**EFFECT OF PRE-EMERGENCE HERBICIDES ON THE GROWTH AND YIELD OF SOYA BEAN [*Glycine max* (L.) Merrill] IN SUDAN SAVANNA**

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**Abstract**

Field trials were conducted during the 2017 rainy season at the Dryland Teaching and Research Farm of the Faculty of Agriculture, Usmanu Danfodiyo University Sokoto (Latitude 13o 7’N and Longitude 50 10’E) and Dutsinma in Katsina State (Latitude 12o 27’N, longitude 70 29’E). The objective of the research was to evaluate the growth and yield of soya bean under three pre-emergence herbicides for weed control in Sudan Savanna. The experiment consisted of Pendimethalin at 0.8, 1.0 and 1.2 kg a.i. /ha, Butachlor at 1.5, 1.8, 2.0 kg a.i. /ha and S-Metolachlor at 0.6, 1.3 and 1.9 kg a.i./ha and a control where weeding was done manually by hand hoeing at 4 and 6 weeks after sowing. The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated three times. Data were collected on weed parameters, growth and yield parameters of soya bean. Based on the findings of this research, the results obtained showed that all the herbicide treatments significantly reduced weed infestation during the first four weeks after sowing but the crop experienced competition with weeds thereafter which varied according to the type and rate. Butachlor at the rate of 2.0 kg a.i./ha, S-Metolachlor at the rate of 1.9 kg a.i./ha, Pendimethalin at the rate of 1.0 kg a.i./ha produced best soya bean vegetative growth and together with hoe weeded plots, they produced the best soya bean grain yield compared to other treatments. Therefore, they could be introduced to farmers in the study area.

**Key words**: Soya bean, growth, yield, pendimethalin, butachlor, S-Metolachlor

**INTRODUCTION**

 Soya bean (U.K) or Soybean (U.S.), [*Glycine max* (L.) Merr.], is a member of the Leguminosae family, native to East Asia and widely grown for its nutritious bean which has numerous uses (Singh and Singh, 2011). It is used to prepare diverse human food such as soy milk, soy cheese, infant weaning food, soy flour and animal feed (Omoigui, 2014). Oil extracted from it is edible and also used industrially for the production of fatty acid, soap and biodiesel (IITA, 2017). Soya bean improves soil fertility through nitrogen fixation and provides useful crop residue for feeding of livestock (Dugje *et al.,* 2009). It has great potential as an export crop.

Despite the enormous benefits of soya bean cultivation in Nigeria, it faces many challenges, one of which is reduction in yield due to competition with weeds. Weeds compete with soya bean for nutrients, space, moisture and solar radiation with early season competition being the most critical (Datta *et al*., 2017). Ferrell *et al.* (2010) reported that successful weed control is one of the most important practices for economical soya bean production and most of the yield reduction due to weed competition in soya bean farms occurs during the first six weeks after planting; therefore, major emphasis in weed control should be given during this period. Hand hoeing is widely used by local farmers who form the majority of soya bean producers in Nigeria and has serious limitations. It is very tedious, laborious, slow and most times leads to damage of crop roots (Ramawatar *et al.*, 2017). Poor weeding causes reduction in soya bean yield (Dugje *et al.,* 2009)

Recently, attention of farmers is being shifted to the use of herbicides for weed control even at subsistence level. This method of weed control has a lot of advantages over other methods, especially cultural methods such as hand hoeing. It is faster, less labour demanding, less tedious and when applied at pre-emergence stage, protects crops from adverse effects of early weed competition. It is also effective in controlling some perennial weeds (Raphael *et al*., 2013)

A number of herbicides have been recommended for use by soya bean farmers in Nigeria. These include Pendimethalin, Metolachlor and Butachlor (Dugje *et al*., 2009). There is a need to know the herbicide and the rate of application that is most appropriate in controlling weeds in soya bean in Sudan Savanna especially at the early stage of the crop when it is most vulnerable to weed competition. This is sequel to the increase in Soya bean production in this Agro-ecological zone of Nigeria. In the light of the above therefore, the objective of this study is to evaluate the influence of three pre-emergence herbicides for weed control on growth and yield of soya bean.

