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Effect of Weed Control on Growth and Seed Production of Butterfly Pea (*Clitoria ternatea*) Under Rainfed Conditions at Zalingei Western Darfur State - Sudan

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ABSTRACT

A field experiment was conducted during the seasons of 2010/2011 in a semi- arid savannah zone, at the faculty of agriculture demonstration farm University of Zalingei two kilometers east of Zalingei town Western Darfur State. The aim of the experiment is to study the effect of weed control on growth and seed production of (*Clitoria ternatea*) under rainfed conditions. Four treatments viz.; No weeding (W_0), weeding once (W_1), weeding two times (W2), and weeding three times (W3) were randomly assigned to a randomized complete block design with four replicates for statistical analysis. Treatments studied include growth attributes (plant height, plant density, percent plant cover and leaf to stem ratio) and seed yield attributes which include: number of flower per plant, number of pods per plant, number of seeds per pod, hundred seed weight and total seed yield. Results indicated that weed control have a vital effect on Clitoria plants establishment especially during the early stages of growth. W_1, W2 and W_3 treatments significantly increased plant growth and seed yield attributes at different growth stages in relation to (W_0) treatment, while no differences were recorded between W2 and W_3 treatments for both growth and yield attributes. W_3 treatment significantly increased total yield resulted in high seed yield reached up to 687Kg/ha.

Keywords: *Butterfly pea, Weed management, Seed production*

1. INTRODUCTION

Sudan is rich in animal resources, estimated at 131.6million head, (48.00million sheep, 42 million goats, 3.3million camels and 38.3 million cattle) which equivalent to about 65 animal unit [1]. These large animal resources contribute very much to the national economy through foreign earnings .The huge animal population of the country is kept under traditional nomadic systems and transhumance; animals greatly depend on the natural vegetation as their source of feed for maintenance and production. The productivity and total production of the Sudan rangelands declined very much due to the successive drought spells, allotment of rangelands to rain fed agriculture , accidental fires and the over burden of the increased animal population in these rangeland where the stocking rate is far in excess of the stock carrying capacity [4]. Urbanization On the other hand was dramatically increased in the Sudan due to migration of rural inhabitants to big cities. Consequently, animal population increased around these cities which resulted in establishment of large numbers of dairy farms and fattening centers around (high demand for forage production) [3]. In order, to alleviate the pressure on rangeland, as well as to improve livestock production, it's necessary to encourage irrigated pasture production through providing pasture seeds of good quality to guarantee provision of adequate forage supply which represents possible and feasible short term solution to the current feed supply problem. This entailed the uses of improved cultural practices and high yielding varieties.

1.1 Butterfly Pea (Clitoria ternatea):

Butterfly pea (*Clitoria ternatea*) is a multi-purpose forage legume. The crop is originally selected as a cover crop, and widely planted as an ornamental on fence rows. Now the crop is used for short and medium-term pastures and as green manure, cover crop and protein bank. It increases soil fertility and improve yields of subsequent crops (maize, sorghum, wheat) when grown as green manure or ley- pasture. Also used for cut-and-carry and conserved as hay, this is making it suitable for goats in Sudan [11]. The crop is adaptable to a wide range of temperature, rainfall and altitude. Butterfly pea *(Clitoria ternatea*) is highly palatable forage legume and generally preferred by livestock over other legumes. It has thin stem and large leaves, nil bloat and non toxic which make it ideal for forage and hay making. Production and utilization of this legume for animal production will provide adequate nutrition and reduce grazing pressure on natural ranges. The crop exhibits excellent re-growth after cutting or grazing within short-period and produce high yields [9]. Clitoria can out yielded 1-15 t/ha/yr DM after four month growth. The levels of crude protein and crude fibre in the leaves were 21.5% and 21.5-29% respectively .Total plant protein ranges from 21.5-29%.Seeds contains25-38% protein 5%total sugar and 1% oil.

1.2 Impact of Noxious Weeds

A weed is any plant that requires some form of action to reduce its effect on the economy, the environment, human health and amenity. Weeds are one of the major threats to the natural environment. They are

destroying native habitats, threatening native plants and animals and choking our natural systems. The effects of weeds are well known, where crops are grown around the globe. If weeds are left uncontrolled they can seriously reduce crop yields [7]. Weeds reduce farm and forest productivity, they invade crops, smother pastures and in some cases can harm livestock. They aggressively compete for water, nutrients and sunlight, resulting in reduced crop yield and poor crop quality [16]. Weeds can also cause human health problems. Many common weeds such as Ragweed and Rye Grass cause asthma and other respiratory problems, especially in children. Some weeds can also cause skin irritation and some are poisonous. Some water weeds such as Water Hyacinth (*Eichhornia crassipes*) and Cabomba (*Cabomba caroliniana*) can affect the quality of our drinking water if infestations are not managed within water supply dams [8]. Farmers spend a large amount of time and money in managing weeds. Despite control efforts, recent researchers found that weeds were the most commonly reported natural resource management issue affecting landowners. In order to reduce the impact of weeds on crops, there is a need to understand the critical period of weed control. In the crop life cycle, there is a period when weeds should be removed in order to increase yield and there is also a period when the weeding does not rescue the crop [6]. This means that timing of weed control is very important and the length of period when the crop should be free of weeds is crucial. It has been demonstrated that weeding at two weeks after crop emergence could prevent crop yield loss in both smallholder and large scale commercial farms [13].

