EFFECT OF CHEMICAL WEED CONTROL TREATMENTS AND INTER-ROW SPACING ON THE GROWTH AND YIELD OF SESAME *(Sesamum indicum* L.)

BY

B. Tech. Agriculture (Minna)

A thesis submitted to the Post-graduate School, Ahmadu Bello University, Zaria in partial fulfilment of the requirement for the degree of Master of Science in Agronomy.

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12TH AUGUST, 1997

DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my research work. It has not been previously forwarded for the award of a higher degree.

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CERTIFICATION

This Thesis entitled Effect of Chemical Weed Control Treatments and Inter-row Spacing on the Growth and Yield of Sesame (*Sesamum indicum* L.) by **Abdullahi Aliyu Ndarubu** meets the regulations governing the award of degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This work is dedicated to my wife and daughter

AMINAT AND **FATIMAT**

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ABSTRACT

Field experiments were conducted during the 1995 and 1996 wet seasons at the Research Farm of the Institute for Agricultural Research, Samaru, Zaria (11° 11 N; 7° 38 m; 680m above sea level) in the northern Guinea Savanna zone of Nigeria. The study was conducted to evaluate the effects of inter-row spacing (seed broadcast, 30, 60 and 90cm) on the efficiency of four pre-emergence herbicides (imazaquin, metolachlor + metobromuron, metolachlor + diuron and simazine + ametryn) each applied at two rates on sesame. The different herbicide treatments gave varying significant effects on the performance of the crop. While metolachlor + metobromuron at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha, imazaquin at 0.20kg a.i./ha and metolachlor + diuron at 1.0 + 0.25kg a.i./ha provided good weed control and were well tolerated by the crop, the application of metolachlor + diuron at 1.0 + 0.5 and 1.5 + 0.5kg a.i./ha and also simazine + ametryn at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha were phytotoxic to the crop resulting in significant stand and yield losses. Inter-row spacing also had significant effect on the yield and related parameters of sesame. The highest values for number of branches, capsules, dry matter production, seed yield per plant and seed weight were obtained under the inter-row spacing of 90cm, while the maximum values for plant height and number of stands were obtained under seed broadcast. However, the maximum seed yield of 401.00 and 511.26kg/ha were obtained from the application of metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha under 30cm inter-row spacing in 1995 and 1996, respectively. Yield reductions of 81 and 88% were recorded in 1995 and 1996 cropping seasons, respectively, due to unrestricted weed growth throughout the crop life cycle.

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CHAPTER 1

1.0 INTRODUCTION

1.1 Sesame production and economic importance

Sesame *(Sesamum indicum* L.) is locally known under different names as ***gingelly*** and **til** in India, **Simsim** in the Arabian countries and East Africa, and as **beniseed** in West Africa (Seegeler, 1989). It is a crop of great antiquity and probably one of the most ancient oilseed crops under cultivation (Weiss, 1983).

Sesame was domesticated in Africa, probably in Ethiopia and spread very early to India where a secondary centre of diversity developed (Purseglove, 1968, Onwueme and Sinha, 1991). World production of sesame recorded for about 2,014,000 t/year in 1993 (Hassanah, 1995). The crop is now cultivated in the sub-tropical and tropical regions of Asia and Africa.

The major sesame growing countries are China, India, Mexico and Sudan (Onwueme and Sinha, 1991, Sigmund and Gustav, 1991). Nigeria is classified among sesame exporting countries of Africa (Weiss, 1983). In Nigeria, the crop is grown mainly in the Benue, Kogi and Federal Capital terriroty, Abuja areas of Southern Guinea Savanna ecological zone (Phillips, 1977). It is cultivated either as a sole crop or in mixture with other crops like groundnut (*Arachis hypogaea*) or cotton (*Gossypium* spp) (Katung, 1987). Most of the world total production is consumed locally, and only about a fifth of this reaches the export market and the commercial products of value are both whole seeds and the oil (Sigmund and Gustav, 1991). However, the crop is mainly grown for the oil obtain from its seeds. The seed contains about 50 - 51% oil, 17 - 19% protein and 16 - 18% carbohydrate (Yermanos *et al.*, 1972).

The oil is edible, odourless and semi-drying, containing Oleic, Stearic and Palmitic acids (Yermanos et al., 1972). The oil is related next to olive oil in terms of quality and often used as a cheaper substitute (Weiss, 1983). The poorer grades of the oil are used in making soap, paints, lubricants and as a lamp fuel. Based on its constituents of sesamolin and sesamin, sesame oil is also used as a synergist for insecticides (Ryu *et al.*, 1992).

1.2 Climatic and Agronomic Requirements

A rainfall of about 500 to 600mm is considered adequate for the crop. The crop can not tolerate frost and performs poorly in areas of continued heavy rainfall. Once established it can tolerate short periods of drought. Average temperature requirement during the growth period is 23 to 30°C. However, a temperature of 25 to 27°C encourages rapid germination, initial growth and flower formation (Weiss, 1983). The crop thrives well on a wide range of soils but does best on moderately fertile and free-draining loamy textured soil with pH of between 5.5 to 8.0. It can also be grown on clays or dark alluvial soils, where moisture is not limiting and water-logging is not pronounced (Sigmund and Gustav, 1991).

Sesame is propagated by seeds drilled in rows interspaced between 30 to 90cm or broadcast on prepared land (van Rheenen, 1973). The matured plant is an erect, sometimes branched annual herb, 50 to 120cm in height with a well developed roots system, solitary flowers and alternate leaves. Sesame exhibits a very high degree of genetic variability in terms of leaf size and shape and flower colour even on the same plant (Osman and Khidir, 1974). Sesame respond to the application of phosphorus (up to 40kg $P_2 0_5$) and Nitrogen (up to 40kgN) may be applied as basal dressing (Rao *et al.*, 1990).

1.2 Weeds and their Control in Sesame

Young sesame plants do not tolerate competition from weeds because of their small-sized seeds (2.5 to 3.2g per 1000 seeds) and initial slow growth. The critical period of weed interference in sesame has been estimated to be between 3 to 6 weeks after planting (Onwueme and Sinha, 1991). The crop is notably not tolerant of shading at early stages of growth. The results of trials at Mokwa Research Station indicated that a yield loss of over 70% could be caused by uncontrolled weeds on sesame plots (Busari and Bature, 1993. Dharam *et al.* (1992) also obtained 35.7% yield reduction in sesame due to weed infestation in India.

Sesame seed yield is the lowest among the oilseed crops in the world (Desai and Gloyal, 1981). This is because the crop is still grown as a minor crop, in poor soils and without an appropriate production package. In Nigeria, where the crop is grown mainly in the Benue and Kogi states of Southern Guinea Savanna zone, the seed yield on farmer's field ranges between 90 to 250 kg/ha (van Rheenen, 1973). Plant density and weed control have been identified as the major agronomic problems for the low seed yield in these areas (van Rheenen, 1973). The practice of seed broadcast on flat in Benue state (Tiv's practice) results in over-population and poses difficulties in weeding operations while planting on widely spaced ridges observed in Kogi State (Igbirra's practice) results in low crop density (Stonebridge, 1963).

Planting seeds in rows at a spacing of 60cm x 10cm has been recommended in past studies (Adeyemo et al., 1992, Olowe and Busari, 1994). However, such recommendation was based on the farmer's traditional method of hoe-weeding which necessitate planting in widely spaced rows. A closer row spacing could be adopted where herbicides are used for weed control in this crop. Kondap *et al.* (1983) observed that since most oilseed crops are grown under rainfed conditions, it is not desirable to disturb the soil continuously for weeds removal with mechanical implements, hence, it is better to use herbicides immediately after sowing. However, there is a general paucity of information on chemical weed control in sesame particularly in Nigeria, hence the need not only for identifying selective herbicides in the crop but also their application under various agronomic practices such as an appropriate row-spacing to enhance weed control and crop yield.

The study was therefore conducted with the following objectives:

i. to evaluate some pre-emergence herbicides for selective weed control in sesame

and

ii. to determine the effect of inter-row spacing on the efficiency of the weed control treatments in the crop.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Effect of Inter-row Spacing on Growth of Sesame

Row spacing is a production factor that strongly affects the morphology of crops. Samir and Elsorgy (1989) reported that sowing sesame at a spacing of 20cm between hills tended to produce the shortest plants compared to inter-spacing of 30cm, and plant height was increased remarkably with increasing number of plants per hill. Similarly, Katung (1987) observed increase in plant height at harvest with increases in plant population from 100,000 to 400,000 plants/ha (dense planting). Also similar trend of increased plant height with decrease in intra and inter-row spacing have been reported (Mazzani and Cobo, 1956, Weiss, 1983, van Rheenen, 1973 and Delgado and Yermanos, 1975, Weiss, 1983). However, Anon (1966) reported a marked tendency towards stunted growth at a very close intra-row spacing of less than 8cm.

Increase in plant spacings and thus decreasing plant density, progressively delayed flowering and crop maturation and also increased the number of branches per plant and total dry matter accumulation (Gupta, 1982).

2.2 Effect of Inter-row Spacing on Yield and Yield components of Sesame

The variation in spacing and plant densities in sesame is considerable (Weiss, 1983). Method of sowing, seed rate and spatial arrangement determine the density of sesame plants in cultivated fields (Adeyemo *et al.*, 1992). Olowe and Busari (1994) obtained increased number of seeds per capsule, number of capsules per plant and plant dry matter production with increase in intra-row spacing from 30cm to 90cm. Therefore, plant density plays an important role in affecting yield components of sesame. Plant in wide rows are exposed to less intra-specific competition and tend to be most vigorous and productive.

Delgado and Yermanos (1975) reported increase in seed yield per plant with increase in spacing. Olive and Canon (1954) also found from their experiments in El-Savador that an inter-row spacing of 30cm gave better yields than either of 60 or 90cm but varying the intra-row spacing from 10 to 20 and 30cm had little effect on yield. Similarly, an inter-row spacing of 25cm was reported to produce higher seed yield per hectare than 50cm and 75cm row spacings. However, the trend was reversed for the seed yield per capsule, the number of capsule per branch and total number of capsules per plant (Adeyemo *et al.*, 1992).

In Nigeria, the two types of planting pattern practiced by the traditional farmers' have differential effects on the crop performance. Stonebridge (1963) in experiments carried out at Mokwa, compared Igbira, Tiv and experimental method of sowing (row-planting). He concluded that from a yield point of view, the Tiv's method of broadcasting seed and Igbira's planting in widely spaced hills were both inferior to the experimental row planting. Katung (1987) also reported insignificant decreases in the number of seeds per pod, length of pods and 1,000-seed weight with increasing plant population up to 250,000 plants per hectare.

2.3 Effect of Inter-row Spacing on Weed Control

Wide spacings favour higher weed competition in crops (Akobundu, 1987). Wax and Pendleton (1968) reported that some broadleaf weeds, unaffected by trifluralin made sufficient growth to impair soybean yield in wide rows but not in narrow rows. Dougherty (1969) proposed that shading of weeds by quickly formed canopy of soybean planted in narrow rows account for more efficient weed control than in wide rows. The efficiency of herbicides (particularly the pre-emergence formulations) for weed control in crops is thus enhanced by high density planting which facilitates quick formation of complete crop canopy that smoothers weeds.

2.4 Chemical Weed Control in Sesame

2.4.1 Herbicides evaluation for weed control in sesame

Herbicide use has become very important in modern agriculture because, they more than any other tools so far developed for weed control by man, are able to suppress weeds on a large scale before or at emergence without heavy dependence on human labour (Akobundu, 1987). This technology has not been fully adopted by subsistence farmers for most crops in the tropics. Busari and Bature (1993) reported that the use of herbicide in the production of sesame is rarely practiced in Nigeria, partly due to scanty information on the appropriate technology. However, through experimental field evaluations, some herbicides have been suggested for use in this crop on the basis of their selectivity to the crop and broadspectrum control of weeds.

Application of herbicide alone may not be adequate to provide effective weed control particularly where there is a preponderance of noxious weeds such as *Rottboelia cochinchinensis* and *Imperata cylindrica*. In an integrated weed management studies in India, Bansode and Shelke (1991) obtained highest yields of 689kg/ha with pre-emergence aplication of alachlor (0.75kg a.i./ha) plus a supplementary hoe-weeeding compared to hand weeding plus hoeing (583kg).

2.5. Characteristics Of Some Selected Herbicides

2.5.1 Amides

This is a large group of herbiciees with different chemical structures but they are all substituted acids and the amide herbicides take the name of the acid represented by the R-group. A major subdivision of the amide class of herbicides is the chloroacetamides. They have a monochlorinated methyl (cl=CH2) in the R-1 position and include metolachlor and alachlor (Ashton and Klingman, 1975). They are readily absorbed by susceptible plants primarily by seeds and roots of germinating seedlings and appear to be translocated primarily in the apoplast. They inhibit mitochondrial phosphorylation and reduce cell division in primary meristems (Audus, 1976). They are most exclusively used as selective herbicides in vegetable and field crops mainly for the control of grasses although they may have activities on broad leaved weeds and sedges (Ashton and Crafts, 1973).

In field trials carried out in India, Subramanian and Sanka (1977) reported effective control of both grasses and some broadleaves with a pre-emergence application of alachlor at 2.25kg a.i./ha. The application of alachlor at 1.0 to 2.0kg a.i./ha was also found to be highly selective in sesame (Schrodter and Rawson, 1984, Graph *et al.*, 1985). In Ethiopia, pre-emergence application of alachlor at 1.6 and 2.7kg a.i./ha was the safest of the herbicides tested in sesame grown under irrigation (Anon., 1973), while Busari and Bature (1993) recommended the pre-emergence application of butachlor at 2.4kg a.i./ha for sesame production in the southern guinea savanna zone of Nigeria. Application of Galex[R] (Metobromuron + Metolachlor) at 1.8kg a.i./ha gave a yield of 2.07 tonnes/ha compared to 1.57t/ha with hoe-weeded control in Egypt (Hussein *et al.*, 1983).

2.5.2 <u>Dinitroanilines</u>

Many members of this group are soil active herbicides with little or no foliar activity. Pendimethalin is the only member of this group which is active when used as a pre-plant incorporated pre-emergence or post-emergence herbicide. Others are essentially soil incorporated. The dinitroanilines kill seedlings by inhibiting the development of lateral roots in susceptible plants and as a group, they are very effective in the control of corn grass (*Rottboelia cochinchinensis* Roxb) (Parker and Soper, 1977). The dinitroanilines degrade readily in the soil through the action of micro-organisms (Zimdahl and Gwynn, 1977).

