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Effect of the Herbicides Oxyfluorofen and Pendimethalin on Weed Control, Growth and Yield of Common Bean (*Phaseolus vulgaris L*)

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Abstract

A field experiment was conducted at the Faculty of Agricultural Sciences Farm, at El Selaim, University of Dongola, Sudan during 2010/2011 and 2011/2012 seasons, to determine the magnitude of yield losses in common bean due to weed competition, and to evaluate the effects of two pre-emergence herbicides oxyfluorofen and pendimethalin. The results showed that unrestricted weed growth reduced common bean yield by 47.01 – 54.44%. All herbicides, irrespective of the rate used, had significantly reduced weed biomass compared to the weedy check. The herbicides were more effective in controlling grassy weeds. Pedimethalin effected 77.3 - 98.2% and 80.4 - 94.9% control of grassy weeds in 2010/2011 and 2011/2012 respectively. Oxyfluorofen control of grasses, on other hand, effected 68.9 to 96.5% and 74.9 to 96.4 in 2010/2011 and 2011/2012 respectively. Pedimethalin at 0.5 kg a.i /fed produced the minimum weed index of 0.8 and 18.91 and attained crop yield (997.32 and 1140.37 kg/fed) comparable to the weed free treatment.

Key Words: Common Bean, Weed Competition, Chemical weed Control**,** Yield losses.

Introduction

Common bean *(Phaseolus vulgaris L.)* is an important legume in human diet. Over 200 million people in sub-Saharan Africa depend on the crop as a primary stable food (Akibode, 2011). Common bean presents an important component of food crops consumed in Sudan and it considered a vital crop for achieving food and nutritional security for both producers and consumers (Mukhtar, 2012).The crop is extensively cultivated in Dongola, Northern State, Sudan, and rank second after faba bean (Khogali *et al*, 2007). Yield in Northern State is generally low; factors responsible for low common bean yield are many. Weed competition is of prime importance and uncontrolled weed populations can substantially reduce crop yield. Mukhtar (2012) reported that, in

Donola area, unrestricted weed growth reduced common bean yield by 57.98%. Malik *et al*., (1993)also pointed out that the reduction in yield of common bean due to weed infestation ranged between 24 – 74%. The traditional method for controlling weeds in common bean in Northern State is late hand weeding carried out voluntarily by farmers to collect fodder for their livestock. Hand weeding is labor intensive, tedious, laborious, time consuming and expensive. Yield losses caused by weed competition are mainly due to delayed weeding or insufficient weed control (Akibode, 2011). Chemical weed control in common bean in Northern State constitutes a new and highly efficient method for controlling weeds. Many researchers suggest chemical weed control in common bean fields. Aleksandra (2010) indicated that herbicides in common bean fields lead to excellent weed control and high crop yield. Chemical weed control in common bean in Northern State is receiving a great attention by using different herbicides. Therefore, the objective of this study was to determine the magnitude of yield losses due to weed competition and evaluate the effects of tow pre-emergence herbicides (oxyfluorofen 42% EC) and (pendimethalin 500 EC) in controlling weeds and effect on common bean growth and yield.

Materials and Methods

A field experiment was conducted during the winter seasons 2010/2011 and 2011/2012 at the Faculty of Agriculture Sciences Farm, El Selaim, Dongola University, Northern State, Sudan (Latitude 16° 22` N and Longitude 20° 32` E). The experimental site was ploughed, harrowed, leveled and divided into plots 3x2 m each plot was five rows. Common bean c.v (Baladi) was planted in holes on flat at three seeds per hole on 17th November in both seasons, seedlings were thinned later to one plant/hole, inter and intra row spacing was 60 cm and 10 cm respectively. The herbicides oxyfluorofen (42% EC) at 0.1, 0.2, 0.3, 0.4 and 0.5 kg a.i/fed, and Pendimethalin (500 EC) at 0.5, 0.6, 0.7 and 0.8 kg a.i /fed were applied as pre- emergence treatments. The herbicides were applied by knapsack sprayer equipped with a flood jet nozzle. The treatments were laid in randomized complete block design with four replications, a hand weeded and weedy controls were included for comparison. The irrigation was applied immediately after, herbicides spraying and then at 10 – 15 days according to weather conditions. Weeds were initially dried at room temperature for one week, and then transferred to a forced drought oven set at 70° for 48 hours. The effect of treatments on weeds were measured by counting individual weed species in 1m^2 quadrate at four weeks from sowing, type of weeds and their dry weight were also determined. Predominant weeds in the experimental sites were recorded. Eq1 was used to calculate weed control efficiency (WCE).

$$\text{Eq1} = (\text{WCE}) = \frac{\text{DWC} - \text{DWTx } 100}{\text{DWC}}$$

Where DWC= Dry weight of weeds from control plot.