1.3 Weed Management Practices

Effective weed management practices include those that reduce the potential for weeds to adversely impact crop growth and yield. These practices often allow the crop to utilize all available resources necessary to achieve its yield potential. The most common weed management practices in agronomic crops include cultural, mechanical, and chemical approaches [18]. Cultural weed management practices allow the crop to become established without experiencing any negative effects of weed interference. Proper crop variety selection and planting date, adequate soil fertility and crop row spacing are examples of factors that can be manipulated to improve the competitive ability of the crop [19]. Mechanical weed management involves physical disturbance of the weeds, through activities including pulling weeds, tilling the soil before or after weeds emerge, and mowing. In chemical Weed Control, herbicides are often the primary tools of choice for weed management across most acres of the crop production areas [12].

2. MATERIALS AND METHODS

A field experiment was carried out at the Faculty of Agriculture demonstration farm University of Zalingei, 2km East of Zalingei town, Western Darfur state, during the (kharief) season of 2010/2011, to study the effect of weed control on growth and seed production of Butter fly pea (*Clitoria ternatea)*. The area site lies on the semi-arid Savannah zone, which is affected by the elevation of Jabel Marra Massif (rain and temperature). The soil of the area is loamy clay [5]. The climate is generally characterized by cold dry winds and hot rainy summers. The beginning of the rainy season is typical of the semi-arid savannah which is marked by great irregularity. The rainy season usually begins in the late June and extends to middle of October, with occasional limited shower in April- May and November. The annual rainfall varied from 400mm to 600 mm with bulk of more than 60% falling during July and August [14].

2.1 Treatments and Experimental Design

Apiece of land at the demonstration farm was used to conduct the experiment. It was first disc plowed, leveled and then the land was divided into four blocks (replicates) with four plots (4x4m) each. Four treatments were set these include; no weeding (W_0), weeding once (W_1), weeding two times (W_2) and weeding three times (W_3). The treatments were randomly assigned into a complete randomized block design (RCBD) with four replicates to make a total of 16 plots ($256m^2$).

2.2 Planting

Seeding of the site was carried out by Butter fly pea (*Clitoria ternatea)* seeds immediately after the rain showers on the first of July 2010 (in rows) at a rate of 5kg/fed, 2-3 seeds/ hole [20].

2.3 Weed Control

Weeding was carried out several times during the experimental period manually by using hands hoes to destroy the noxious weeds. First weeding was done after tow weeks from sowing, the subsequent weeding were done there after thirty days between each weeding.

2.4 Plant Density (population counts)

This includes the number of plants (shoots) per unit area. An area of one meter square (1x1 meter quadrate) was permanently marked in each treatment (middle of each plot) in which the number of shoots were counted. Counting was done three times according to the crop stages (seedling, flowering and at maturity).

2.5 Plant Height

To determine the average plant height, five plants were randomly marked in each treatment for measuring plant height; plant height was taken from the first node to the apical bud of the main stem axis. Then the mean of the five plants was obtained in cm.

2.6 Crop Coverage%

This parameter was measured visually two times (seedling and at flowering) as a percent for each plot in relation to the bare soil around.

2.7 Leaf to Stem Ratio (LSR)

Five plants from each experimental unit were selected, clipped, and portioned into leaves and stems, and air dried for 30 days until a constant weight was reached. The leaf to stem ratio was then expressed on dry weight basis.

2.8 Number of Flower Per Plant

Five plants were selected randomly from each experimental unit and tagged for counting the number of flowers per plant. The mean of the five plants was obtained and expressed as a number of flowers per plant.

2.9 Number of Pods Per Plant

Five plants were selected randomly from each treatment for counting the number pods per plant.

2.10 Number of Seeds Per Pod

The same five plants that selected for counting the number pods per plant were used for counting the number of seeds per pods. Mature pods were picked, threshed and the number of seeds for each pod was counted. The average number of seeds per pod was then recorded.

2.11 Total Seed Weight

Seed yield was determined when the crop was 70-80% mature and when pods turned into yellow colors. Mature pods were picked manually several times from each experimental unit. The harvested pods were collected in paper bags and air dried for 15 days. Seeds were then threshed manually and sieved. The pure cleaned seeds form each plot were weighed and the total seed production was expressed in kg/ha.