Graph *et al.* (1985) reported that pre-sowing incorporation of 0.125 to 0.186kg a.i./ha trifluralin was selective to sesame with efficient weed control. Patro *et al.* (1982) also used trifluralin at 0.5kg a.i./ha in sesame efficiently. Busari and Bature (1993) reported excellent weed control of broadleaves with pendimethalin at 1.9 and 2.4kg a.i./ha, although there was slight phytotoxicity to sesame at the highest rate.

In India, pre-emergence application of fluchoralin at 0.72kg a.i./ha effectively controlled weeds in sesame fields, and gave good number of capsules per sesame plant, number of seeds per capsule as well as weight of seeds (Gosh and Mukhopadyay, 1980).

2.5.3 Substituted urea

These are large group of herbicides derived from the urea molecule. Most of the urea herbicides are readily absorbed by roots and rapidly translocated to the upper plant parts through the apoplast (Ashton and Crafts, 1973). They are generally photosynthetic inhibitors and are metabolished readily in plants and soils through the action of enzymes and micro-organisms respectively (Geissbuhler *et al.*, 1975).

Diuron is a popular member of this group used for selective weed control in cotton, sugarcane, cowpea and yam (Lagoke *et al.*, 1981). Metobromuron is also used for the selective control of broadleaved weeds in cowpea and sesame (Lagoke *et al.*, 1981, Hussein et al., 1983, Busari and Bature, 1993). Linuron at 1.8kg a.i./ha resulted in seed yield of 1.8t/ha compared with 1.5t/ha in unweeded plots of sesame (Hussein *et al.*, 1983).

2.5.4 Symmetrical triazines

The *s*-triazines are so called because the 3 nitrogen atoms in their heterocyclic benzene ring are symmetrically arranged (Akobundu, 1987). They show a high degree of crop tolerance and soil activity. While uptake of all herbicides in this group is mainly through plant roots, foliar uptake occur with more soluble triazines such as ametryn and atrazine. (Akobundu, 1987). The *s*-traiazines move in the transpiration stream mostly in the apoplast of treated plants and are well known inhibitors of photosynthetic electron transport (Akobundu, 1987). They control seedling grasses and broadleaves (Kearney, 1970; Akobundu, 1987). Members of this group include atrazine, simazine, ametryn, prometryn and prometon.

Busari and Bature (1993), reported that pre-emergence application of atrazine at 0.5 and 1.0kg a.i/ha gave high degree of weed control but with remarkable phytotoxicity to sesame at the rates used.

2.5.5 Diphenyl ethers

The diphenyl ethers are contact herbicides which are adsorbed strongly to soil organic matter (Fadayomi and Warren, 1977). They require light for their phytotoxic action and are used for control of seedling broadleaves in field and vegetable crops either at pre-emergence or post-emergence stages of both crops and weeds (Fadayomi and Warren, 1976). Members of this group include acifluorfen, bifenox, fluorodifen, lactofen, oxyfluorfen and nitrofen.

Pre-emergence application of nitrofen at 1 to 2kg a.i./ha effectively controlled the weeds, but resulted in a very poor stand, stunted growth and very low seed yield of sesame (Gosh and Mukhopadyay, 1980).

2.5.6 Miscellaneous herbicides

These are herbicides that do not conveniently fall into the major groups like the imidazolines represented by imazaquin. It is readily absorbed by plant roots and foliage, and it is translocated in both phloem and xylem (Akobundu, 1987).

The mechanism of action is the inhibition of acetohydroxyl acid synthase, the amino acids (Valine, leucine and Isoleucine). It is the reduction in the level of these acids that leads to death of the affected weeds. (Akobundu, 1987).

Imazaquin is a selective herbicide for weed control in cowpea, beans, peas, soybeans, tobacco and coffee (Akobundu, 1987). Busari and Bature (1993) reported that imazaquin at 0.18kg a.i./ha applied pre-emergence gave good weed control and was well tolerated by sesame.

CHAPTER 3

3.0 MATERIALS AND METHODS

3.1 Experimental Site

Field trials were conducted during the 1995 and 1996 cropping seaons at the Research Farm of the Institute for Agricultural Research, Samaru, Zaria (11° 11′ N; 7° 38′E, 680 meters above Sea level) in the northern Guinea Savanna ecological zone of Nigeria. The soil of the sites was sandy loam. Details of the physico-chemical composition of the soil at experimental sites are shown in Table 1, while details of the distribution of rainfall, relative humidity, sunshine and temperature at Samaru during the period of the trials are shown in Appendices I and 2.

3.2 Treatments and Experimental Design

The set of treatments studied consisted of ten weed control measures and four inter-row spacing. The weed control treatments were four herbicides each tested at two rates including imazaquin (Scepter^R) at 0.18 and 0.20kg a.i./ha, metalachlor + metobromuron (Galex^R) at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha, metolachlor + diuron (tank mixture) at 1.0 + 0.5 and 1.5 + 0.5kg a.i./ha and simazine + ametryn (Gesatopz^R) at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha. Hoe-weeding at 3, 6 and 9 weeks after sowing (WAS) and weedy plots were included as controls while the inter-row spacings were seed broadcast (6 kg seed/ha), 30cm, 60cm and 90cm. Details of the herbicides used are shown in Appendix 3. The experiment was laid out in a split-plot design with three replications and the weed control treatments were alloted to the main plots while the inter-row spacings were in the sub-plots. Gross and net plot sizes were 4m x 3m ($12m^2$) and 4m x 1.8m ($7.2m^2$), respectively. Alley ways of 1m were maintained between the plots.

Table 1: The Physical and chemical properties of the soil collected to a depth of 30cm from the experimental site at Samaru in 1995 and 1996.

Soil Composition	Characteristics	
	1995	1996
% Sand	29	35
% Silt	30	38
% Clay	32	27
Textural class	loam	Sandy loam
<u>Chemical Properties</u>		
pH H_20	6.0	5.8
(1:2:5) $Cacl_2$	5.5	5.5
Carbon %	0.15	0.54
Available P_20_5(ppm)	27.5	16.12
Total nitrogen %	0.072	0.085
<u>Exchangeable cations meq/100g soil</u>		
Ca	4.0	3.40
Mg	1.30	0.53
K	0.27	0.26
Na	0.15	0.03
C.E.C	8.00	5.70

3.3 Cultural Practices

3.3.1 Land preparation and sowing

The land was ploughed and harrowed twice to obtain a fine tilth. Sesame variety **Yandev 55** which is late maturing (120 days) was sown on 7th July and 10th July in 1995 and 1996, respectively. Seeds were sown and later thinned to an intra-row spacing of approximately 5cm apart at 3 WAS.

3.3.2 Herbicide application

All the herbicides were applied pre-emergence, one day after sowing using a CP3-Knapsack sprayer with green nozzle calibrated to deliver 250L/ha herbicide solution at a pressure of $2kg/cm^2$.

3.3.3 Fertilizer application

Fertilizer was aplied at the rate of 40kg N, 50kg P and 20kg K, (Maurya *et al.*, 1995). These fertilizers were mixed properly and broadcast uniformly on the experimental field at 3 WAS.

3.3.4 Crop protection

Seeds were treated with Apron-plus (34% Furathiocarb + 10% metalaxyl + 6% carboxin) at 10g/2kg of sesame seeds before planting to offer protection against black ants and soil-borne diseases.

3.4.5 Harvesting

The crop was harvested when the leaves and stems changed colour from green to yellow (about 100 - 120 days). Harvesting was manually carried out with knives by cutting the plants at the base and then put into sacks. They were allowed to dry inside the sacks so as to minimize seed loss when pods shattered. When the plants were adequately dried, the sacks were gently beaten with sticks in order to release all the seeds from the pods. The seeds were separated from the chaff by winnowing.

3.5 Observation and Data Collection

All data collection were made within the net plot (7.2m^2). Five plants were randomly selected and tagged in each of such plots for the measurement of various plant parameters.. All the weights were taken using **mettler** electronic weighing balance.

3.5.1 Stand count

Establishment count of plants in each plot was taken immediately after thinning at 4 WAS and the plant/stand count was repeated just before harvesting at crop maturity.

3.5.2 Phytotoxicity rating

Visual rating of the phytotoxicity of the weed control measures (herbicides) were made at 2 WAS. A scale of 0 to 10 was used where these represented no crop injury and complete crop kill, respectively.

3.5.3 Crop vigour score

A visual rating of the crop vigour were made at 3 and 6 WAS. A scale of 0 to 10 was used where these represented a completely retarded growth and the most vigorous plant growth, respectively.

3.5.4 Weed cover score

The extent of ground cover and weed aggressiveness in each plot were visually rated at 3 and 6 WAS using a scale of 0 to 10 where these represented clean plots and a complete weed cover of plot, respectively.

3.5.5 Plant height (cm)

Heights of the tagged plants in each plot were measured at maturity just before harvesting. Measurement was taken from the ground level to the tips of the main stems using a graduated meter rule in centimeters. The mean of the five plants was recorded.

3.5.6 Number of branches and capsules per plant

The number of branches and capsules per plant were obtained by counting these characters on each of the selected five plants at harvest. The mean of the five plants was recorded.

3.5.7 Height to first capsule (cm)

The height to the first capsule from the ground level on each of the tagged plants from all the plots were measured. The mean of the five plants was recorded.

3.5.8 Dry matter production per plant(g/plant)

Five plant samples were randomly taken in each of the plots at about 90 to 100% capsule formation (12 WAS). These were oven-dried and weighed and the means recorded.

3.5.9 Weed dry matter production per plot (kg/ha)

Weeds were sampled from each plot at 12 WAS using a quadrat size of 1m x 1m ($1m^2$), oven-dried, weighed and recorded.

3.5.10 Seed yield per plant (g/plant)

All the capsules on the tagged plants in each plot were harvested, dried, threshed and winnowed to obtain clean seeds which were then weighed and recorded.

3.5.11 Weight of 1000 seeds(g)

For each of the plots, 1000 seeds were counted and weighed. This procedure was repeated twice and the means worked out and recorded.

3.5.12 Seed yield (kg/ha)

All plants from the net plots were harvested, threshed winnowed and the clean seeds were weighed to obtain seed yield per plot. The yield from the five tagged plants in each plot earlier taken were also added before converting the values to yield per hectare.

3.5.13 Data analysis

Analysis of variance was carried out to test for significance in the treatment effects using the F-test as described by Snedecor and Cochran (1967). Where the F-test was significant, Duncan's Multiple Range Test (DMRT) (Duncan, 1955) was used to evaluate differences among the treatment means. Correlation analysis was carried out between yield per hectare and some characters to evaluate the degree of their association.

CHAPTER 4

4.0 RESULTS

4.1 Effects of Chemical Weed Control Treatments on Weeds

4.1.1 Weed cover

The common weed species observed on the sites and their relative level of occurrence are shown in Table 2.

The effect of weed control treatments had significant effect on weed cover in both years at 3 and 6 WAS (Table 3). Metolachlor + diuron at 1.5 + 0.5Kg a.i./ha significantly reduced weed cover at 3 and 6 WAS in 1995 and at 3 WAS in 1996 compared with the other herbicide treatments and the hoe-weeded control in 1995 only, but had comparable low weed cover values in 1996 (Table 3). Inter-row spacing also had a significant effect on the weed cover at 3 and 6 WAS in both years (Table 3). The broadcast method of sowing consistently reduced weed cover at all periods of observation in both years which is significantly different compared with the 60cm and 90cm inter-row spacings. The 30cm spacing significantly reduced weed cover also compared with the 60 and 90cm row spacings (Table 3).

The interaction between weed control treatments and inter-row spacing was not significant at 3 and 6 WAS in 1995 but significant in 1996 at 3 and 6 WAS (Table 3). At 3 WAS, metolachlor + diuron at both rates (1.0 + 0.5 and 1.5 + 0.5kg a.i./ha) with seed broadcast and 30cm inter-row spacing significantly reduced weed cover score compared with the other weed control treatments at 60 and 90cm inter-row spacing (Table 4). At 6 WAS, similar trend of low weed cover was observed (Table 5).

In general, with closer spacing, the less is the weed cover obtained and the efficiency of the herbicide applied is also enhanced, while weed cover increased as the inter-row spacing increased (Tables 3, 4 and 5).

Table 2: Weed species present on the experimental sites and their levels of occurrence.

	Weed Species	Occurrence	
a.	Annual greases:	1995	1996
	1. *Cenchrus biflorus* Roxb	+	++
	2. *Chloris pilosa* Schumach	++	++
	3. *Cynodon dactylon* (L) Pers	+++	+++
	4. *Dactyloctenum aegyptium* (L) Richt	+++	+++
	5. *Eleusine indica* (L.)	++	++
	6. *Eragrostis tremula* (L.)	+	+
	7. *Paspalum obiculare* Forst	++	+
	8. *Rottboelia cochinchinensis* (L) Roxb	++	+
b.	Broad leaved weeds:		
	1. *Acanthospermum hispidum* (DC)	++	+++
	2. *Ageratum conyzoides*	+++	+++
	3. *Amaranthus spinosus* (L)	++	++
	4. *Cleome viscosa* (L)	++	++
	5. *Crotalaria retusa* (L)	+	+
	6. *Cuscuta australis* R. Br.	-	++
	7. *Euphorbia hetrophylla*	++	++
	8. *Euphorbia hirta*	+	++
	9. *Ipomoea enopcarpa* R.	+	+
	10. *Portulaca oleraceae* (L)	+	+
	11. *Physalis angularis* (L) Br.	+	+
	12. *Solanum nigrum* (L)	++	+
	13. *Varnonia galamensis* (L)	++	+
c.	Sedges:		
	1. *Cyperus esculentus* (L)	+++	++
	2: *Cyperus rotundus* (L)	++	+

+++ = High occurrence (60-90%) + = Minor occurrence (1-39%)

++ = Moderate occurrence (40 - 59%) - = Nil (absent)

Table 3: Effect of chemical weed control treatments and Inter-row spacing on weeds in sesame at Samaru in 1995 and 1996.