**MATERIALS AND METHODS**

 **Experimental Sites**

 Field trials were conducted at the Dryland Teaching and Research Farm of the Faculty of Agriculture, Usmanu Danfodiyo University, Sokoto (Latitude 13o 56’N and Longitude 50 15’E ) (Kowal and Knabe, 1972) and Dutsinma in Katsina State ( Latitude 12o 27’N and Longitude 70 29’E). Both locations fall within the Sudan Savanna with annual rainfall range of between 380 mm and 889 mm. The sites experience a short rainy season which falls between the months of May and September and a long dry season from October to April. Their minimum and maximum temperatures range from 15 0C to 40 0C respectively (Agabi, 1995).

 **Treatments and Experimental Design**

The treatments consisted of three pre-emergence herbicides [Pendimethalin (0.8, 1.0 and 1.2 kg a.i./ha), Butachlor (1.5, 1.8 and 2.0 kg a.i./ha.) and S-Metolachlor, (0.6, 1.3 and 1.9 kg a.i./ha)] and a control (hand hoeing at 4 and 6 weeks after sowing). The experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Each plot was 4 m x 4 m (16 m2) comprising 5 rows of soya bean. The net plot was 2.25 m x 4 m (9m2) comprising 3 rows of soya bean.

**Land preparation**

Each experimental site was cleared, ploughed and harrowed using a tractor.

 **Seed treatment**

The soya bean seeds were treated with’ Dress Force’ 45 WS (20% Metalaxyl, 15% Carboxin, 7% Furathiocarb) at the rate of one sachet (10 g) per 4 kg of seed. The seeds were put into a bag, lightly moistened with water and Dress Force was added to it. The mouth of the bag was tied with rope, and the bag was thoroughly shaken to ensure proper mixing of the seeds with the chemical. The seeds were then dried under shade for one hour and kept for sowing.

**Sowing**

Three seeds were dibbled per hole at a spacing of 10 cm apart within the rows and 75 cm between rows. Sowing depth was approximately 3-5 cm. The plants were thinned to two plants per stand at two weeks after sowing (WAS).

**Weed control**

The weeds were controlled according to the treatments. For the plots where weeds were controlled with herbicides, they were applied immediately after the seeds were sown. The herbicides were measured using syringe and applied to each plot according to treatment using 2 Litre capacity hand sprayer while weeding was carried out in control plots manually by hand hoeing at 4 and 6 WAS.

**Fertilizer application**

Fertilizer was applied during land preparation in line with the recommended fertilizer rate for soya bean production in Nigeria of 20 kg N/ha, 40 kg P2O5/ha and 20 kg K2O/ha. This was achieved using 133 kg/ha of NPK 15:15:15 fertilizer and 100 kg/ha of Single Super Phosphate.

**Pests and disease control**

Pests observed during the field trial were caterpillar (*Vanessa cardui*) at 4 WAS and stink bug (*Halyomorpha halys*) at 8 WAS. They were controlled with Lambda (Cypermethrin 10% EC) at the rate of one litre per hectare. No disease symptom was observed throughout the period of the trial.

**Harvesting**

The pods were harvested manually at physiological maturity. This was attained when 95 percent of the pods changed from green to brownish colour (Kandel, 2013).

**Drying and shelling of harvested pods**

The harvested pods were further dried under shade until they attained constant weight and shelled, for data collection.