DWT= Dry weight of weeds from treated plot.

Yield reduction due to weed competition,weed index, (WI) were measured by using Eq2.

Eq 2 = Weed index (WI) =

$$\frac{Average\ yield\ in\ weed\ free\ plot - Average\ yield\ in\ plot\ under\ treatment}{Average\ yield\ in\ weed\ free\ plot} x\ 100$$

At eight weeks after sowing ten plants selected randomly from the three inner rows, were used to measure crop plant height and number of leaves/plant. At harvest pods of ten randomly selected plants from each treatment were cut to record number of pods/ plant and number of seeds/pod, the same pods were windrowed to dry and threshed manually with hand sticks to determine 100 seeds weight and total grain yield. Data were subjected to analysis of variance and means were separated using Duncan's Multiple Range Test.

Results and Discussion

The predominant weed species in the experimental site were Branched Fenugreek (*Trigonella hamosa* L.), Common Caltrops (*Tribulus terrestris* L.), Cheese weed mallow (*Malva palviflora* L.), Smooth Sow Thistle (*Sonchus oleraceus* L.), White Pigweed (*Amaranthus graecizans* L.), Black Nightshade (*Solanum nigrum* L.), Fat Hen (*Chenopodium album* L.), Bermuda grass (*Cynodon dactylon* L Pers.), Water Grass (*Echinochloa colona* L. Link) and Wild Sorghum (*Sorghum arundinaceum*(Desv.)S). Visual observations showed that oxyfluorofen at 0.3, 0.4 and 0.5kg a.i/fed and pendimethalin at 0.7 and 0.8kg a.i/fed were toxic to common bean. They caused stunting during the early stages of growth. However, the symptoms disappeared and the crop partially recovered after six weeks from planting. In the experimental site Bermuda Grass (*Cynodon dactylon* L Pers.) has shown some tolerance as manifested by its appearance in the herbicides treated plots. All herbicides treatments, irrespective of rate used, had

significantly reduced weed biomass compared to untreated plots (Table 1). The lowest weed biomass ($3.3g/m^2$) in season 2010/2011 was recorded from plots treated with pendimethalin at 0.8 kg a.i /fed, while in season 2011/2012 the lowest weed biomass ($1.3g/m^2$) was obtained from plots treated with oxyfluorofen at 0.4 kg a.i /fed (Table 1). Oxyfluorofen weed control efficiency (WCI) ranged between 68.9% to 96.5% and 74.9% to 96.4% for grassy weeds in 2010/2011 and 2011/2012 seasons respectively, as for broadleaved weeds; oxyfluorofen gave a WCI of 14.9% to 77.8% and 20.6% to 70.4% in 2010/2011 and 2011/2012 seasons respectively. Pendimethalin WCI ranged between 77.3% to 98.25 and 80.4 to 94.8% for grassy weeds, and between 59.6 to 74.4% and 50.4 to 70.8% for broadleaved weeds in 2010/2011 and 2011/2012 seasons respectively (Table 1).

The two herbicides were more effective in controlling grassy weeds than broadleaved weeds. Similar results were reported by Khogali *et al.*, (2007). The tallest common bean plant (37.48cm and 29.80cm) and the largest number of leaves/ plant (47.9 and 50.20) in 2010/2011 and 2011/2012 seasons were recorded from plots kept weed free till harvest (Table 2). This might be a result of enhanced crop growth attributed to elimination of weed competition. These results closely match findings of Stefanic *et al.*,(2003) who reported that keeping common bean plants free of weeds caused a significant

increase in crop growth components. Herbicides treatments had no effect on common bean yield components, number of pods/plant and number of seeds/ pod in both seasons (Data not shown).