Treatments	Herbicide rates (Kg a.i./ha)	Weed Cover Score[2]				Weed Dry Matter at 12 WAS (kg/ha)	
		1995		1996			
		3WAS[3]	6 WAS	3 WAS	6 WAS	1996	1996
Weed Control treatments(W)							
Imazaquin	0.18	3.0c[1]	5.0c	2.5bc	3.9b	242.2bcd	234.4cde
-do-	0.20	3.0c	4.4d	2.3cd	3.6b	212.0cde	226.7cde
Metolachlor + metobromuron	0.75 + 0.75	2.0d	4.3d	2.1de	2.6c	195.2de	174.2def
-do-	1.0 + 1.0	2.0d	4.2d	2.0def	2.6c	149.1ef	175.6def
Metolachlor + diuron	1.0 + 0.5	1.0e	3.5e	1.7f	2.7c	137.4ef	165.8f
-do-	1.5 + 0.5	1.0e	2.8f	1.8ef	2.6c	143.2ef	161.0f
Simazine + ametryn	0.75 + 0.75	3.4ab	5.7b	3.2a	2.7a	293.5b	277.3b
-do-	1.0 + 1.0	3.2bc	5.5b	2.7b	5.4a	279.8bc	242.7c
3 hoe-weeding (3,6 and 9 WAS)		2.0d	3.3e	1.8ef	1.6d	88.4f	47.1g
Weedy check		3.7a	6.9a	3.3a	5.8a	492.6a	378.9a
SE±		0.14	0.12	0.12	0.20	31.70	28.2
Inter-row spacing (p)							
Seed broadcast		2.40b	3.0c	2.0b	3.1d	179.6c	168.8d
30cm		2.43b	4.1b	2.1b	3.5c	211.1b	198.3c
60cm		2.53a	4.6a	2.4a	3.8b	211.1b	218.1b
90cm		2.53a	4.8a	2.5a	4.2a	383.6a	248.3a
SE±		0.05	0.06	0.10	0.2	3.91	4.70
Interactions							
W x P		NS[4]	NS	*	*	**	**

1 Means followed by similar letter(s) in the same column and treatment are not significantly different at - = 0.05 (DMRT).
2 On a scale of 0 to 10 where 0 = no weed cover and 10 = complete weed cover
3 WAS = Weeks After Sowing
4 NS = Not significant * = Significant at 5% ** = Significant at 1%

Table 4: Interaction between chemical weed control treatments and inter-row spacing on weed cover scores (6 WAS) in sesame at Samaru in 1995.

Weed Control treatments (W)	Herbicide Rates (Kg a.i./ha)	Inter-row spacing(p)			
		Seed broadcast	30cm	60cm	90cm
Imazaquin	0.18	4.3e[2]	4.6de	4.7de	4.7de
-do-	0.20	4.0f	4.3e	4.7de	4.7de
Metolachlor + metobromuron	0.75 + 0.75	4.0f	4.0f	4.7de	4.7de
-do-	1.0 + 0.5	2.7gh	3.0g	4.0f	4.0f
Metolachlor + diuron	1.0 + 0.5	2.3gh	2.3gh	3.0g	3.0g
-do-	1.5 + 0.5	2.7gh	2.7gh	3.0g	3.0g
Simazine + ametryn	0.75 + 0.75	5.0d	5.0d	6.0c	6.7b
-do-	1.0 + 1.0	5.0d	5.0d	6.0c	6.0c
3 hoe-weeding (3,6 and 9 WAS[3])		1.5i	1.6i	1.0g	1.0j
Weedy check		5.0d	6.7d	8.0a	8.0a
SE± (W x F = 0.19)					

1 Means followed by similar letter(s) in the same column and treatment are not significantly different at P = 0.05 (DMRT).
2 WAS = Weeks After Sowing

Table 5: Interaction between chemical weed control treatments and inter-row spacing on weed cover scores **(6WAS)** in sesame at Samaru in 1996.

Weed control treatments(W)	Herbicide rates (kg a.i./ha)	Seed broadcast	Inter-row spacing(P) 30cm	60cm	90cm
Imazaquin	0.18	3.3hi[1]	3.7gh	4.0fg	4.7e
-do-	0.20	2.7j	3.7gh	3.8fg	4.2f
Metolachlor + metobromuron	0.75 + 0.75	2.2kl	2.7j	2.7j	3.0ij
-do-	1.0 + 1.0	2.2kl	2.5jk	2.7j	2.8j
Metolachlor + diuron	1.0 + 0.25	2.5jk	2.5jk	3.3hi	2.8j
-do-	1.5 + 0.25	2.2kl	2.5jk	2.8j	2.8j
Simazine + ametryn	0.75 + 0.75	4.7e	5.2d	6.0c	6.7a
-do-	1.0 + 1.0	5.0de	5.3d	5.2d	6.2c
3 hoe-weedings at 3, 6 and 9 WAS[2]		1.7m	1.8lm	1.5m	1.5m
Weedy check		4.7e	5.0de	6.3bc	7.0a
SE + (WxP = 0.21)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = **0.05** (DMRT).

2 WAS = Weeks after sowing

4.1.2 Weed dry matter production

Weed dry matter production was significantly affected by weed control treatments and inter-row spacing in both trials (Table 3). All the herbicide treatments resulted in significantly lower weed dry matter production than the weedy check while the hoe-weeded control had the least weed dry matter production. Among the herbicide treatments, metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha and metolachlor + diuron at both rates of 1.0 + 0.5 and 1.5 + 0.5kg a.i./ha significantly produced lower weed dry matter compared with the other herbicide treatments in both trials (Table 3). The least and maximum weed dry matter was produced by seed broadcast and inter-row spacing of 90cm in the two years (Table 3). However, the difference in weed dry matter production between 30cm and 60cm inter-row spacing was only significant in 1995.

The interaction between weed control treatments and inter-row spacing on weed dry matter production was significant in 1995 and 1996 (Figs. 1 and 2). All the herbicide treatments had lower weed dry matter production under closer inter-row spacing and the least quantities were obtained from the application of metolachlor + metobromuron (1.0 + 1.0kg a.i./ha) and metolachlor + diuron (1.5 + 0.25kg a.i./ha) under seed broadcast in 1995 and 1996 respectively (Figs 1 and 2). Application of simazine + ametryn at 1.0 + 1.0kg a.i./ha resulted in comparable weed dry matter weight with the weedy check.

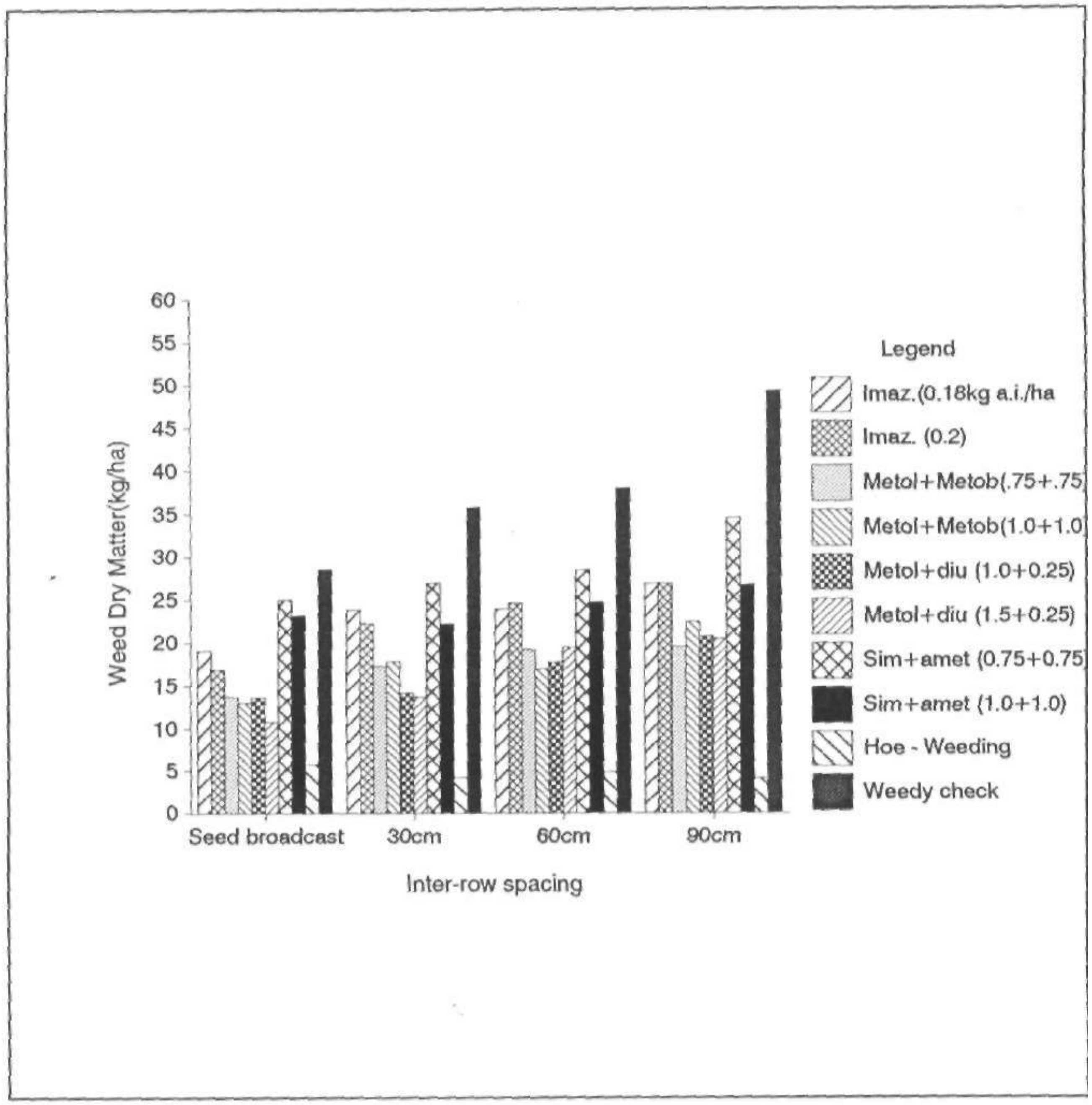

Fig 1

Interactions between chemical weed control treatments and inter-row spacing on weed dry matter production (kg/ha) at 12was in sesame at Samaru,1996.

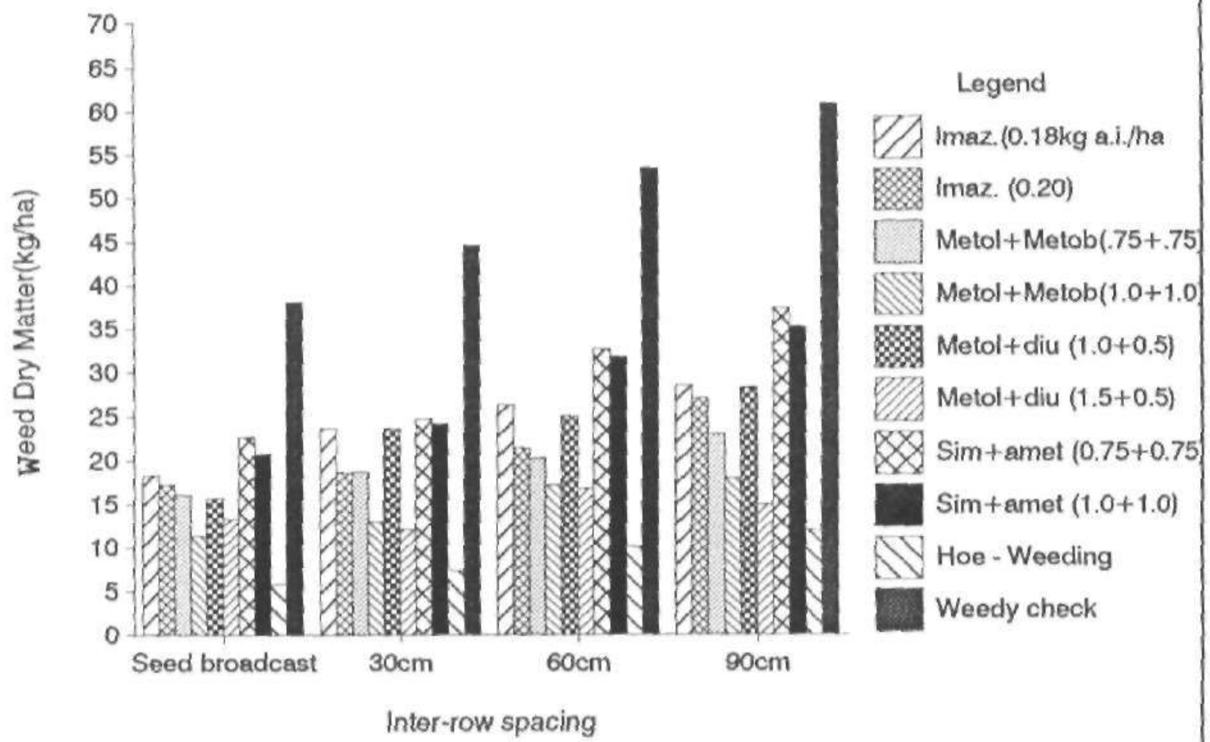

Fig 2

Interactions between chemical weed control treatments and inter-row spacing on weed dry matter production (kg/ha) at 12was in sesame at Samaru 1996.

4.2 Effect of Chemical Weed Control Treatments and Inter-row spacing on Growth and Yield of Sesame

4.2.1 Phytotoxicity rating

All the herbicides showed varying levels of phytotoxicity on the crop (Table 6). Application of metolachlor + metobromuron at both rates (0.75 + 0.75 and 1.0 + 1.0kg a.i./ha) showed the least phytotoxic effect of sesame in both trials while metolachlor + diuron at 1.0 + 0.5 and 1.5 + 0.5kg a.i./ha in 1995 and simazine + ametryn at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha in both years were most phtotoxic to the crop. Phytotoxicity rating was not significantly affected by inter-row spacing. Similarly, the interaction between inter-row spacing and weed control treatments was not significant in both seasons (Table 6).

4.2.2 Crop vigour score

Crop vigour was significantly affected by both weed control treatments and inter-row spacing in both seasons (Table 6). Generally, plants in the herbicide treated plots were less vigorous than the hoe-weeded plants at 3 and 6 WAS. The lower concentration of each herbicide gave higher crop vigour scores than the corresponding higher rates. Application of metolachlor + metobromuron at 0.75 + 0.75kg a.i./ha produced the most vigorous plants at both 3 and 6 WAS in both years. Row spacing also had significant effect on vigour, and plants in the wider inter-rows were more vigorous in growth at 6 WAS (Table 6). However, there was no significant difference in the vigour of plants under seed broadcast and those in 30cm inter-row spacing and also between those planted in 60cm and 90cm inter-row spacing except at 6 WAS in 1996 where crop vigour score increased with increase in inter-row spacing.

The interaction of weed control treatments and inter-row spacing on crop vigour was not significant in both trials (Table 6).