**Data Collection**

The following data were collected from the field trials: plant height (cm), leaf area, number of days to 50% maturity, pod weight, one hundred (100) grain weight and Grain yield.. The height of each of the five randomly tagged plants in each net plot was measured using meter rule. The measurements were taken from the ground level to the top of the main stem. Leaf area was measured at 2, 4, 6 and 8 WAS. The length and breadth of five middle leaflets from five tagged plants were measured and the average recorded. The leaf area was calculated by multiplying the length by the breadth of the leaves and then multiplying it by a factor 2.0185 (Richter *et al*., 2014). Number of days at which 50% of the pods in the net plot matured was recorded. The pods matured when they changed from green to brownish colour (Kandel, 2013). Pod weight was determined by sun drying the pods obtained from net plot to constant weight and recording the value. The values obtained were extrapolated and expressed as pod weight in kg ha-1. One hundred (100) grain weight was obtained by counting one hundred (100) grains which were randomly counted from the threshed pods from each net plot and weighed to obtain the 100 grain weight. Grain yield was determined by weighing grains obtained from the net plots after the pods were shelled and the grains were sun dried to a constant weight. The values obtained were extrapolated and expressed as grain yield in kg ha-1.

**Statistical Analysis**

The data collected were subjected to statistical analysis of variance (ANOVA), using GenStat® 18th Edition where the treatment effects were observed to be significant, mean separation was carried out using Duncan’s Multiple Range Test (DMRT).

**RESULTS**

**Plant Height**

Plant height of soya bean as influenced by three pre-emergence herbicides for weed control treatments in soya bean at Dutsinma and Sokoto during 2017 wet season showed significant effects of the different herbicides, In Dutsinma, the plant height of the crop was significantly (P<0.05) influenced by weed control methods at 2 and 4 WAS. At 2 WAS, Pendimethalin (1.0 kg a.i./ha) produced the tallest plants, but was comparable to Butachlor (1.8 kg a.i./ha and 2.0 kg a.i./ha) and S-Metolachlor (1.9 kg a.i./ha). Hoe weeding and S-Metolachlor (0.6 kg a.i./ha) produced the shortest plants but were comparable to Butachlor (1.5 kg a.i./ha), and Pendimethalin (1.2 kg a.i./ha.). At 4 WAS, Pendimethalin (1.0kg a.i./ha), S-Metolachlor (1.9 kg a.i./ha) and Butachlor (2.0 kg a.i/ha) produced the tallest plants but were similar to Pendimethalin (0.8 kg a.i./ha), S-Metolachlor (1.3 kg a.i./ha ) and Butachlor (1.5 and 1..8 kg a.i./ha). Hoe weeding. However, the plant height of the crop at 6 and 8 WAS was not significantly (P>0.05) influenced by the rates and types of herbicides.

In Sokoto location, plant height of soya bean at 2, 4 and 8 WAS, were significantly influenced by the different rates and types of herbicides. At 2 WAS, S-Metolachlor (1.9 kg a.i./ha) produced the tallest plants but was comparable to all other weed control treatments with the exception of Pendimethalin (1.2 kg a.i./ha), S-Metolachlor (0.6 kg a.i./ha) and hoe weeding. Hoe weeding and Pendimethalin (1.2 kg a.i./ha) produced the shortest soya bean plants and were comparable to S-Metolachlor (0.6 kg a.i./ha). At 4 WAS, S-Metolachlor (1.9 kg a.i./ha) and Butachlor (2.0 kg a.i.ha) produced the tallest plants but were comparable to all the rates of the other herbicides except Pendimethalin (1.2 kg a.i./ha) and hoe weeding which produced shorter plants. Plant height at 6 WAS was not significantly influenced by the different rates of the herbicides. At 8 WAS, Butachlor (2.0 kg a.i.ha) produced the tallest plants but was comparable to the other rates of Butachlor and S-Metolachlor (1.3 and 1.9 kg a.i./ha). Pendimethalin (1.2 kg a.i./ha) produced the shortest plants but was comparable to all the other treatments except all the rates of Butachlor.

