full season treatment (Table 3). It is also indicated that, within the two herbicides the best fresh pod yield was achieved with Fusilade at 1.5 l.a.i/fed which applied post-emergence. These increases could be attributed to the use of herbicides treatments which suppressed weeds and freed okra to reach its potential growth parameters and hence reflected in an increased okra fresh pod yield. Further, these increases may be as a result of the beneficial effects of other cultural operations such as the fertilizer uptake. Similar results were obtained by Kumar and Charanjit (1986); Ramachandra-Boopathi *et al*. (1992) and Lyagba *et al*. (2012).

Table (3): Effect of herbicides treatments on okra vegetable fresh pod yield and its components during summer seasons (2014- 2015, combined)

Treatments	Herbicide rate kg a.i/fed	No. of pods/plant	No. of seeds/pod	100 seed weight (g)	Fresh pod yield (kg/fed)
Fusilade post	0.7	16.9 b	59.9 ab	6.0 a	2846bc
Fusilade post	1.1	15.9bc	60.6 ab	6.0 a	2131cd
Fusilade post	1.3	15.3 bcd	60.1 ab	5.8 a	2316c
Fusilade post	1.5	16.1 bc	59.0 ab	5.3 a	3193.b
Glyphosate pre	0.3	11.8 e	58.6 ab	6.0 a	1065e
Glyphosate pre	0.4	13.6 cde	60.3 ab	6.0 a	2059cd
Glyphosate pre	0.5	12.6 de	57.6 ab	5.8 a	1427de
Glyphosate pre	0.6	13.5 cde	59.5 ab	6.0 a	1298de
Glyphosate post	0.3	13.6 cde	52.5 bc	5.5 a	804e
Glyphosate post	0.4	13.1 de	53.6 bc	5.8 a	1053e
Glyphosate post	0.5	12.5 e	47.1 cd	5.8 a	740.e
Glyphosate post	0.6	13.0 de	45.6 d	5.8 a	761e
Weed free full	-	19.9 a	65.3 a	6.0 a	4199a
Weedy full	-	14.4 bcde	54.4 bc	5.3 a	1369de
C.V%	-	16.3 %	12.4%	12.0%	45.3%
S.E%	-	1.2 1	3.5	0.4	408.3

Means in the same column with the same letter(s) are not significantly different at p (0.05)
a.i = Active ingredient.

Conclusions

- The positive effect of herbicides on weed control lead to a significant increase in okra vegetable fresh pod yield (kg/fed). While, unrestricted weed growth significantly reduced fresh pod yield (kg/fed) by 67.40%.
- Within the two herbicides treatments, the best fresh pod yield (kg/fed) was achieved with Fusilade treatment at 1.5 l.a.i./fed.
- Among the two herbicides treatments, the best weed control was achieved in terms of total weed biomass reduction with Fusilade treatments at 0.7, 1.1, 1.3 and 1.5 l.a.i/fed.

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