Table 1: Effect of herbicides treatments on weed biomass and weed control efficiency during 2010/2011 and 2011/2012 seasons

Treatments	Weed biomass (g/m^2)		Weed control efficiency (%)			
			Grasses		Broad leaved	
Oxyfluorofen	2010/2011	2011/2012	2010/2011	2011.2012	2010/2011	2011/2012
o.1 kg a.i /fed	11.8^{b}	12.3^{b}	68.9	74.9	14.9	20.6
o.2 kg a.i /fed	12.2^{b}	10.2^{bc}	93.1	89.6	52.5	60.2
0.3 kg a.i Kg/fed	11.6^{b}	10.5^{bc}	91.8	90.4	59.8	65.4
o.4 kg a.i /fed	8.5^{d}	1.3^{de}	95.2	95.6	65.1	69.8
0.5 kg a.i /fed	7.8^{d}	1.4^{de}	96.5	96.4	77.8	70.4
Pendimethalin						
0.5 kg a.i /fed	9.5^{c}	9.2^{bc}	77.3	80.4	59.6	50.4
0.6 kg a.i /fed	9.2^{c}	9.5^{bc}	89.7	87.5	59.6	57.6
0.7 kg a.i /fed	4.8^{e}	7.1^{bcd}	95.5	97.6	64.3	68.4
0.8k a.i /fed	3.3^{f}	4.5^{cde}	98.2	94.8	74.4	70.8
Weed free	0.0	0.0^{e}	100	100	100	100
Weedy	52.2^{a}	20.1^{a}	0.0	0.0	0.0	0.0
S.E±	6.3	2.1	-	-	-	-

Means followed by the same letter (s) within each column are not significantly differ at 5% level of probability according to Duncan's Multiple Range Test.

Table 2: Effect of herbicides treatments on common bean plant height and number of leaves/plant during 2010/2011 and 2011/2012 seasons

Treatments	Plant height (cm)		Number of leaves/plant	
Oxyfluorofen	2010/2011	2011/2012	2010/2011	2011/2012
o.1 kg a.i /fed	29.00^{ab}	22.81^{abc}	43.90^{ab}	30.28^{cd}
o.2 kg a.i /fed	19.90^{bc}	23.83^{abc}	40.60^{abc}	40.00^{bc}
0.3 kg a.i Kg/fed	19.95^{bc}	19.30^{bc}	41.10^{abc}	40.62^{ab}
o.4 kg a.i /fed	14.90^{c}	14.80^{c}	35.75^{bcd}	40.50^{ab}
0.5 kg a.i /fed	15.90^{c}	15.21^{c}	27.10^{de}	20.90^{cd}
Pendimethalin				
0.5 kg a.i /fed	2260^{bc}	19.40^{bc}	21.25^{e}	20.9^{cd}
0.6 kg a.i /fed	21.00^{bc}	19.80^{bc}	41.20^{abc}	40.40^{ab}
0.7 kg a.i /fed	21.60^{bc}	19.50^{bc}	29.61^{cde}	30.20^{cd}
0.8k a.i /fed	28.70^{ab}	24.22^{ab}	26.70^{de}	20.90^{d}
Weed free	37.48^{a}	29.80^{a}	47.90^{a}	50.20^{a}
Weedy	20.65^{bc}	16.82^{bc}	29.40^{cde}	20.90^{d}
S.E±	3.23	2.99	3.72	0.29

Means followed by the same letter (s) within each column are not significantly differ at 5% level of probability according to Duncan's Multiple Rang Test.

Weed free treatment produced the heaviest 100 seeds weight (26.30g and 30.70g) in 2010/2011 and 2011/2012 seasons respectively (Table 3). Pendimethalin, irrespective of rate used, resulted in significantly comparable 100 seeds weight to

weed free treatment in the first season (Table 3). Weed index (WI), which is a measure of yield reduction due to weed competition varied within herbicides treatments (Table 3). The highest WI was obtained from weedy check treatment 54.44% and 47.01% in 2010/2011 and 2011/2012 seasons respectively. This was due to competition by unchecked weed growth for nutrients, moisture and light as indicated by poor growth and yield components. These results are in accordance with Wilson(2005)who reported that weeds were strong competitors with common bean, reducing yield between 82 - 87%. The grain yield obtained from plots treated with pendimethalin, irrespective of rate, was significantly comparable to that of weed free treatment in both seasons (Table3). The lowest WI 0.08 - 18.91 was achieved by pendimethalin at 0.5 kg a.i /fed which showed consistently the maximum grain yield (997.32 and 1140.37 kg/fed) (Table 3). These results are in line with those of Mishra *et al*(1998) who reported that application of the herbicide pendimethalin decreased weed index and increased common bean yield components.