**Leaf Area**

The leaf area of soya bean as influenced by different weed control treatments at Dutsinma and Sokoto during 2017 wet season indicated significant effects of treatments in both locations. In Dutsinma, the leaf area of soya bean was significantly (P<0.05) influenced by different rates of the herbicides at 2, 4 and 6 WAS. No significant (P>0.05) effect of weed control methods on the leaf area of the crop was observed at 8 WAS. At 2 WAS, the widest leaf area was produced by S-Metolachlor (1.9 kg a.i./ha) but was comparable to Pendimethalin (1.0 kg a.i./ha) and Butachlor (2.0 kg a.i./ha). The smallest leaf area was obtained from hoe weeded plots though comparable to Pendimethalin (1.2 and 0.8 kg a.i./ha), S-Metolachlor (0.6 kg a.i./ha) and Butachlor (1.5 kg a.i./ha). At 4 WAS, the widest leaf area was obtained from Butachlor (2.0 kg a.i./ha) and S-Metolachlor (1.9 kg a.i./ha) which was statistically similar to Pendimethalin (1.0 kg a.i./ha) and Butachlor (1.8 kg a.i./ha). The smallest leaf area was obtained from hoe weeded plots but was comparable to S-Metolachlor (0.6 kg a.i./ha), Butachlor (1.5 kg a.i./ha) and Pendimethalin (0.8 and 1.2 kg a.i./ha). At 6 WAS, Butachlor (2.0 kg a.i./ha) also produced the widest leaf area but comparable to Butachlor (1.5 and 1.8 kg a.i./ha) and S- Metolachlor (1.3 and 1.9 kg a.i./ha). Hoe weeded plots produced the smallest leaf area but was comparable to S-Metolachlor (0.6 kg a.i./ha), Pendimethalin (0.8 and 1.2 kg a.i./ha). At 8 WAS, the leaf area of soya bean in Dutsinma was not influenced by the treatments.

At Sokoto, the effect of weed control treatments on the leaf area at 2 WAS, was highly significant. Butachlor (2.0 kg a.i./ha), Pendimethalin (1.0 kg a.i./ha), Butachlor (1.8 kg a.i./ha) and S-Metolachlor (1.9 kg a.i./ha) produced the widest leaf area (Table 2). All the other treatments were comparable. Effect of the treatments on leaf area at 4 WAS was also highly significant. The widest leaf area was obtained from Butachlor (2.0 kg a.i./ha) and S-Metolachlor (1.3 kg a.i./ha) which was comparable to Pendimethalin (1.0 kg a.i./ha), S-Metolachlor (1.9 kg a.i./ha) and Butachlor (1.8 kg a.i./ha). The least leaf area was obtained from hoe weeded plots and Pendimethalin (0.8 kg a.i./ha) which was similar to Pendimethalin (1.2 kg a.i./ha), Butachlor (1.5 kg a.i./ha) and S-Metolachlor (0.6 kg a.i./ha). At 6 WAS, Butachlor (2.0 kg a.i./ha) and S-Metolachlor (1.9 kg a.i./ha) produced the widest leaf area which was similar to all the other rates of Butachlor, S-Metolachlor (1.3 kg a.i./ha) and Pendimethalin (1.0 kg a.i./ha). All other treatments were comparable and produced least leaf area. At 8 WAS, Butachlor (2.0 kg a.i./ha) produced the widest leaf area but was comparable to S-Metolachlor (1.9 kg a.i./ha). Hoe weeding, Pendimethalin (0.8 and 1.2 kg a.i./ha), S-Metolachlor (0.6 kg a.i./ha) and Butachlor (1.5 kg a.i./ha) produced the least leaf area

**Days to 50% Maturity**

Number of days to 50% maturity of soya bean as influenced by three pre-emergence herbicides for weed control treatments in soya bean at Dutsinma and Sokoto during the 2017 wet season was significantly (P<0.05) influenced by the treatments. At Dutsinma, hoe weeding and Butachlor (2.0 kg a.i./ha) took longer days to attain 50% maturity but was comparable to Pendimethalin (1.0 kg a.i./ha), S-Metolachlor (1.3 and 1.9 kg a.i./ha) and Butachlor (1.8 kg a.i./ha). Butachlor (1.5 kg a.i./ha) produced crops with the least days to 50% maturity but was comparable to Pendimethalin (0.8 and 1.2 kg a.i./ha) and S-Metolachlor (0.6 kg a.i./ha). At Sokoto location, hoe weeding took longer days to attain 50% maturity but was comparable to Pendimethalin (1.0 kg a.i./ha), S-Metolachlor (1.9 kg ai/ha) and Butachlor (2.0 kg a.i./ha). Pendimethalin (1.2 kg a.i./ha), S-Metolachlor (0.6 and 1.3 kg a.i./ha) produced plants that took shorter days to attain 50% maturity but were comparable to Pendimethalin (0.8 kg a.i./ha) and Butachlor (1.5 kg a.i./ha) (Table 3).