Table 6: Effect of chemical weed control treatments and inter-row spacing on phytotoxicity, vigour and stand count of sesame at Samaru in 1995 and 1996.

Treatments	Herbicide rate (K a.i/ha)	Phytotocity[3] (2WAS)		Crop Vigour Scores[3]				Stand count/net plot at harvets	
		1995	1996	1995	1996	1995	1996	1995	1996
Weed control treatments (W)									
Imazaquin	0.18	2.0e[1]	2.3d	4.0b	3.0e	6.5d	5.7e	283.3	328.8d
-do-	0.20	3.0d	2.9c	3.6c	2.8f	5.3f	5.4e	261.8	354.8d
Metolachlor + Metobromuron	0.75 + 0.75	1.3f	1.5e	4.8a	4.2b	7.9b	7.6b	338.5	428.8b
-do-	1.0 + 1.0	1.3f	2.1d	4.0b	3.9c	7.3c	7.5b	309.8	396.4c
Metolachlor + diuron	1.0 + 0.5	5.6b	2.2d	1.8e	3.8c	4.5g	6.9c	208.6	415.9bc
-do-	1.5 + 0.5	6.7a	2.3d	1.0f	3.3d	2.8h	6.5d	173.7	317.4e
Simazin + Ametryn	0.75 + 0.75	3.6c	3.6d	3.6c	2.9e	5.8e	4.2f	255.3	266.8f
-do-	1.0 + 1.0	3.7c	4.5a	3.0d	2.3g	4.6g	4.2f	231.3	232.9g
3 hoe-weeding (3,6 and 9 WAS[4])		0.3g	0.3f	4.7a	4.8a	8.3a	7.9a	318.2	461.0a
Weedy check		0.3g	0.3f	3.0d	3.4d	4.7g	4.0f	337.2	462.7a
SE±		0.18	0.16	0.15	0.16	0.12	0.11	12.59	13.42
Inte-row spacing (P)									
Seed broadcast		3.0a	2.6a	3.5a	3.6a	5.6c	5.5d	494.9a	620.3a
30cm		3.0a	2.6a	3.5a	3.6a	5.6c	5.8c	321.7b	413.0b
60cm		2.9a	1.5a	3.6a	3.7a	5.8b	6.2b	146.7c	258.3c
90cm		2.9a	2.5a	3.6a	3.7a	6.0a	6.5a	106.9d	177.6d
SE±		0.01	0.01	0.01	0.02	0.04	0.05	2.23	2.49
Interactions									
W x P		NS[5]	NS	NS	NS	NS	NS	**[6]	**

1 Means followed by similar letter(s) in the same column and treatment are not significantly different at P = 0.05 (DMRT).
2 On a scale of 0 to 10 where 0 = no crop injury and 10 = complete crop kill.
3 On a scale of 0 to 10 where 0 = completely retarded growth and 10 - most vigorous plant
4 WAS = Weeks After Sowing 5 NS = Non signifant 6 ** = Significant at 1%.

4.2.3 Stand count

Number of crop stands per plot was significanlty affected by weed control treatments and inter-row spacing (Table 6). The highest number of stands were obtained from the hoe-weeded and unweeded plots in both trials while the least number of stands were obtained from plots treated with metolachlor + diuron at 1.5 + 0.5kg a.i/ha in 1995. However, when the same herbicide was used at the rate of 1.0 + 0.25kg a.i./ha in 1996, the number of stands obtained was comparable to the application of metolachlor + metobromuron at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha. The number of crop stands also increased significantly with narrow inter-row spacing in both trials while the maximum was obtained under seed broadcast.

Similarly, the interaction of inter-row spacing and weed control treatments on this parameter was significant in both trials (Tables 7 and 8). All the weed control treatments had highest values under seed broadcast. Application of metolachlor + metobromuron at 1.5kg a.i./ha under seed broadcast had higher stand count than all herbicide treatment and the hoe-weeded control irrespective of inter-row spacing.

4.2.4 Days to first flowering' 50% flowering and crop maturity

The weed control treatments and inter-row spacing had no significant effect on the number of days to first flowering, 50% flowering and days to crop maturity (Table 9). Similarly, the interaction between inter-row spacing and chemical weed control treatments on these parameters were also not signigicant in both trials (Table 9).

4.2.5 Height to first capsule

Height to first capsule was significantly affected by weed control treatments and inter-row spacing (Table 10). Plants in the unweeded plots mostly had only terminal capsules while plants

Table 7: Interaction between chemical weed control treatments and inter-row spacing on stand count in sesame at **Samaru** in 1995.

Weed control treatments(W)	Herbicides rates (kg a.i./ha)	Seed broadcast	Inter-row spacing(P) 30cm	60cm	90cm
Imazaquin	0.18	511.0c[1]	372.3f	155.3m	95.Oop
-do-	0.20	471.3d	340.0gh	145.7m	90.Oop
Metolachlor + metobromuron	0.75 + 0.75	654.0a	375.0f	185.3kl	139.7mn
-do-	1.0 + 1.0	584.0b	345.3g	178.3l	19.7q
Metolachlor + diuron	1.0 + 0.5	369.0f	236.3j	110.3o	78.0p
-do-	1.5 + 0.5	312.3i	204.7k	99.7op	88.7op
Simazine + ametryn	0.75 0.75	477.3d	322.0hi	133.0mn	81.3p
-do-	1.0 + 1.0	430.7e	308.7i	120.7n	133.0mn
3 hoe-weeding at (3, 6 and 9 WAS[2])		471.0d	354.3fg	154.3m	140.3mn
Weedy check		668.0a	358.7fg	180.3l	
SE ± (W x P = 9.26)					

1 Means followed by similar letter(s) **in both row and** column are not significantly different at P = 0.05 (DMRT).
2 WAS = Weeks After Sowing.

Table 8: Interaction between chemical weed control treatments and inter-row spacing on stand count in sesame at Samaru in 1996.

Weed control treatments(W)	Herbicides rates (kg a.i./ha)	Seed broadcast	Inter-row spacing(P) 30cm	60cm	90cm
Imazaquin	0.18	496.3f[1]	354.0j	258.7n	206.3p
-do-	0.20	580.0d	407.0i	230.7o	201.3p
Metolachlor + metobromuron	0.75 + 0.75	715.0b	478.0fg	303.31	223.0o
-do-	1.0 + 1.0	636.7c	488.7f	261.7n	198.7p
Metolachlor + diuron	1.0 + 0.25	642.0c	493.0f	327.7k	201.0p
-do-	1.5 + 0.25	559.7e	328.7k	226.7o	201.0p
Simazine + ametryn	0.75 + 0.75	494.3f	303.01	176.7q	93.3tu
-do-	1.0 + 1.0	433.3h	287.7m	137.0s	73.7u
3 hoe-weeding at (3, 6 and 9 WAS[2])		583.3d	456.7g	348.0j	
Weedy check		839.0a	497.0f	317.okl	191.3pq
SE ± (W x P - 9.35)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = 0.05 (DMRT).
2 WAS = Weeks After Sowing.

Table 9: Effect of weed control treatments and inter-row spacing on days to first flower, 50% flowering and crop maturity in sesame at Samaru in 1995 and 1996.

Treatments	Herbicide rates (Kg a.i/ha	Days to first flower 1995	Days to first flower 1996	Date of 50% flowering 1995	Date of 50% flowering 1996	Days to maturity 1995	Days to maturity 1996
Weed control treatments (W)							
Imazaquin	0.18	33	35	63	65	104	105
-do-	0.20	34	35	63	65	104	105
Metolachlor + Metobromuron	0.75 + 0.75	33	35	63	65	105	105
-do-	1.0 + 1.0	33	34	65	65	103	105
Metolachlor + diuron	1.0 + 0.5	34	34	65	65	103	105
-do-	1.5 + 0.5	34	34	65	66	103	105
Simazin + Ametryn	0.75 + 0.75	34	35	65	66	103	103
-do-	1.0 + 1.0	34	35	64	64	105	105
3 hoe-weeding (3,6 and 9 WAS[1])		33	35	64	64	105	105
Weedy check		33	34	62	63	100	102
SE±		0.01	0.01	0.02	0.02	0.02	0.02
Inte-row spacing (P)							
Seed broadcast		33	34	64	65	104	104
30cm		33	34	64	65	104	104
60cm		34	35	65	66	105	105
90cm		34	35	65	66	105	105
SE±		0.01	0.01	0.01	0.01	0.02	0.02
Interactions							
W x P		NS[2]	NS	NS	NS	NS	NS

1 WAS = Weeks After Sowing
2 NS = Not significant

in the herbicide treated and hoe-weeded plots bore capsules throughout the entire part of their stem-length.

In 1995, all the herbicides tested except metolachlor + metobromuron at both rates (0.75 + 0.75 and 1.0 + 1.0 kg a.i./ha) resulted in comparable height to first capsule with the hoe-weeded control (Table 10). However in 1996, only plants treated with metolachlor + diuron at 1.0 + 1.0 kg a.i./ha was comparable to the hoe-weeded plants in values of height to first capsule. The parameter also increased with closer row spacing and only small fraction of stem-length bore capsules under seed broadcast having greater values of height to first capsule while the first capsules were bored closer to the ground level under 90cm inter-row spacing.

The interaction of chemical weed control treatments and inter-row spacing on height to first capsule was significant in each of the trials (Tables 11 and 12). The maximum values were obtained from plants treated with simazine + ametryn at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha under seed broadcast in 1995 and 1996, respectively. Similarly, all the other herbicide treatments had higher values of this parameter under seed broadcast.

4.2.6 <u>Plant height</u>

Plant height was significantly affected by the weed control treatments and inter-row spacing (Table 10). All the herbicide treatments produced significantly taller plants than the weedy check in both trials. However, among the herbicide treatments, plants in plots treated with metolachlor + metobromuron at both rates (0.75 + 0.75 and 1.0 + 1.0kg a.i./ha) were tallest in height and these were comparable to those in hoe-weeded control in 1995. The application of metolachlor + metobromuron (0.75 + 0.75 and 1.0 + 1.0kg a.i./ha) and metolachlor + diuron (1.0 + 0.25 and 1.5 + 0.25kg a.i./ha) resulted in plant heights comparable to the hoe-weeded plots. Plant height decreased significantly with increase in inter-row spacing and the maximum values were obtained under seed broadcast in both trials (Table 10).

Table 10: Effect of chemical weed control treatments and inter-row spacing on height to first capsule and plant height in sesame at Samaru in 1995 and 1996.

Treatments	Herbicide rates (Kga.i./ha)	Height of first capsule at harvest (cm)		Plant height at harvest (cm)	
		1995	1996	1995	1996
Weed control treatments (w)					
Imazaquin	0.18	62.43a[1]	52.42c	98.15b	97.83c
-do-	0.20	64.21a	57.25b	102.65b	95.83c
Metolachlor + metobromuron	0.75 + 0.75	49.34d	52.67c	122.63a	108.42ab
-do-	1.0 + 1.0	57.42bc	61.08b	126.70a	117.08ab
Metolachlor + diuron	1.0 + 0.5	63.50a	59.17b	72.44c	111.25ab
-do-	1.5 + 0.5	62.36a	57.92b	78.70c	108.75ab
Simazine + ametryn	0.75 + 0.75	61.33ab	59.00b	82.41c	85.33d
-do-	1.0 + 1.0	64.65a	65.92a	78.25c	80.08d
3 hoe-weeding (3,6 and 9 WAS[2])		66.33a	68.33a	115.34a	120.00a
Weedy check		53.54c	44.08d	63.19d	50.25e
SE±		2.17	2.03	5.25	4.63
Inter-row spacing(P)					
Seed broadcast		69.54a	65.67a	114.60a	108.00a
30cm		66.51b	60.87b	102.56b	101.60a
60cm		56.23c	53.97c	89.84c	87.53b
90cm		48.52d	48.70d	84.87c	82.80b
SE±		0.77	0.65	4.5	5.6
Interactions					
W x P		**[3]	**	**	**

1 Means followed by similar letter(s) in the same column and treatment are not significantly different at P = 0.05 (DMRT)
2 WAS = Weeks After Sowing. 3 ** = Significant at P = 0.01.

Table 11: Interaction of chemical weed control treatments and inter-row spacing on plant height to first capsule in sesame at Samaru in 1995.

Weed control treatments(W)	Herbicide rates (kg a.i./ha)	Seed broadcast	Inter-row spacing(P) 30cm	60cm	90cm
Imazaquin	0.18	71.53a-d[1]	66.47c-f	56.17i-n	49.53mo
-do-	0.20	71.85a-d	67.33b-e	55.67i-n	53.00k-o
Metolachlor + metobromuron	0.75+ 0.75	73.67abc	74.67ab	58.33g-k	50.00l-o
-do-	1.0 + 1.0	65.33d-h	64.67d-h	54.00j-o	33.00p
Metolachlor + diuron	1.0 + 0.5	67.33b-e	66.67b-f	48.67no	47.00o
-do-	1.5 + 0.5				
Simazine + ametryn	0.75 + 0.75	75.33a	63.00e-i	55.67i-n	55.33i-n
-do-	1.0 + 1.0	72.67a-d	62.67e-i	56.00i-n	55.00i-n
3 hoe-weeding at (3, 6 and 9 WAS[2])		69.00a-e	70.00a-e	62.00e-j	56.33i-n
Weedy check		63.00e-i	59.00f-k	52.33k-o	39.67p
SE ± (W x P = 2.42)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = 0.05 (DMRT).
2 WAS = Weeks After Sowing.

Table 12: Interaction between chemical weed control treatments and inter-row spacing on height to first capsule in sesame at Samaru in 1996.

Weed control treatments(W)	Herbicide rates (kg a.i./ha)	Seed broadcast	Inter-row spacing(P) 30cm	60cm	90cm
Imazaquin	0.18	66.67a-d[2]	57.00d-g	44.33jk	41.67k
-do-	0.20	66.33a-d	66.00a-d	52.00f-j	44.67ijk
Metolachlor + metobromuron	0.75 + 0.75	60.33c-f	48.67g-k	54.33e-i	47.33h-k
-do-	1.0 + 1.0	69.00abc	65.33a-d	57.33d-g	52.67e-j
Metolachlor + diuron	1.0 + 0.25	66.67a-d	61.33b-f	62.33b-e	46.33ijk
-do-	1.5 + 0.25				
Simazine + ametryn	0.75 + 0.75	66.67a-d	64.67b-d	60.00c-f	44.67ijk
-do-	1.0 + 1.0	75.00a	75.00a	54.67e-i	59.00d-g
3 hoe-weeding at (3, 6 and 9 WAS[2])		68.67abc	55.33a-d	57.33d-g	62.00b-e
Weedy check		47.00h-k	47.00h-k	39.33k	43.00k
SE ± (W x P = 3.43)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = 0.05 (DMRT).
2 WAS = Weeks After Sowing.