Table 3: Effect of herbicides treatments on common bean yield components during 2010/2011 and 2011/2012 seasons

Treatments	100 seeds weight(g)		Grain yield(kg/fed)		Weed index(%)	
Oxyfluorofen	2010/2011	2011/2012	2010/2011	2011/2012	2010/2011	2011/2012
o.1 kg a.i /fed	24.82 ^{ab}	21.20^{bc}	705.25 ^{ab}	860.40 ^{bc}	29.85	38.82
o.2 kg a.i /fed	23.30 ^{b}	21.60^{bc}	894.60 ^{ab}	797.90 ^{bc}	11.01	43.26
0.3 kg a.i/fed	25.43 ^{ab}	22.40^{bc}	550.05 ^{b}	674.20 ^{bc}	4529	52.06
o.4 kg a.i /fed	24.08 ^{ab}	22.30^{bc}	599.90 ^{b}	659.13 ^{bc}	40.33	53.13
0.5 kg a.i /fed	24.60 ^{ab}	22.10^{bc}	601.48 ^{b}	609.28 ^{bc}	40.17	56.78
Pendimethalin						
0.5 kg a.i /fed	27.30 ^{a}	21.30^{bc}	997.32 ^{a}	1140.37 ^{a}	.800	18.91
0.6 kg a.i /fed	26.30 ^{ab}	21.00^{bc}	980.40 ^{ab}	1122.62 ^{ab}	4.07	20.17
0.7 kg a.i /fed	24.75 ^{ab}	20.30^{bc}	829.32 ^{ab}	1026.02 ^{ab}	17.51	27.04
0.8k a.i /fed	25.10 ^{ab}	21.12^{bc}	801.72 ^{ab}	964.43 ^{ab}	20.25	30.29
Weed free	26.30 ^{ab}	30.70^{a}	1005.38 ^{a}	1406.37 ^{a}	0.00	0.00
Weedy	19.60 c	19.10^{c}	532.70 ^{b}	640.71 ^{b}	47.01	54.44
S.E±	1.20	1.10	12.90	10.20	-	-

Means followed by the same letter (s) within each column are not significantly differ at 5% level of probability according to Duncan's Multiple Range Test.

Conclusions

Weed competition in common bean in Dongola area Northern Sudan, is primarily responsible for crop yield reduction. Unrestricted weed growth reduced crop yield by 47.01 – 54.44%. The available evidence suggest that the use of the herbicide pendimethalin is likely to have be a crucial factor in reducing the effect of weeds in common bean fields. The perennial weed, Bermuda grass, is tolerant to both oxyfluorofen and pendimethalin. There is need for further studies relating to all weed control methods to establish the extent and significance of integrated weed management in common bean fields.

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تأثير مبيد اوكسيفلوروفن و بندايمثيل علي مكافحة الحشائش و نمو و إنتاجية الفاصوليا(*Paseolus vulgaris L.*)

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المستخلص

أجريت هذه التجربة بمزرعة كلية العلوم الزراعية بمنطقة السليم، جامعة دنقلا خلال الموسمين 2011/2010 و2012/2011 لتقدير الفاقد في إنتاجية محصول الفاصوليا الناتجة عن منافسة الحشائش وتقيم تأثير مبيد اوكسيفلوروفن و بندايمثيل علي مكافحة الحشائش و نمو وإنتاجية المحصول ، المبيدان استخدما قبل الإنبات، بالإضافة لمعاملة إزالة الحشائش طول الموسم و معاملة ترك الحشائش لمنافسة المحصول طول الموسم. أظهرت النتائج إن عدم مكافحة الحشائش أدي إلي نقص الإنتاجية بمعدل 47.01 – 54.44%. المبيدان، و بغض النظر عن التركيز المستخدم ،أديا لنقص معنوي في الوزن الجاف للحشائش مقارنة مع معاملة ترك الحشائش طول الموسم كما اظهرا فعالية أكثر في مكافحة الحشائش رفيعة الأوراق و التي تراوحت ما بين 77.3 – 98.2% و بين 80.4 – 94.4% للموسمين 2011/2010 و 2012/2011 علي التوالي لمبيد بندايمثيل، و ما بين 68.9 – 96.5% و بين 74.9 – 96.4% للموسمين 2011/2010 و2012/2011 علي التوالي لمبيد اوكسيفلوروفن. المبيد بندايمثيل بتركيز 0.5 كيلوجرام مادة فعالة للفدان كان الأكثر فعالية في التأثير علي الحشائش و أعطي إنتاجية متساوية معنويا مع إنتاجية معاملة إزالة الحشائش طول الموسم (997.32 و 1140.37) كيلوجرام للفدان للمواسم 2011/2010و 2012/2011 علي التوالي .