**Pod Weight**

Pod weight of soya bean as influenced by three pre-emergence herbicides for weed control treatments in soya bean at Dutsinma and Sokoto during 2017 wet season in Dutsinma indicated no significant (P>0.05) effect of treatments on the pod weight of the crop. In Sokoto, pod weight of the soya bean crop was significantly (P<0.05) influenced by treatments. Butachlor (2.0 kg a.i./ha) produced the heaviest pod weight which was comparable to Pendimethalin (1.0 kg a.i./ha), S-Metolachlor (1.9 kg a.i./ha) and hoe weeded plots (Table 4). S-Metolachlor (0.6 and 1.3 kg a.i./ha) produced the lightest pod weight which was comparable to all other treatments except Pendimethalin (1.0 kg a.i/ha), (S-Metolachlor 1.9 kg a.i./ha) and Butachlor (2.0 kg a.i./ha).

 **One Hundred (100) Grain Weight**

One Hundred (100) grain weight of soya bean as influenced by three pre-emergence herbicides for weed control treatments in soya bean at Dutsinma and Sokoto during 2017 wet season in both locations was significantly (P<0.05) influenced by the treatments. In Dutsinma, hoe weeded plots produced the heaviest 100 grain weight but was comparable to Butachlor (2.0 kg a.i./ha) which was followed by Pendimenthalin (1.0 kg a.i./ha) which was also comparable to S-Metolachlor (1.9 kg a.i./ha). Pendimethalin (0.8 and 1.2 kg a.i./ha), S-Metolachlor (0.6 kg a.i./ha) and Butachlor (1.5 and 1.8 kg a.i/ha) produced lightest 100 grain weight but was comparable to and S-Metolachlor (1.3 kg a.i./ha). Similarly, in Sokoto location, hoe weeded plots produced the heaviest 100 grain weight which was comparable to Butachlor (2.0 kg a.i./ha) (Table 5). S-Metolachlor (1.9 kg a.i./ha) produced a heavier 100 grain weight which was comparable to S-Metolachlor (1.3 kg a.i./ha). The lightest 100 weight grain was obtained from Butachlor (1.5 kg a.i./ha), which was comparable to Pendimethalin (1.2 kg a.i./ha).

**Grain Yield**

Grain yield of soya bean as influenced by three pre-emergence herbicides for weed control treatments in soya bean at Dutsinma and Sokoto during 2017 wet season was significantly (P<0.05) influenced by treatments in both locations.In Dutsinma location, (Butachlor 2.0 kg a.i./ha) and S-Metolachlor (1.9 kg a.i./ha) produced the heaviest grain yield and was comparable to hoe weeded plots and plots treated with Pendimethalin (1.0 kg and 1.2 kg a.i./ha). Plots Treated with S-Metolachlor (0.6 kg a.i./ha) and Butachlor (1.5 kg a.i./ha) produced the lightest grain yield but was comparable to S-Metolachlor (1.3 kg a.i./ha), Pendimethalin (0.8 and 1.2 kg a.i./ha), and Butachlor (1.8 kg a.i./ha). In Sokoto location, Butachlor (2.0 kg a.i./ha) produced highest grain yield and was comparable to (S-Metolachlor 1.9 kg a.i./ha), Pendimethalin (1.0 kg a.i./ha) and hoe weeded plots (Table 4). Least grain yield was obtained from S-Metolachlor (0.6 kg a.i./ha), Butachlor (1.5kg a.i./ha), Pendimethalin (0.8 kg a.i./ha) which were comparable to S-Metolachlor (1.3 kg a.i./ha), Pendimethalin (1.2 kg a.i./ha) and Butachlor (1.8 kg a.i./ha).