The interaction between the inter-row spacing and weed control treatments on plant height was significant in both trials (Tables 13 and 14). In 1995, the tallest plants were obtained in plots treated with metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha under seed broadcast in 1995 while in 1996, plots established by seed broadcast and treated with metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha produced the tallest plants comparable to that obtained with hoe-weeded control under seed broadcast in both trials.

4.2.7 Number of branches per plant

The effect of inter-row spacing and weed control treatments on number of branches per plant was significant in both trials (Table 15). In 1995, plants treated with metolachlor + metobromuron at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha had the highest numbers of branches which were comparable to that obtained from the hoe-weeded control.

In 1996, the highest number of branches per plant was recorded from plots treated with metolachlor + diuron at 1.0 + 0.25kg a.i./ha which was not significantly different from the hoe-weeded control. Application of imazaquin at 0.20kg a.i./ha and simazine + ametryn at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha resulted in similar effect on the number of branches per plant in each of the trials. The number of branches per plant also increased significantly with increase in inter-row spacing and the maximum values were obtained under 90cm inter-row spacing in each trial.

The interaction between chemical weed control treatments and inter-row spacing on number of branches produced in sesame was significant in both years (Tables 16 and 17). All the chemical weed control treatments had higher number of branches per plant under the maximum inter-row spacing of 90cm. In 1995, application of metolachlor + metobromuron at

Table 13: Interaction between chemical weed control treatments and inter-row spacing on height of sesame at Samaru in 1995.

Weed control treatments(W)	Herbicides rates (kg a.i./ha)	Seed broadcast	Inter-row spacing(P) 30cm	60cm	90cm
Imazaquin	0.18	115.62c-g[1]	102.64e-j	89.84j-o	85.79k-p
-do-	0.20	118.11cde	103.11e-j	95.89i-m	101.93f-j
Metolachlor + metobromuron	0.75 + 0.75	141.30ab	127.24bc	97.56h-l	94.00i-n
-do-	1.0 + 1.0	145.33a	127.44bc	114.45c-g	107.32d-i
Metolachlor + **diuron**	1.0 + 0.5	122.33cd	116.74c-f	114.91c-g	119.0cde
-do-	1.5 + 0.5				
Simazine + ametryn	0.75 + 0.75	81.891-q	71.33p-s	62.77rs	58.81s
-do-	1.0 + 1.0	113.70c-h	99.50g-k	80.87m-q	75.560-r
3 hoe-weeding at (3, 6 and 9 WAS[2])		140.35ab	116.34c-g	106.79e-j	102.50f-j
Weedy check		70.76p-s	65.57qrs	62.77rs	58.81s
SE ± (W x P= 4.89)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = 0.05 (DMRT).
2 WAS = Weeks After Sowing.

Table 14: Interaction between chemical weed control treatments and inter-row spacing on hieght of sesame at Samaru in 1996.

Weed control treatments(W)	Herbicides rates (kg a.i./ha)	Inter-row spacing(P) Seed broadcast	30cm	60cm	90cm
Imazaquin	0.18	110.33de[1]	95.00g-k	85.00k-n	76.67no
-do-	0.20	106.67def	103.33e-h	91.67i-m	81.67mn
Metolachlor + metobromuron	0.75 + 0.75	116.67cd	95.00g-k	85.00k-n	85.00k-n
-do-	1.0 + 1.0	141.67a	130.00ab	105.00efg	93.33h-l
Metolachlor + diuron	1.0 + 0.25	125.00bc	123.33bc	103.33e-h	93.33h-l
-do-	1.5 + 0.25				
Simazine + ametryn	0.75 + 0.75	86.67j-n	95.00g-k	82.67lmn	77.00no
-do-	1.0 + 1.0	95.00g-k	88.33i-n	69.33op	67.67opq
3 hoe-weeding at (3, 6 and 9 WAS[2])		140.00a	121.67bc	108.33cd	108.33cd
Weedy check		53.33pq	54.33pq	45.00r	48.33qr
SE ± (W x P = 4.10)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = 0.05 **(DMRT)**.

2 WAS = Weeks After Sowing.

Table 15: Effect of Chemical Weed control treatments and inter-row spacing on number of branches and number of capsule per plant in Sesame at Samaru in 1995 and 1996.

Treatments	Herbicides Rate (Kg a.i./ha)	Number of branches/plant at harvest		Number of Cpsules/plant at harvest	
		1995	1996	1995	1996
Weed Control Treatments (W)					
Imazaquin	0.18	5.9b[1]	3.8d	72.8d	58.7c
-do-	0.20	4.7c	4.1d	79.6cd	53.5c
Metolachlor + Metobromuron	0.75 + 0.75	8.6a	5.9c	98.8a	65.7b
-do-	1.0 + 1.0	9.0a	6.0bc	92.8ab	87.3a
Metolachlor + diuron	1.0 + 0.5	3.0d	4.4d	41.1f	70.6b
-do-	1.5 + 0.5	2.8d	6.7ab	36.2f	71.0b
Simazin + Ametryn	0.75 + 0.75	4.6c	4.0d	57.8e	34.5d
-do-	1.0 + 1.0	4.1c	4.2d	40.4f	54.2c
3 hoe-weeding (3,6 and 9 WAS[4])		8.4a	7.2a	86.3bc	84.8a
Weedy check		1.1e	1.6e	8.0g	9.3e
SE±		0.48	0.33	3.53	3.25
Inte-row spacing (P)					
Seed broadcast		3.4d	2.9d	32.8d	31.6d
30cm		4.1c	3.5c	49.3c	44.6c
60cm		5.8b	5.6b	70.1b	70.8b
90cm		7.5a	7.1a	93.4a	88.9a
SE±		0.13	0.20	1.8	1.53
Interactions					
W x P		**[3]	**	**	**

1 Means followed by similar letter(s) in the same column and treatment are not significantly different at P = 0.05 (DM
2 WAS = Week After Sowing. 3 Significant at P = 0.01

Table 16: Interaction between chemical weed control treatments and inter-row spacing on number of branches per plant in sesame at Samaru in 1995.

Weed control treatments(W)	Herbicide rates (kg a.i./ha)	Seed broadcast	Inter-row spacing(P) 30cm	60cm	90cm
Imazaquin	0.18	3.4k-p[1]	4.2j-n	5.8fgh	7.5de
-do-	0.20	3.8j-n	4.7h-l	7.1ef	8.6cd
Metolachlor + metobromuron	0.75 + 0.75	3.3l-q	3.31l-q	5.7f-i	6.4efg
-do-	1.0 + 1.0	5.8fgh	6.4efg	9.3bc	12.8a
Metolachlor + diuron	1.0 + 0.05	5.9fgh	6.8ef	10.0b	13.34a
-do-	1.5 + 0.5	2.0q	3.2m-q	3.4k-p	4.3i-m
Simazine + ametryn	0.75 + 0.75	2.3opq	2.2pq	3.3l-q	3.4l-q
-do-	1.0 + 1.0	3.7k-o	3.9j-n	4.8h-k	5.9fgh
3 hoe-weeding at (3, 6 and 9 WAS[2])		5.8g-j	5.2g-j	9.6bc	12.9a
Weedy check		2.0q	2.2pq	2.3opq	2.3opq
SE ± (W x P = 0.42)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = 0.05 (DMRT).
2 WAS = Weeks After Sowing.

Table 17: Interaction between chemical weed control treatments and inter-row spacing on number of branches per plant in sesame at Samaru in 1996.

Weed control treatments(W)	Herbicide rates (kg a.i./ha)	Seed broadcast	Inter-row spacing(P) 30cm	60cm	90cm
Imazaquin	0.18	2.7lm[1]	2.8lm	4.0jkl	5.8fgh
-do-	0.20	2.8lm	3.1lm	4.1i-l	6.5efg
Metolachlor + metobromuron	0.75 + 0.75	3.7j-m	4.0jkl	7.8b-e	8.0bcd
-do-	1.0 + 1.0	3.7j-m	4.7h-k	6.7d-g	9.0ab
Metolachlor + diuron	1.0 + 0.25	2.8lm	3.4klm	5.7gh	5.5ghi
-do-	1.5 + 0.25	3.8i-m	4.7h-k	8.1bc	9.3ab
Simazine + ametryn	0.75 + 0.75	2.4m	2.9lm	5.1hij	5.5ghi
-do-	1.0 + 1.0	2.71m	2.7lm	4.9h-k	6.3efg
3 hoe-weeding at (3, 6 and 9 WAS[2])		3.0lm	4.7h-k	8.4bc	12.5a
Weedy check		1.5n	1.7n	1.6n	1.5n
SE ± (W x P = 0.50)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = 0.05 (DMRT).
2 WAS = Weeks After Sowing

1.0 + 1.0kg a.i./ha and simazine + ametryn at 1.0 + 0.5kg a.i./ha produced the highest number of branches per plant under inter-row spacing of 90cm. In 1996, application of metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha and metolachlor + diuron at 1.5 + 0.25kg a.i./ha produced number of branches per plant comparable to the maximum obtained from hoe-weeded control under the same inter-row spacing of 90cm.

4.2.8 Number of capsules per plant

The number of capsules per plant was significantly affected by weed control treatements and inter-row spacing in both seasons (Table 15). All the weed control treatments had higher number of capsules per plant than unweeded control. Application of metolachlor + metobromuron at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha resulted in the highest values of this character which were comparable to the hoe-weeded control in 1995 and 1996 respectively. Number of capsules per plant also increased with increase in inter-row spacing and the maximum was obtained under 90cm inter-row spacing in each trial.

The interactions of chemical weed control treatments and inter-row spacing on the number of capsules per plant were significant in both seasons (Tables 18 and 19). All the weed control treatments resulted in higher inter-row spacing in each trial. The application of metolachlor + metobromuron at both rates under 90cm inter-row spacing resulted in the highest number of capsules per plant in both seasons. Similarly all the other weed control treatments had higher number of capsules per plant in 90cm inter-row spacing than that obtained in the other row spacings.

Table 18: Interaction between chemical weed control treatments and inter-row spacing on number of capsules per plant in sesame at Samaru in 1995.

Weed control treatments(W)	Herbicide (kg a.i./ha)	Seed broadcast	Inter-row spacing(P) 30cm	60cm	90cm
Imazaquin	0.18	32.2p-t[1]	47.7l-p	66.4ijk	91.2d-g
-do-	0.20	32.8p-t	61.7jkl	85.9e-h	99.8c-f
Metolachlor + metobromuron	0.75 + 0.75	34.3c-s	42.9m-p	67.7ijk	137.2a
-do-	1.0 + 1.0	70.9h-k	83.2f-i	103.9cde	144.2a
Metolachlor + diuron	1.0 + 0.5	52.3k-o	71.6hij	105.3cd	115.4bc
-do-	1.5 + 0.5	19.2st	32.0p-t	45.8l-p	67.3ijk
Simazine + ametryn	0.75 + 0.75	14.2tu	31.2p-t	43.8l-p	55.7j-n
-do-	1.0 + 1.0	22.1rst	38.6n-r	60.8j-m	93.3def
3 hoe-weeding at (3, 6 and 9 WAS[2])		115.4bc	129.7ab	135.5a	142.1a
Weedy check		14.2tu	19.2st	22.2rst	23.8q-t
SE ± (W x P = 5.68)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = 0.05 (DMRT).

2 WAS = Weeks After Sowing.

Table 19: Interaction between chemical weed control treatments and inter-row spacings on number of capsules per plant in sesame at Samaru in 1996.

Weed control treatments(W)	Herbicide rates (kg a.i./ha)	Inter-row spacing(P) Seed broadcast	30cm	60cm	90cm
Imazaquin	0.18	24.7no[2]	35.0mn	78.3ghi	96.7c-f
-do-	0.20	36.0mn	36.6mn	64.0ij	77.0ghi
Metolachlor + metobromuron	0.75 + 0.75	32.0mno	33.7mno	82.3fgh	114.7ab
-do-	1.0 + 1.0	46.7klm	69.0hij	105.3bcd	128.3a
Metolachlor + diuron	1.0 + 0.25	39.7lmn	66.7hij	67.3hij	111.3bc
-do-	1.5 + 0.25	38.3mn	58.3jk	88.3efg	99.0b-e
Simazine + ametryn	0.75 + 0.75	19.0op	23.3no	40.0lm	55.7jkl
-do-	1.0 + 1.0	30.7mno	31.7mno	73.7ghi	80.7fgh
3 hoe-weeding at (3, 6 and 9 WAS[2])		36.7mn	81.7fgh	100.7b-e	120.3ab
Weedy check		11.3p	9.7p	10.7p	5.7q
SE ± (W x P = 5.82)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = 0.05 (DMRT).

2 WAS = Weeks After Sowing.

4.2.9 Plant dry matter production

Plant dry matter production was significantly affected by the weed control treatments and inter-row spacing (Table 20). All the herbicide treatments had higher plant dry matter than the unweeded control. Plots treated with metolachlor + metobromuron at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha produced highest plant dry matter comparable to hoe-weeded control in 1995 and 1996, respectively. The parameter also increased with wider inter-row spacing and the maximum was obtained under the inter-row spacing of 90cm in both years. However, there was no significant difference in dry matter production between seed broadcast and 30cm and also between 60cm and 90cm inter-row spacing.

The interaction of weed control treatments and inter-row spacing on plant dry matter production was only significant in 1996 (Table 21). The maximum plant dry matter production was obtained from the application of metolachlor + metobromuron at 1.0 + 1.0kg a.i.ha under 90cm inter-row spacing. Similarly, all the other herbicide treatments had higher plant dry matter production under the inter-row spacing of 90cm.

Table 20: Effect of chemical weed control treaments and row spacing on dry matter production and 1,000 seed weight in sesame at Samaru in 1995 and 1996.