2.12 Hundred Seed Weight

A sample containing 100 seeds from the harvested seeds of each treatment were weighed and expressed in grams.

2.13 Statistical Analysis

The collected data from each experimental unit was subjected to analysis of variance (ANOVA) using Randomized Complete Block Design with four replications as described by [10]. Means were separated using Least Significant difference (L.S.D) range test values ($p \leq 0.05$) to test for significant differences among treatment means.

3. RESULTS

3.1 Effect of Treatment on Plant Growth and Yield Attributes

3.1.1 Plant Height

Weed control showed significant effect on plant height among the different treatments. However, W_2 significantly increased plant height in relation to other treatments (W_0, W_1 and W_3) at different stages of growth during the two growing season as shown in Table (1). On the other hand, There is no significant differences were recoded between the treatments W_2 and W_3 during the two growing seasons expect during the seedling and flowering stages of second season in which the treatment W_2 exceed that of treatment W_3, however, treatment W_1 showed better performance during the first season at seedling stage of growth among the other treatments (Table 1).

3.1.2 Plant Density

As shown in Table (2), weed control significantly influenced plant density at different growth stages during the two growing seasons, in which plots that received different weeding steps (W_1, W_2 and W_3) were significantly recorded higher population densities in relation to no weeding ones, except at the seedling stage of first season in which the W_1 treatment showed no significant effect on population counts.

3.1.3 Percent Plant Cover

Percent plant cover was improved as a result of weed control**.** At both seedling and flowering stages weeded plots significantly resulted in highest percent cover in which weeded plots of W_3 treatment gave the best results at seedling and flowering stage during the first and second season of growth in relation to W_0 and W_1 treatments. No significant differences were observed between the treatments (W2 and W_3) at flowering stage for the two growing seasons (Table, 3).

3.1.4 Leaf to Stem Ratio

The effect of treatments on Clitoria leaf to stem ratio was illustrated in Table (4) in which weed control was statically increased leaf to stem ratio at flowering stage of the first season. However, W_2 and W_3 were recoded the highest leaf to stem ratios among the other two treatments (W_0 and W_1**)** but no significant differences were recorded between the other treatments at different growth stages.

3.2 Seed Yield Production Attributes

As shown in Table (5) weed control measures significantly increased seed production attributes viz.; number of flowers per plant, number of pods per plant, hundred seed weight (grams) and total seed yield (kg /ha.), between different treatments for the two growing seasons. But weed control measures showed no significant effect on the number of seeds per pod, this attribute is not affected by such treatments because they genetically controlled and is parts of the plant characteristics. W_2 and W_3 treatments out yielded the highest seed production recording 652and 687kg/ha respectively in relation to the other two (W_0 and W_1) treatments during the first season. On the other hand, for the second season the total seed production was reduced by 87% although, there was significant increased in seed production as a result of different weeding treatments.

Table 1: Effect of weed control on Clitoria plant height

Growth stages	**Seedling stage**		**Flowering stage**		**Maturity stage**	
Treatments	First season	Second season	First season	Second season	First season	Second season
W_0	27b	69c	68.9b	95c	95.0b	101.8b
W_1	32.4a	62d	93.4a	104b	112.3a	158.8a
W_2	26.8b	88.5a	90.8a	114.8a	116.5a	159a
W_3	28.8b	79b	86.8a	108b	117.9a	154.3a
LSD	2.8*	6.2*	8.7*	4.8*	9.4*	6.2*
C.V%	12.31	23.3	12.9	13	10.6	12

Means followed by the same letter (s) within a given column are not significantly different at ($p<0.05$) level according to L.S.D range tests.

Keywords: W_0: No weeding W_1: weeding once. W_2: weeding two times. W_3: weeding three times.

Table 2: Effect of weed control on Clitoria plant density

Growth stages	**Seedling stage**		**Flowering stage**		**Maturity stage**	
Treatments	First season	Second season	First season	Second season	First season	Second season
W_0	4.5a	59c	4.9c	70d	5.34c	133.d
W_1	5.0a	130.5b	9.7b	140.5c	10.3b	198.3c
W_2	4.6a	161a	15.8a	196a	16.6a	273.8a
W_3	4.5a	173.5a	15.4a	183.5b	16.5a	257.8b
LSD	1.09ns	14.3*	1.93*	6.3*	2*	9.9*
C.V%	28.9	28.4	27.2	28.5	24.2	22.4

Means followed by the same letter (s) within a given column are not significantly different at ($p<0.05$) level according to L.S.D range tests.

Keywords: W_0: No weeding W_1: weeding once. W_2: weeding two times. W_3: weeding three times.