**DISCUSSION**

The shorter plants and smaller leaf area index values which were observed in plots where Pendimethalin (0.8 kg a.i./ha) S-Metolachlor (0.6 kg a.i./ha) and Butachlor (1.5 kg a.i./ha) were applied and where hand hoeing was carried out when compared to other herbicide treatments could be due to their inability to effectively control weed infestation which occurred during the early establishment stage which resulted in competition for environmental resources between soya bean crops and the weeds. This is in line with the observation by Datta *et al*., (2017) that weeds emerging with soya bean crop causes great reduction in yield potentials of the crop if they are not adequately managed. It is also in line with the report by Jannink *et al*. (2000) and Sodangi *et al*. (2006) that soya bean is not a strong competitor with weeds in early growth stages and weeds outgrow it in the absence of proper weed management. It also concurs with the observation by Rajan and Swanton (2001) that physiological activities and growth of crops are negatively affected by the presence of weeds. Similar reduction in plant height and smaller leaf area index value was observed in plots where Pendimethalin (1.2 kg a.i./ha) was applied in both locations with pale colouration which lasted between two and four weeks after sowing. This could be due to crop injury associated with high rate of pendimethalin application. Hepperly (2016) observed that Pendimethalin can cause crop injury if cold, wet weather follows its application or if it is applied to a poorly prepared seedbed or at high rate. It was also observed that such injury does not often last long as crops usually recover and resume normal growth. This could imply that the rate was high for soya bean in both locations where the field trial was conducted. The higher grain yields recorded in Butachlor (2.0 kg a.i./ha), S-Metolachlor (1.9 kg a.i./ha) and Pendimethalin (1.0 kg a.i./ha) with Butachlor (2.0 kg a.i./ha) exhibiting superior performance in both locations where the trial was conducted suggests the existence of a relationship between weed control and grain yield in soya bean. Treatments that minimized weed competition with soya bean recorded better soya bean grain yield. Sodangi *et al*. (2006) reported that two common factors responsible for poor soya bean grain yield in farmers’ plots are weed-crop competition and low soil fertility. The most important yield limiting factor in this work is weed competition since plant nutrients were taken care of. This is in line with the findings of Jannink (2000), who reported that weed interference is the main factor that causes soya bean grain yield reduction.

Treatments where soya bean faced serious competition with weeds especially during reproductive phase experienced shorter days to 50% maturity. This could be attributed to harsh environment created by competition with weeds which compelled the crop to hasten to maturity. Treatments which experienced minimal competition with weeds took longer time to attain days to 50% maturity.

 Herbicide rates which were able to control weed competition especially at the early stage of crop growth gave the highest yield. This is a confirmation of the observation by (Knezevic *et al*., 2003; Hock *et al*., 2005) that early season weed management is important in soya bean production in other to achieve good yields. The heaviest 100 grain weight recorded in hoe weeded plots in both locations where the trial was conducted could be attributed to low weed density of the plots during the reproductive phase of soya bean. The plots where weeds were controlled with herbicides were relatively weed free during the early growth phase of the crop but faced competition with weeds during the reproductive phase while hoe weeded plots faced competition during the early growth phase of the crop but were relatively weed free during the reproductive phase of the crop. This confirms the observation by Hepperly (2016) that pre-emergence herbicides are good in controlling weeds during the establishment stage of soya bean, they do not guarantee complete control of weeds throughout the growth phase of the crop as it may still face competition with weeds afterwards especially in the tropics which could affect grain yield and quality.

**CONCLUSION**

Based on the findings of this research, Butachlor at the rate of 2.0 kg a.i./ha, Pendimethalin at the rate of 1.0 kg a.i./ha, S-Metolachlor at the rate of 1.9 kg a.i./ha and hoe weeding produced the best weed control and soya bean grain yield compared to other treatments. Therefore, they could be introduced to farmers in the study area.