Treatments	Herbicides Rate (kg a.i./ha)	Dry matter production (g)/plant) 1995	Dry matter production (g)/plant) 1996	1000 seed weight(g) 1995	1000 seed weight(g) 1996
Weed control treatments (W)					
Imazaquin	0.18	3.33c[1]	7.68d	3.16cd	3.12c
"	0.20	3.08c	5.82e	3.19cd	3.20c
Metolachlor + metobromuron	0.75 + 0.75	4.63a	9.64c	3.61b	3.43a
"	1.0 + 1.0	4.61a	11.86a	3.82a	3.45a
Metolachlor + diuron	1.0 + 0.5	4.58a	8.88d	3.03d	3.36b
"	1.5 + 0.5	1.31d	7.43d	3.31c	3.36b
Simazine + ametryne	0.75 + 0.75	2.83e	2.53f	3.12c	2.94d
"	1.0 + 1.0	2.49f	2.54f	2.86e	2.91d
3 hoe weedings at (3, 6 and 9 WAS[2])		3.38b	10.39b	3.14cd	3.52a
Weedy check		0.91g	0.70g	2.63f	2.60e
SE ±		0.11	0.52	0.10	0.04
Inter-row (P)					
Seed broadcast		2.66b	5.20b	3.11b	3.01b
30cm		2.76b	5.92b	3.11b	3.11b
60cm		3.00a	7.97a	3.25a	3.27a
90cm		3.23a	8.49a	3.28a	3.32a
S.E ±		0.04	0.25	0.04	0.03
Interactions					
W x P		NS[3]	*[4]	NS	NS

1 Means follwoed by similar letter (s) in the same column and treatment are not signficantly differents at P = 0.05 (DMRT).
2 WAS = Weeks after sowing. 3 Not significant. 4 Significant at 5% (P = 0.05)

Table 21: Interactions between chemical weed control treatments and inter-row spacing on DM production per plant in sesame at Samaru in 1996.

Weed control treatments(W)	Herbicide rate (kg a.i./ha)	Inter-row spacing(P)			
		Seed broadcast	30cm	60cm	90cm
Imazaquin	0.18	5.97i[1]	6.80h	8.43f	9.53e
-do-	0.20	5.60i	4.93j	5.73i	7.00g
Metolachlor + metobromuron	0.75 + 0.75	8.53f	7.23g	8.97f	12.63b
-do-	1.0 + 1.0	7.80g	10.03d	12.73b	16.87a
Metolachlor + diuron	1.0 + 0.25	6.87h	7.47g	9.90e	11.27c
-do-	1.5 + 0.25	5.40i	7.80g	7.30g	9.23e
Simazine + ametryn	0.75 + 0.75	1.37m	1.86m	3.07k	3.03k
-do-	1.0 + 1.0	1.73m	2.001	3.33k	3.10k
3 hoe-weeding at (3, 6 and 9 WAS[2])		8.17f	10.30d	10.33d	12.77b
Weedy check		0.60n	0.80n	0.90n	0.50n
SE ± (W x P = 0.78)					

1 Means followed by similar letter(s) in both row and column are not significantly different at P = 0.05 (DMRT).

2 WAS = Weeks After Sowing.

4.2.10 Weight of 1000 seeds

The weight of 1000 seeds of sesame was significantly affected by weed control treatment and inter-row spacing in both years (Table 20). All the herbicide treated plots had higher 1000 seed weight than weedy check. Application of metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha produced the maximum seed weight in 1995 while the same herbicide at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha produced the highest seed weights and were comparable to the hoe-weeded control in 1996 (Table 20). Weight of 1000 seeds increased with wider inter-row spacing and the maximum was obtained under 90cm inter-row spacing in both years. However, no significant difference was observed in seed weight of sesame under seed broadcast and 30cm and also between 60cm and 90cm inter-row spacings in each year.

The interaction of inter-row spacing and weed control treatments on seed weight was not significant in both trials (Table 20).

4.2.11 Seed yield per plant

Seed yield per plant was significantly affected by weed control treatments and inter-row spacing (Table 22). All the herbicide treatments had higher seed yield per plant than the unweeded control in both seasons. Similaly, the application of metolachlor + metobromuron at both rates resulted in higher values of this character than that obtained from the hoe-weeded control in both seasons. Seed yield per plant also increased with increase in inter-row spacing and the maximum was obtained from inter-row spacing of 90cm.

The interaction between weed control treatments and the inter-row spacing on seed yield per plant was highly significant (Table 23 and 24). Sesame sown at an inter-row spacing of 90cm and treated with metolachlar + metobromuron at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha produced the highest seed yield per plant in 1995 and 1996, respectively. All the other herbicide treatments had maximum seed yield per plant under the 90cm inter-row spacing in each year, while the seed yield per plant was lowest under seed broadcast of each weed control treatment in both years.

Table 22: Effects of chemical weed control treaments and inter-row spacing on seed yield of sesame at Samaru in 1995 and 1996.

Treatments	Herbercides Rate (kg a.i./ha)	Seed Yield (g/plant) 1995	Seed Yield (g/plant) 1996	Seed Yield(kg/ha) 1995	Seed Yield(kg/ha) 1996
Weed control treatments (W)					
Imazaquin	0.18	4.1cd[1]	3.5f	235.7c	284.0b
"	0.20	4.9c	3.4f	226.7c	288.2b
Metolachlor + metobromuron	0.75 + 0.75	13.6a	9.3a	260.8b	374.4a
"	1.0 + 1.0	8.2b	7.7b	317.2a	385.1a
Metolachlor + diuron	1.0 + 0.5	2.1ef	5.9d	161.7d	367.6a
"	1.5 + 0.5	3.9cd	4.7e	170.7d	281.6b
Simazine + ametryne	0.75 + 0.75	3.2de	2.9g	159.6d	121.6c
"	1.0 + 1.0	2.5ef	2.8g	120.7e	107.8c
3 hoe weedings at (3, 6 and 9 WAS[2])		5.0c	5.6c	260.6b	374.2a
Weedy check		1.6f	1.4h	49.2f	43.7d
SE ±		0.57	0.33	15.45	13.63
Inter-row spacing (P)					
Seed broadcast		3.1d	3.1d	235.7a	315.4a
30cm		3.9c	3.7c	230.2a	322.2a
60cm		6.0b	5.0b	181.5b	236.8b
90cm		6.8a	5.7a	137.6c	184.11c
S.E ±		0.2	0.2	12.30	15.31
Interactions					
W x P		**[3]	**	**	**

1 Means follwoed by similar letter (s) in the same column and treatment are not signficantly differents at **P = 0.05 (DMRT)**.
2 WAS = Weeks after sowing.
3 Significant at 1% (P = 0.01)

Table 23: Interaction between chemical weed control treatments and inter-row spacing on seed yield (g/plant) in sesame at Samaru in 1995

Weed Control Treatments(W)	Herbicide rate kg a.i./ha)	Seed broadcast	Inter-row spacing(P) 30cm	60cm	90cm
Imazaquin	0.18	2.20p-s[1]	2.40n-r	5.03hij	4.73ij
-do-	0.20	3.07lmn	3.30klm	3.37kl	7.73f
Metolachlor + metobromuron	0.75 + 0.75	8.53e	9.00e	17.87b	19.17a
-do-	1.0 + 1.0	5.10hi	5.37ghi	10.80d	11.53c
Metolachlor + diuron	1.0 + 5.0	1.53stu	2.30o-r	3.03l-r	2.67l-p
-do-	1.5 + 5.0	2.43n-r	4.60ij	5.90g	1.90q-t
Simazine + ametryn	0.75 + 0.75	1.90q-t	3.4kl	4.00jk	1.77r-u
-do-	1.0 + 1.0	2.30o-r	3.10lmn	3.33klm	3.33klm
3 hoe-weeding (3,6 and 9 WAS[2])		3.5kl	5.57gh	5.53gh	5.37ghi
Weedy check		0.6v	1.10uv	2.20p-s	2.57m-q
SE± (W x P = 0.58)					

1 Means followed by similar letter (s) in the both row and column are not significantly different at $P = 0.05$ (DMRT).
2 WAS = Weeks After Sowing.

Table 24: Interaction between chemical weed control treatments and inter-row spacing on seed yield (g/plant) in sesame at Samaru in 1996.

Weed Control Treatments(W)	Herbicide rate kg a.i./ha)	Inter-row spacing(P)			
		Seed broadcast	30cm	60cm	90cm
Imazaquin	0.18	2.03no[1]	2.33mn	2.67mn	2.80k-n
-do-	0.20	2.13no	2.13no	2.40mn	3.10j-m
Metolachlor + metobromuron	0.75 + 0.75	5.47ef	5.17ef	6.53d	7.97b
-do-	1.0 + 1.0	5.10ef	5.67e	7.47bc	8.80a
Metolachlor + diuron	1.0 + 0.25	3.63hij	3.56h-k	5.50e	7.06cd
-do-	1.5 + 0.25	2.97j-m	4.10ghi	2.40i-l	4.20gh
Simazine + ametryn	0.75 + 0.75	1.13p	1.43op	2.53mn	1.53mn
-do-	1.0 + 1.0	1.12p	1.53op	2.63lmn	2.00no
3 hoe-weeding (3,6 and 9 WAS[2])		3.03j-m	5.46ef	6.33d	8.30ab
Weedy check		0.33q	0.47q	0.67q	0.30q
SE± (W x P = 0.44)					

1 Means followed by similar letter (s) in the both row and column are not significantly different at P = 0.05 (DMRT).
2 WAS = Weeks After Sowing.

4.2.12 Seed yield per hectare

Weed control treatments and inter-row spacing had significant effect on seed yield per hectare (Table 22). All the herbicide treatments resulted in higher seed yield per hectare than the weedy check. Maximum seed yield was obtained from the application of metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha in both seasons. The application of metolachlor + metobromuron at 0.75 + 0.75kg a.i./ha also gave very high seed yield which was only comparable to hoe-weeded control in 1995. Similarly, the application of metolachlor + diuron at 1.0 + 0.25kg a.i./ha resulted in seed yield which was comparable with hoe-weeded control in 1996. Seed yield per hectare also increased significantly with closer inter-row spacing and the maximum was obtained with seed broadcast although there was no significant difference between 30cm and seed broadcast in each year.

The interaction between weed control treatments and inter-row spacing on this characater was highly significant in each trial (Fig. 3 and 4). The highest seed yield of 401.00 and 511.26kg/ha were obtained from the application of metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha under 30cm inter-row spacing in 1995 and 1996, respectively. The application of metolachlor + diuron at 1.0 + 0.25kg a.i/ha and imazaquin at 0.20kg a.i./ha resulted in comparable seed yield under seed broadcast and 30cm inter-row spacing in 1996. All the herbicide treatments produced higher seed yield per hectare under seed broadcast and inter-row spacing of 30cm.

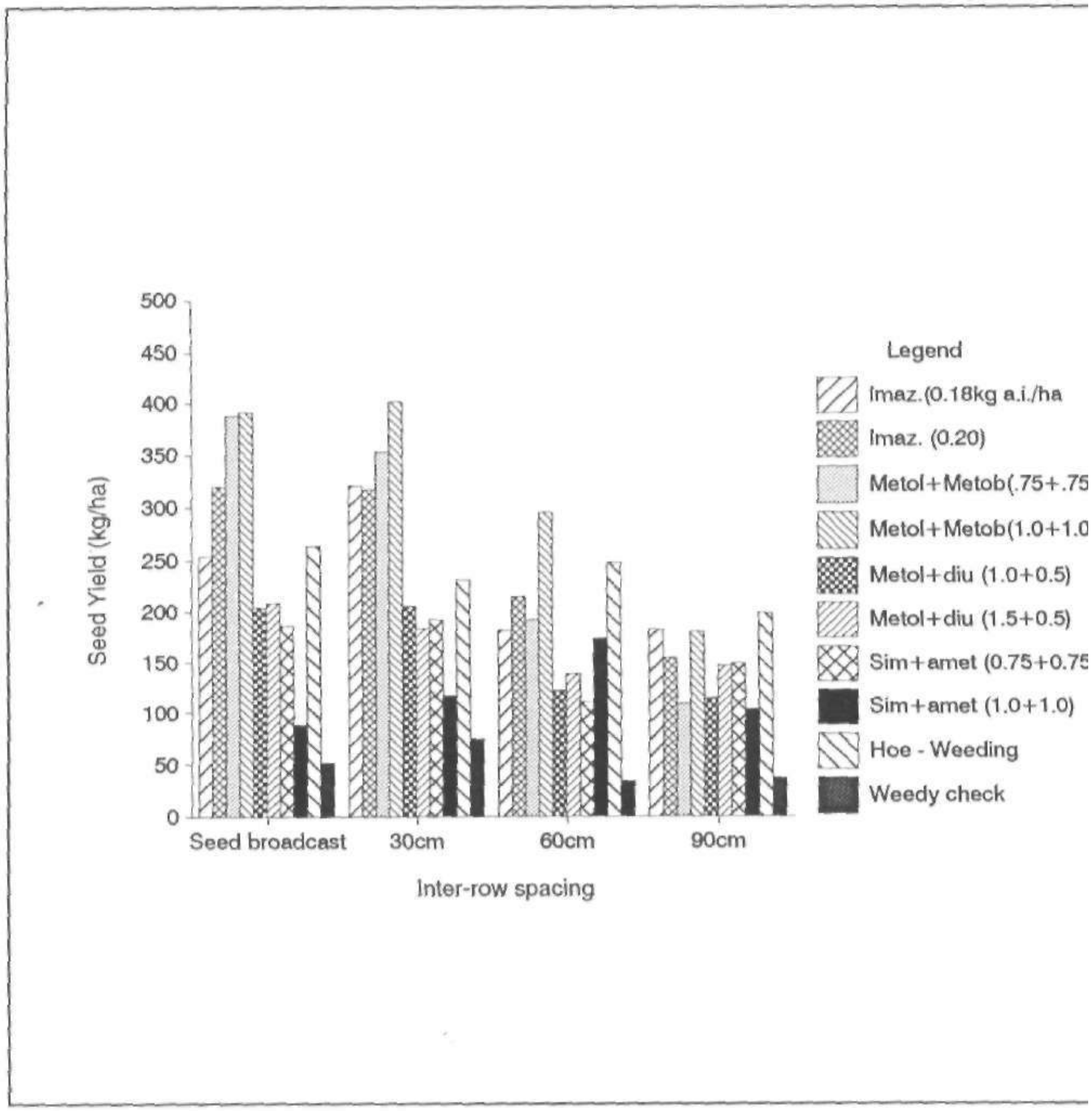

Fig 3
Interactions between chemical weed control treatments and inter-row spacing on seed yield per hectare in sesame at Samaru 1995.