Table 3: Effect of weed control on Clitoria percentage cover

Growth stages	**Seedling stage**		**Flowering stage**	
Treatments	First season	Second season	First season	Second season
W_0	11.3c	43.8d	12.5b	52.5d
W_1	76.3a	72.5c	51.3a	90b
W_2	32.5b	77.5b	62.5a	83.8c
W_3	25.0b	82.5a	72.5a	98.8a
LSD	8.6*	4.2*	14*	5.1*
C.V%	29	17.2	36	18

Means followed by the same letter (s) within a given column are not significantly different at ($p<0.05$) level according to L.S.D range tests.

Keywords: W_0: No weeding W_1: weeding once. W_2: weeding two times. W_3: weeding three times.

Table 4: Effect of weed control on Clitoria leaf to stem ratio

Growth stages	**Flowering stage**		**Maturity stage**	
Treatments	First season	Second season	First season	Second season
W_0	1.6c	0.98a	2.3a	0.6a
W_1	1.6c	0.97a	2.0a	0.6a
W_2	1.9b	0.98a	2.0a	0.6a
W_3	2.2a	0.94a	2.0a	0.6a
LSD	0.21*	0.28ns	0.2ns	0.1ns
C.V%	15	12.3	12	22.4

Means followed by the same letter (s) within a given column are not significantly different at ($p<0.05$) level according to L.S.D range tests.

Keywords: W_0: No weeding W_1: weeding once. W_2: weeding two times. W_3: weeding three times.

Table 5: Effect of weed control on Clitoria yield attributes

Growth stages	No. of flowers/ plant		No. of pods/plant		No. of seeds/pods		100seed weight Gms.		Total yield Kg/ha	
Treatments	First season	Second season	First season	Second season	First season	Second season	First season	Second season	First season	Second season
W_0	37.5c	13.6c	11.3d	5.8b	7.6a	4.9a	3.7c	4.03a	100d	46.2b
W_1	78.8b	52.2b	16.8c	6.0b	7.7a	8.5a	3.7c	4.23a	396c	48.6b
W_2	95.3a	63.9a	37a	6.0b	7.7a	22.4a	3.95b	4.23a	652b	57.5b
W_3	102a	64.7a	26.5b	7.0a	7.6a	24.3a	4.0a	4.08a	687a	79.8a
LSD	8.3*	7.52*	10.4*	0.15*	0.63ns	24.5ns	0.03*	0.1ns	111*	17.1*
C.V%	29.9	12	21.4	6.6	10	36	5	6.7	30	29.9

Means followed by the same letter (s) within a given column are not significantly different at ($p<0.05$) level according to L.S.D range tests.

Keywords: W_0: No weeding W_1: weeding once. W_2: weeding two times. W_3: weeding three times.

4. DISCUSSION

4.1 Effect of Treatments on Plant Growth and Seed Yield Attributes

Generally weed control improve growth and yield attributes of Butterfly pea *(Clitoria ternatea).* It significantly increased plant height, population density, percent plant cover, leaf to stem ratio at different growth stages (seedling, flowering and maturity), number of flowers per plant, number of pods per plant, hundred seed weight and total seed yield production during the two growing seasons. Weeds generally, threaten the natural environment because weeds have a negative effect on plant establishment and yield quality of forages. It was found that weeds out compete, overwhelm and displace the native species in the natural environment. They may harbor pest and diseases, weed can affect the structure and function of entire systems and so have large and often inter-actable impacts on local and regional biodiversity. In agriculture, horticultural operations and forestry weeds reduce product quality and quantity. Weeds negatively impact pasture quality, productivity and profitability. They interfere with forage grasses by competing for resources and/or by producing and releasing allele-chemicals, that inhibit growth and development of plants [7]. Moreover weeds substantially, reduced feed value of forage and are toxic or unpalatable to livestock. Similar results were stated by [15] and [2] who reported that poisonous and unwanted species are considered a problem in the range land. The undesirable species compete with desirable ones for factors of growth. The noxious weeds represent a real threat to livestock when fed on it. Thus terminating, removal or suppression weeds often results in increased productivity of forages as long as the weeds are replaced by the forage or useful plants and not any other weed. Weeding also is essential to success of soil conservation status, because it ensure good plant cover. Moreover, weed residue as a result of weeding, act as mulch that facilitate the precipitation of water downward. Similarly [17] justified that, since weed germination is affected by soil moisture and temperature mulching (organic weeding) not only suppresses weeds but also maintain soil moisture at high levels compared with un-mulched soils. The good results obtained from the adoption of mechanical weed control may strongly justify the positive impacts of weed control on plants in which weeding can substantially provided plant water, soil nutrients, space and light which in-turn reflected in proper plant growth and high yield of good quality. This is because weeds if not controlled may alter soil structure through root penetration, hence lowering their yield, their nutritional value and longevity.

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