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**Table 1: Effect of pre-emergence herbicide application on plant height of soya bean at Dutsinma and Sokoto in 2017 wet season**

|  |
| --- |
| Dutsinma Sokoto |
|  Treatment  |
|  2WAS 4WAS 6WAS 8WAS 2WAS 4WAS 6WAS 8WAS |
|  |
| Pendimethalin 0.8kg a.i./ha 17.17 b 26.07 ab 50.17 67.70 15.47 ab 22.47 abc 34.77 41.70 bc  |
| Pendimethalin 1.0kg a.i./ha 20.70 a 30.63 a 51.00 64.87 14.67 ab 23.77 ab 32.33 42.83 bc  |
| Pendimethalin 1.2kg a.i./ha 13.63 cd 21.17 bc 44.13 60.87 12.23 c 19.37 c 32.27 39.13 c  |
| S-Metolachlor 0.6kg a.i./ha 12.10 d 21.87 bc 46.97 63.77 14.03 bc 20.67 bc 33.00 42.23 bc |
| S-Metolachlor 1.3kg a.i./ha 16.10 bc 25.13 ab 50.13 68.90 14.93 ab 24.00 ab 34.20 44.93 abc  |
| S-Metolachlor 1.9kg a.i./ha 18.03 ab 28.97 a 50.33 73.37 16.53 a 25.53 a 36.10 45.23 abc  |
| Butachlor 1.5kg a.i./ha 13.27 cd 26.37 ab 46.90 63.27 15.53 ab 23.90 ab 36.43 46.60 ab |
| Butachlor 1.8kg a.i./ha 18.17 ab 26.87 ab 47.20 68.93 15.53 ab 22.67ab 35.90 47.03 ab |
| Butachlor 2.0kg a.i./ha 18.63 ab 28.13 a 49.37 70.77 15.07 ab 24.33 a 41.00 50.57 a  |
| Hoe weeding at 4 & 6 WAS 11.20 d 18.83 c 42.07 58.27 12.10 c 19.33 c 31.57 42.73 bc |

SE 1.476 2.467 5.13 6.28 0.715 1.015 2.760 2.085

Significance Level \*\* \*\* NS NS \*\* \*\* NS \*

Means in a column followed by the same letter(s) are not significantly different at 5% level using Duncan’s Multiple Range Test (DMRT). NS = not significant at 5%. \* = significant at 5% level of significance, \*\* = significant at 1% level of significance. WAS = weeks after sowing

**Table 2: Effect of pre-emergence herbicide application on the leaf area of soya bean at Dutsinma and Sokoto in 2017 wet season.**

 Dutsinma Sokoto

Treatment \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 2WAS 4WAS 6WAS 8WAS 2WAS 4WAS 6WAS 8WAS

Pendimethalin 0.8kg a.i./ha 15.98 c 35.29 cde 68.54 c 94.82 13.66 b 29.19 d 50.30b 73.82c

Pendimethalin 1.0kg a.i./ha 19.75 ab 39.01 abc 74.46 b 106.35 16.81 a 37.42 abc 53.12ab 85.46b

Pendimethalin 1.2kg a.i./ha 4.79 cd 33.94 de 71.83 bc 105.60 12.17 b 34.23 cd 47.80b 75.50c

S-Metolachlor 0.6kg a.i./ha 15.19 cd 32.98 de 73.01 bc 96.31 12.89 b 31.28 cd 47.95b 76.21c

S-Metolachlor 1.3kg a.i./ha 18.97 ab 36.50 bcd 76.58 ab 97.54 14.12 b 40.75 a 59.50ab 85.60b

S-Metolachlor 1.9kg a.i./ha 21.09 a 40.85 a 76.49 ab 98.23 16.47 a 40.15 ab 67.27a 88.91ab

Butachlor 1.5kg a.i./ha 15.63 cd 33.78 de 75.79 ab 98.81 13.87 b 33.53 bcd 54.25ab 74.84c

Butachlor 1.8kg a.i./ha 18.74 b 39.71 ab 77.36 ab 105.50 16.52 a 37.60 abc 62.33ab 84.14b