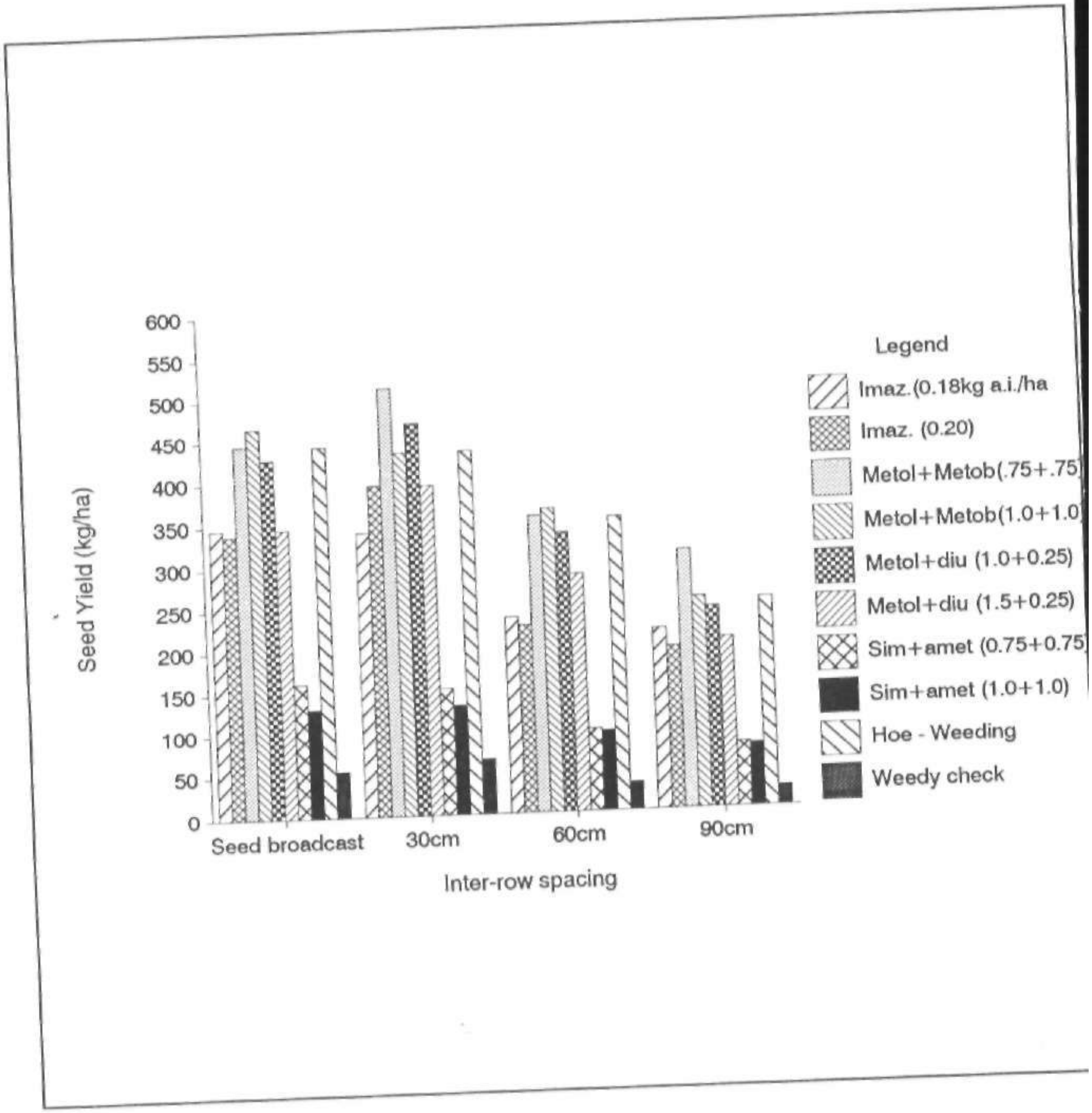

Fig 4
Interactions between chemical weed control treatments and inter-row spacing on seed yield per hectare in sesame at Samaru 1996.

4.3 Correlation

Results of correlation analysis of seed yield per hectare with some growth and yield components of sesame showed a significant positive correlation with crop vigour, stand count, plant height, number of capsules, 1000 seed weight and seed yield per plant in both trials (Table 25 and 26). However, seed yield per hectare was significant and negatively correlated with phytotoxicity rating, weed cover score and weed dry matter prodution.

Seed yield per plant was significant and possitively correlated with crop vigour, number of branches, number of capsules and dry matter production per plant in both years (Tables 25 and 26). However, seed yield per plant was significant and negatively correlated with weed cover and weed dry matter production in both years. The negative correlation between seed yield and pytotoxicity was only significant in 1995.

Table 25: Correlation matrix (r) between seed yield per hectare with crop and weed parameters (1995).

1	2	3	4	5	6	7	8	9	10	11	12	13
1.000												
-0.197*	1.000											
0.422**	-0.729**	1.000										
-0.421**	-0.444**	-0.026	1.000									
0.338**	-0.305**	0.108	-0.160	1.000								
0.431**	-0.207*	0.211*	-0.029	0.425**	1.000							
0.266**	-0.347**	0.687**	-0.139	0.339**	0.185	1.000						
0.199*	-0.001	0.035	-0.098	-0.100	-0.041	0.046	1.000					
0.058	-0.118	0.337**	-0.092	0.686**	0.029	-0.689**	-0.093	1.000				
-0.578**	-0.198*	-0.283**	-0.818**	0.234*	-0.155	-0.330**	-0.099	-0.057	1.000			
-0.504**	-0.517**	0.852**	-0.157	-0.003	0.262**	0.809**	0.237*	-0.358**	-0.466**	1.000		
-0.198*	-0.291**	0.568**	-0.370**	-0.226*	0.117	0.729**	0.332**	-0.534**	-0.217*	0.686**	1.000	
0.429**	-0.008	0.414**	-0.309**	0.147	0.164	0.575**	0.062	-0.345**	-0.435**	0.582**	0.616**	1.0

Key:

1 = Seed yield/ha
2 = Phytotoxicity
3 = Crop vigour (6 WAS)
4 = Weed cover (6 WAS)
5 = Stand count
6 = Plant height
7 = No. of branches/plant
8 = No. of Capsules/plant
9 = Height of first capsule
10 = Weed DM/M^2
11 = Dry matter production/plant
12 = Yield/plant
13 = 1000 seed wt.

** = Significant at 1%
* = Significant at 5%
r (P=0.05) = 0.195
r (P=0.01) = 0.254

Table 26: Correlation matrix (r) between seed yield per hectare with crop and weed parameters (1996).

1	2	3	4	5	6	7	8	9	10	11	12	13
1.000												
-0.113*	1.000											
0.661**	-0.007**	1.000										
-0.820**	-0.104	-0.789**	1.000									
0.462**	-0.159**	-0.015	-0.395**	1.000								
0.829**	-0.244*	0.540**	-0.760**	0.442**	1.000							
0.292**	-0.080	0.661**	-0.375**	-0.483**	0.114	1.000						
0.201*	-0.108	0.712**	-0.411**	-0.489**	-0.164	0.871**	1.000					
0.403**	-0.183	0.001	-0.303**	0.386**	0.646**	-0.159**	-0.189	1.000				
-0.754**	-0.136*	-0.651**	0.831**	-0.356**	-0.797**	-0.350**	-0.379**	-0.473**	1.000			
-0.567**	-0.020	0.873**	-0.691**	-0.112	0.464**	0.677**	0.801**	-0.333**	-0.559**	1.000		
-0.513**	-0.037	0.893**	-0.656**	-0.142	0.422**	0.725**	0.788**	-0.015	-0.565**	0.901**	1.000	
0.574**	-0.137	0.825**	-0.675**	0.169	0.504**	0.659**	0.686**	-0.022	-0.640**	0.767**	0.785**	1.

<u>Key</u>:
1 = Seed yield/ha
2 = Phytotoxicity
3 = Crop vigour (6 WAS)
4 = Weed cover (6 WAS)
5 = Stand count
6 = Plant height
7 = No. of branches/plant
8 = No. of Capsules/plant
9 = Height of first capsule
10 = Weed DM/M^2
11 = Dry matter production/plant
12 = Yield/plant
13 = 1000 seed wt.

** = Significant at 1%
* = Significant at 5%
r(P=0.05) = 0.195
r(P=0.01) = 0.254

CHAPTER 5

5.0 DISCUSSION

Maximum grain yield of 401 and 511kg/ha recorded with the application of metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha under row spacing of 30cm in 1995 and 1996 respectively were higher than records of yield on farmer's field and in earlier trials by Busari and Bature (1993) and Katung (1987) in Nigeria. The application of metolachlor + metobromuron at (1.0 + 1.0kg a.i./ha) was comparable to hoe-weeded treatment in both trials with respect to efficiency of weed control. Similarly, the significantly higher yields obtained with all the weed control treatments compared with weedy check confirmed the importance of weed control in this crop. The progressive increase in yield with narrower spacing also indicate the significance of sesame's tolerance of high density planting.

5.1. Effect of Herbicide Treatments on Weed

When compared to weedy check all the weed control treatments significantly reduced weed cover and weed dry matter production throughout the crop life cycle. The efficacy of the metolachlor + metobromuron (1.0 + 1.0kg a.i./ha) in controlling weeds in this crop may be due to the complimentary activities of the component active ingredients on grass and broad leaved weed species. Lagoke *et al.* (1982) observed that the performance of metolachlor in controlling weeds was enhanced when applied in combination with other compatible herbicides such as metobromuron. Subramanian and Sanka (1977) also achieved adequate control of weeds in sesame with the application of alachlor at 2.25kg a.i./ha. However, the application of simazine + ametryn at both 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha did not provide adequate control of weeds and had weed dry weight comparable to the unweeded control at 12 WAS.

The rates used were probably sublethal for effective control of the existing weed species.

It was apparent that the higher rates of the herbicides significantly reduced weed dry matter production at harvest than compared with the corresponding lower rates. The lowest weed dry weight of 16.1g/m^2 was obtained with metolachlor + diuron at 1.5 + 0.5kg a.i./ha. This is probably due to the residual effect of diuron in the mixture. Akobundu (1987) observed that the efficacy of soil-active herbicide depend on its persistence in the soil. Geissbuhler *et al.* (1975) reported that metabolism of the phenylurea (e.g. diuron or linuron) occurs gradually in the soil through microbial degradation.

5.2. Effect of Herbicide Treatments on Crop Growth and Yield

Among the herbicide treatments, only metolachlor + metobromuron at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha and 2.0kg ai/ha and imazaquin at 0.18kg a.i./ha were consistently selective in the crop as reflected in the phytotoxicity rating. The former has been successfully used for weed control in this crop in the past (Hussein *et al.*, 1980, Busari and Bature, 1993). Similarly, pre-emergence application of alachlor at rates between 1.0 and 2.7kg ai/ha was reported to be safe in sesame (Schrodter and Rawson 1984, Graph *et al.*, 1985). At Samaru, Sinha and Lagoke (1982) also reported that metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha resulted in similar or higher net profits in irrigated tomatoes compared with two and three hoe weedings. Furthermore, Busari and Bature (1993) also reported that imazaquin (0.18kg ai/ha) was found safe for use in controlling weeds in sesame. Ayeni *et al.* (1996) achieved adequate control of weeds in cowpea and soybean with pre-emergence application of imazaquin at 0.3kg a.i./ha.

The low rate of herbicides resulted in shorter plants but higher height to first capsule. This may be because the lower rates did not control weeds effectively and resulted in plant growth suppression due to competition from weeds. Similar observation was reported in wheat by Yahaya (1993). Application of simazine + ametryne at both rates resulted in stunted crop growth and low crop stands probably because the rates were phytotoxic to the crop. And as observed with plant height, application of diuron + metolachlor at 1.0 + 0.5 or 1.5 + 0.5kg a.i./ha in 1995 also reduced number of crop stand as many seedlings could not recover from the toxic effect of diuron at the rate used.

All rates of metolachlor + metobromuron and low rate of diuron + metolachlor had higher number of branches and capsules per plant similar to those with hoe-weeded control due to the high selectivity of herbicide treatments in the crop. Selectivity of herbicides and its effect on similar crop parameters had been stressed in earlier trials (Schrodter and Rawson 1984, Graph *et al.*, 1985 and Busari and Bature 1993).

Application of selective pre-emergence herbicides tend to give higher yield than the hoe-weeded treatment probably because they suppresses weeds before emergence thereby giving the crop an initial advantage over weeds competition. In these trials, application of metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha resulted in yield increase of 21% and 29% when compared with hoe-weeding in 1995 and 1996 respectively. The difference in the yield increment was due to different weed levels in the cropping seasons. The lower rate of each herbicide despite its greater selectivity resulted in lower yield compared to the corresponding upper rate due to lower weed control efficiency. The yield obtained with metolachlor + diuron at 1.0 + 0.5 and 1.5 + 0.5kg a.i./ha in 1995 did not reflect its performance on weed due to the crop phytotoxicity observed at these rates. The selectivity of this mixture increased when the concentration of diuron was reduced to 0.25kg a.i./ha in 1996.

5.3 Effect of Row Spacing on Weeds

Difference in weed cover score between row spacings tested became significant only after 3 weeks from planting but the differences between seed broadcast and 30cm and also between 60cm and 90cm inter-row spacings were not significant at 3 WAS. However, weed dry matter production were least with seed broadcast in both trials. This was because wide spaces between rows favoured greater weed competition in the crop as weeds established themselves aggressively in the intervening spaces. Dougherty (1969) proposed that shading of weeds by the quickly formed canopy in crop planted in narrow rows account for more efficient weed control than observed, in wide inter-rows. Therefore, there is an obvious advantage in planting by seed broadcast which facilitate smoothering of weeds by shading effect through rapid canopy formation. van Rheenen (1973) also observed that weeds are less aggressive in closely spaced sesame plants than in widely spaced rows.

5.4 Effect of Row Spacing on Crop Growth and Yield

Plants in the wider rows were more vigorous in growth in both trials. Higher number of branches and number of capsules per plant were also obtained with wider row spacing. However, plant height and height to first capsule tend to be higher with closer spacing. Yield per plant, weight of 1000 seeds and dry matter production also increased significantly with increase in the inter-row spacing. All these result could be attributed to lower intra-specific competition among crop stands. The wide rows permited higher interception of solar radiation (light) and better supply of all other growth factors. Similar result was obtained by Samir and Elsorgy (1989) in sesame.

Grain yield was higher with closer spacing despite the enhanced plant productivity in widely spaced rows. This may be attributed to the higher crop stand establishment and probably more efficient control of weeds under narrow row spacing. Menon (1967) observed that yield of any crop depend on average yield per plant but most importantly on the number of plants per unit area. Kostrinsky (1959) reported that yield of sesame were 22% higher with an inter-row spacing of 75cm than that at 100cm. Olive and Canon (1954) also obtained higher yields of sesame at an inter-row spacing of 30cm than at 60cm or 90cm.