Butachlor 2.0kg a.i./ha 20.83 ab 41.90 a 80.91 a 108.84 16.97 a 40.75 a 67.31a 91.61 a

Hoe weeding at 4 & 6 WAS 13.50 d 31.53 e 72.31 bc 97.33 11.59 b 29.53 d 51.35b 71.02 c

SE 0.713 1.233 1.664 7.284 0.767 2.045 4.573 1.855

Significance Level \*\* \*\* \*\* NS \*\* \*\* \*\* \*\*

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**Table 3: Effect of pre-emergence herbicide application on days to 50% maturity of soya bean at Dutsinma and Sokoto in 2017 wet season.**

 Dutsinma Sokoto

Treatment \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Days to 50% maturity Days to 50%maturity

Pendimethalin 0.8kg a.i./ha 86.67 bcd 96.00 cd

Pendimethalin 1.0kg a.i./ha 87.67 abc 97.67 abc

Pendimethalin 1.2kg a.i./ha 86.67 bcd 94.67 d

S-Metolachlor 0.6kg a.i./ha 86.33 cd 94.67 d

S-Metolachlor 1.3kg a.i./ha 87.67 abc 95.00 d

S-Metolachlor 1.9kg a.i./ha 88.00 ab 98.33 ab

Butachlor 1.5kg a.i./ha 86.00 d 96.00 cd

Butachlor 1.8kg a.i./ha 87.67 abc 97.33 bc

Butachlor 2.0kg a.i./ha 89.00 a 97.65 abc

Hoe weeding at 4 & 6 WAS 88.67 a 99.33 a

SE. 0.459 0.587

Significance Level \*\* \*\*

Means in a column followed by the same letter(s) are not significantly different at 5% level using Duncan’s Multiple Range Test (DMRT). NS = not significant at 5%. \* = significant at 5% level of significance, \*\* = significant at 1% level of significance.WAS = weeks after sowing

**Table 4: Effect of pre-emergence herbicides on pod weight, 100 grain weight and grain yield of soya at Dutsinma and Sokoto in 2017 wet season.**

 Dutsinma Sokoto

Treatment \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Pod wgt 100 grain Grain yld pod wgt 100 grain Grain yld

 (kg/ha) weight (g) (kg/ha) (kg/ha) weight (g) (kg/ha)

Pendimethalin 0.8kg a.i./ha 1862 12.73 d 1463 bc 1354 bcd 8.97 def 1221 d

Pendimethalin 1.0kg a.i./ha 2144 14.20 b 1626 ab 1551 abc 9.20 cde 1404 abc

Pendimethalin 1.2kg a.i./ha 1994 12.73 d 1554 abc 1399 bcd 8.53 fg 1269 cd

S-Metolachlor 0.6kg a.i./ha 1746 12.87 d 1416 c 1305 d 8.77 ef 1173 d

S-Metolachlor 1.3kg a.i./ha 1921 13.20 cd 1482 bc 1331 d 9.50 bc 1273 cd

S-Metolachlor 1.9kg a.i./ha 2151 13.97 bc 1698 a 1563 ab 9.80 b 1429 ab

Butachlor 1.5kg a.i./ha 1784 12.37 d 1382 c 1341 cd 8.13 g 1211 d

Butachlor 1.8kg a.i./ha 1893 12.67 d 1503 bc 1439 bcd 9.27 cde 1299 cd

Butachlor 2.0kg a.i./ha 2197 14.47 ab 1705 a 1646 a 10.12 ab 1481 a

Hoe weeding at 4 & 6 WAS 2116 15.20 a 1625 ab 1491 abcd 10.30 a 1377 abc

SE 101.8 0.3091 58.90 63.30 0.1570 47.40

Significance Level NS \*\* \*\* \*\* \*\* \*\*

Means in a column followed by the same letter(s) are not significantly different at 5% level using Duncan’s Multiple Range Test (DMRT). NS = not significant at 5%. \* = significant at 5% level of significance, \*\* = significant at 1% level of significance