5.5 Interaction between Weed Control Treatments and Row Spacing

All the herbicide treatments showed best performance under seed broadcast and 30cm inter-row spacing. The most selective and efficient herbicide (metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha) had the highest values of crop vigour, crop stand establishment and seed yield while also having lowest values of weed cover and weed dry weight under narrow row spacing. However, the highest yields of 401.00 and 511.26kg/ha were obtained with the application of metolachlor + metobromuron under 30cm inter-row spacing in 1995 and 1996, respectively. The yield from the same herbicide treatment was lower under seed broadcast than the maximum obtained in each trial. This finding is in agreement with past reports which showed that yield per hectare increases with increasing plant density until a level is reached which is hardly exceeded as plant density was increased further even under favourable growth conditions (Menon, 1967; Gerakis and Tsangarakis, 1969; Delgado and Yermanos, 1975 and Gupta, 1982). Donald (1965) also remarked that the favourable effect shown by wide spacing on characteristics related to plant growth such as crop vigour, number of capsules and plant dry matter production was mainly due to competition for growth factors. However, it can be inferred that the extent of plant population under seed broadcast and 30cm inter-row spacing may have exceeded the advantages that accrued to individual plants under the inter-row spacing of 60cm and 90cm.

5.6 Relationship between Various Parameters and Yield of Sesame.

The significant positive correlation between sesame grain yield and growth characters such as crop vigour, crop stand establishment and plant height indicate the importance of these parameters on yield. The result is similar to the findings of Weiss (1983), van Rheenen (1973), Narayanan and Reddy (1982), Gupta and Labana (1983) and Katung (1987). Similarly, the significant positive correlation between number of capsules per plant and weight of 1000 seeds with grain yield showed their importance as yield components in sesame. Gupta and Labana (1983) reported that seed weight is highly correlated to seed yield in the crop.

The significant negative correlation between seed yield of sesame and phytotoxicity of herbicide treatments, weed cover and weed dry matter production indicate the importance of herbicide selectivity and efficiency of weed control on the productivity of the crop. The significant negative correlation of seed yield per plant and crop dry matter production with grain yield tends to underscore the importance of these parameters compared to other factors such as crop stand establishment and weed dry weight.

CHAPTER 6

6.0 SUMMARY AND CONCLUSION

Field trials were conducted on the Farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria (11°11′N; 7° 38′E) to evaluate the effect of inter-row spacing and chemical weed control in sesame.

In the trials whose sites were characterized by sandy loam soil with average fertility status, four herbicides at two rates each were evaluated along with hoe-weeding and weedy checks under four inter-row spacings as seed broadcast, 30cm, 60cm and 90cm. The herbicides were imazaquin at 0.18 and 0.20kg a.i./ha, metolachlor + metobromuron 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha, metolachlor + diuron at 1.0 + 0.5 and 1.5 + 0.5kg a.i./ha and simazine + ametryne at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha. The concentration of diuron in the tank mixture was reduced to 0.25kg a.i./ha in 1996 to lower its phytotoxicity on sesame. All the herbicide treatments were applied pre-emergence to weeds and crop (a day after sowing), while the hoe-weedings were at 3, 6 and 9 WAS. The treatments were laid out in a split-plot design with three replications and weed control measures were assigned to the main plot and the inter-row spacings were in the sub-plot.

All the herbicide treatments reduced weed level in the crop at the rates used except simazine + ametryn which was not effective at both rates. The most selective herbicide treatments were metolachlor + metobromuron and imazaquin, while diuron at 0.5 kg a.i./ha and simazine + ametryn at 0.75 + 0.75 and 1.0 + 1.0 kg a.i./ha were highly phytotoxic to sesame as was reflected by the phytotoxicity scores. A significant reduction in stand was recorded from plots treated with herbicides which were phytotoxic to sesame.

The highest seed yield was obtained with application of metolachlor + metobromuron 1.0 + 1.0kg a.i./ha in both seasons. However, the difference due to the application of the same herbicide at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha was only significant in 1996. Lowering the concentration of diuron in the tank mixture in 1996, resulted in higher yield than in 1995 and was comparable to 3 hoe-weedings. This herbicide combination particularly gave the most effective season-long broadspectrum control of weeds. Sesame yield increased with increase in efficiency of weed control throughout the crop growth cycle as well as high crop tolerance.

Weed competition increased significantly with wider inter-row spacing as indicated by weed cover scores and weed dry matter production. The agronomic characters of sesame such as number of branches, number of capsules per plant, stover yield and seed yield per plant increased significantly with inter-row spacing while plant stand, plant height, height to first capsule and seed yield per hectare increased with closer spacing. However, highest seed yield was obtained under an inter-row spacing of 30cm, although this was not significantly different from seed broadcast in both trials.

Generally, the highest seed yields of 401 and 511.26kg/ha were obtained with application of metolachlor + metobromuron at 1.0 + 1.0kg a.i./ha under 30cm inter-row spacing in 1995 and 1996, respectively.

Correlation analysis indicated a significant negative relationship between seed yield and level of weed competition and positive relationship with some growth parameters such as stand count and plant height.

In conclusion, this study has shown that the efficiency of pre-emergence application of herbicides for weed control in sesame is most enhanced by the closest row spacing of 30cm and therefore, farmers can use selective herbicide such as metolachlor + metobromuron at 0.75 + 0.75 and 1.0 + 1.0kg a.i./ha as an alternative to handweeding in their traditional method of planting by seed broadcast.

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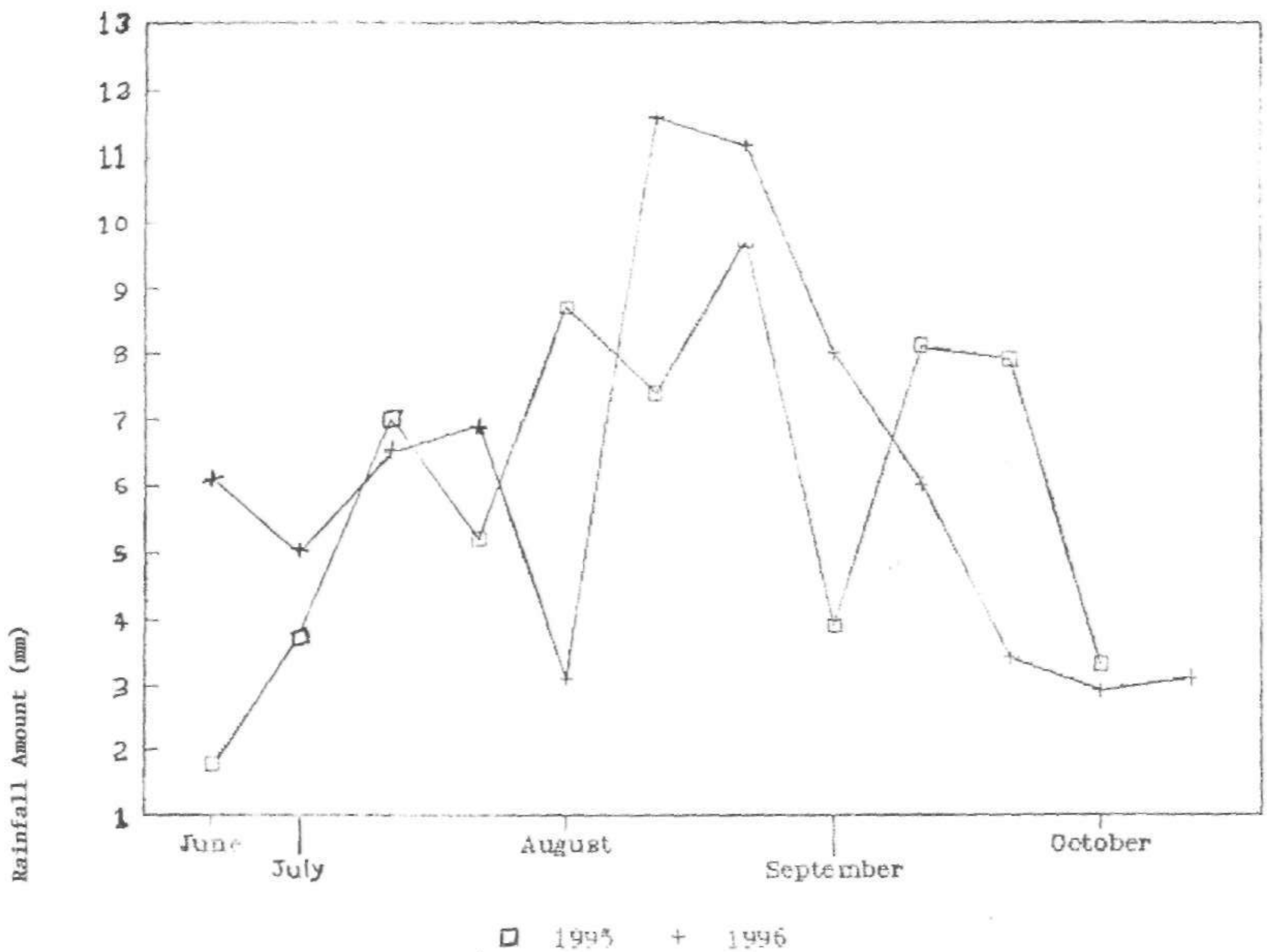

APPENDIX 1: Rainfall Distribution at Samaru in 1995 and 1996
Cropping Seasons (mm)

Appendix 2: Records of Mean Temperature and Relative Humidity at 10-days Interval at Samaru during 1995 and 1996 Cropping Seasons.

MONTHS	TEMPERATURE(°C) 1995		1996		RELATIVE HUMIDITY (%) 1995		1996	
	max	min	max.	min.	10am	4pm	10am	4pm
July								
1-10	29.0	21.8	28.4	19.3	79.3	59.6	78.4	55.6
11-20	30.2	22.7	27.6	16.4	79.4	66.9	74.4	57.1
21-31	30.3	20.8	27.3	19.4	82.2	73.4	77.3	74.9
August								
1-10	28.7	19.9	28.4	20.0	84.4	75.3	80.1	70.6
11-20	29.1	19.5	26.9	19.0	82.8	73.1	83.4	76.6
21-31	28.5	21.0	28.0	19.7	98.6	87.6	82.2	66.8
Sept.								
1-10	29.5	23.9	29.4	21.0	81.9	78.1	82.6	70.0
11-20	29.4	18.9	30.2	19.3	81.6	58.7	81.9	69.6
21-31	28.1	18.6	30.4	19.7	80.5	63.5	80.3	69.6
October								
1-10	31.1	20.1	31.6	20.0	77.9	68.5	78.1	60.2
11-20	31.4	21.2	30.6	19.9	80.5	65.3	76.9	68.3
21-31	31.7	22.6	30.5	19.6	77.5	64.6	76.5	66.4

Appendix 3: **Common and** chemical names of herbicide used

<u>Common Name</u>	<u>Chemical Name</u>
Imazaquin	2-(4-isoprophyl-4-m46hyl-s-Oxo-
	2-i9midazolin-2-7l)-3-quinear-boxylic acid.
Metolachlor	2-46hyl-6-methyl-N-(methyl-2 methoxythyl).
Metobromuron	N-(4-bromophenyl)-N-methoxyl-N-methyl ures.
Diuron	N-(3, 4-dichlorophenyl) - N, N - dimenthyl ures
Simazine	2-chloro-4, 6-bis (ethylamino) - s-triazine.
Ametryn	2-(ethylamin)-4-)isoprophylamino) -6-methythio(-s-triazine).

Appendix 4: ANOVA for Weed Dry Matter (g/m^2) in Sesame at Samaru in 1995

Source	DF	SS	MS	F-value	Prob
1. Replication	2	152.426	76.213	3.0165	0.0742
2. Factor A	9	13352.128	1483.570	58.7190	0.0000**
3. Error (a)	18	454.781	25.268		
4. Factor B	3	1913.545	637.848	116.0572	0.0000**
5. A B	27	627.907	23.256	4.2314	0.0000**
6. Error (b)	60	329.759	5.496		
Total	119	16830.545			

C.V = 10.09%

$S.E_1$ = 0.7948

$S.E_2$ = 31.70

$S.E_4$ = 3.91

$S.E_6$ = 1.41

Appendix 5: ANOVA for Weed Dry Matter (g/m^2) in Sesame at Samaru in 1996

Source	DF	SS	MS	F-value	Prob
1. Replication	2	141.574	70.787	8.599	0.0024**
2. Factor A	9	8201.855	911.317	110.716	0.0000**
3. Error (a)	18	148.160	8.231		
4. Factor B	3	1008.076	336.025	51.396	0.0000**
5. A B	27	526.817	19.512	2.984	0.0002**
6. Error (b)	60	392.280	6.538		
Total	119	10418.761			

C.V = 12.27%

$S.E_1$ = 0.45

$S.E_2$ = 28.2

$S.E_4$ = 4.70

$S.E_6$ = 1.48

Appendix 6: ANOVA for seed yield (kg/ha) in sesame at Samaru in 1995

Source	DF	SS	MS	F-value	Prob
1. Replication	2	141.574	6152.663	0.8994	0.0012**
2. Factor A	9	8201.855	75262.352	11.0021	0.0000**
3. Error (a)	18	148.160	6840.715		
4. Factor B	3	1008.076	57744.120	15.3372	0.0000**
5. A B	27	526.817	8041.622	2.1359	0.0075**
6. Error (b)	60	392.280	3764.960		
Total	119	1429053.124			

C.V = 31.27%

$S.E_1$ = 13.08

$S.E_2$ = 15.45

$S.E_4$ = 12.30

$S.E_6$ = 32.88

Appendix 7: ANOVA for seed yield (kg/ha) in sesame at Samaru in 1996

Source	DF	SS	MS	F-value	Prob
1. Replication	2	2717.245	1358.623	0.6095	0.000**
2. Factor A	9	1783652.129	198183.670	88.9104	0.000**
3. Error (a)	18	40122.471	2229.026		
4. Factor B	3	394713.569	131571.190	155.4117	0.000**
5. A B	27	108132.449	4004.906	4.7306	0.000**
6. Error (b)	60	50795.877	846.598		
Total	119	1429053.124			

C.V = 11.00%

$S.E_1$ = 7.47

$S.E_2$ = 13.63

$S.E_4$ = 15.31

$S.E_6$ = 16.80

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