RESPONSE OF SESAME (*Sesamum indicum*) TO VARYING LEVELS OF MANAGEMENT PRACTICES

A THESIS

By

JAYANTA BHATTACHARYA

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Approved by

Prof. Dr. Md. Fazlul Karim
Department of Agronomy
Sher-e-Bangla Agricultural University
Supervisor

Dr. H. M. M. Tariq Hossain
Department of Agronomy
Sher-e-Bangla Agricultural University
Co-supervisor

Prof. Dr. Md. Jafar Ullah
Chairman
Examination Committee

Sher-e-Bangla Agricultural University
Sher-e -Bangla Nagar, Dhaka-1207

CERTIFICATE

This is to certify that the research work entitled, "**RESPONSE OF SESAME (*Sesamum indicum*) TO VARYING LEVELS OF MANAGEMENT PRACTICES**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE in AGRONOMY,** embodies the result of a piece of bona-fide research work successfully carried out by **JAYANTA BHATTACHARYA** bearing Registration No. **07-02639** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated: 20/12/08
Place: Dhaka, Bangladesh

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Prof. Dr. Md. Fazlul Karim
Department of Agronomy
Sher-e-Bangla Agricultural University

Dedicated to

My

Beloved Parents

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ABSTRACT

The experiment was conducted at the research field or Agronomy Department of Sher-e-Bangla Agricultural University, Dhaka during the period of March to June, 2008 to find out management practices suitable to boost up the seed yield. The experiment comprised of ten treatments viz, T_1= Broadcast sowing without post sowing care (control), T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS, T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1}), T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS, T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS, T_6= Line sowing without post sowing care , T_7= Line sowing + 1 HW at 20 DAS, T_8= Line sowing + recommended fertilizer, T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS , T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS. The trial was set up in Randomized Complete Block Design (RCBD) with four replications. The different management practices exhibit significant influence on the growth, yield and yield attributes of sesame. Significantly highest seed yield (1.33 t ha^{-1}) was obtained from T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) due to maximum capsules $branch^{-1}$ (10.88), capsules $plant^{-1}$ (58.45), seeds $capsule^{-1}$ (69.17) and harvest index (32.62%) of sesame. The yield increase due to line sowing with fertilizer, hand weeding and insect control (T_{10}) was 195% than control (T_1). Broadcast and line sowing without any post sowing care produced significantly the lowest yield. On the other hand, line sown crop always showed better performance than broadcast sown crop. The results indicated that line sowing with 46 kg N, 72 kg P_2O_5, 30 kg K_2O, 20 kg S, 2 kg B and 1 kg Zn ha^{-1}, one hand weeding at 20 DAS and insect control at 45 DAS would be beneficial or optimum for obtaining higher yield of sesame.

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ACRONYMS

AEZ	Agro-ecological Zone
AGDW	Above Ground Dry Weight
B	Boron
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BINA	Bangladesh Institute of Nuclear Agriculture
CGR	Crop growth Rate
cm	Centimeter
Contd.	Continued
CV	Co-efficient of variation
DAS	Days after sowing
EC	Emulsifiable Concentrate
et al.	and others
FYM	Farm Yard Manure
g	Gram
ha	Hectare
HI	Harvest Index
i.e.	that is
K	Potassium
kg	Kilogram
LAI	Leaf Area Index
LSD	Least significant difference
m	Meter
MP	Muriate of Potash
N	Nitrogen
NAR	Net Assimilation Rate
P	Phosphorus
RCBD	Randomized Complete Block Design
RGR	Relative Growth Rate
S	Sulphur
$t\ ha^{-1}$	ton per hectare
TSP	Triple Superphosphate
viz.	namely
%	Percentage
^{0}c	Degree Celsius

CHAPTER 1

INTRODUCTION

Chapter 1

INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the most important oil crops under the Pedaliaccae family. It is locally known as til. According to cultivable area and production it occupies second position as an oil crop in Bangladesh followed by rape seed and mustard (BARI, 2001). Sesame is drought resistant and annually cultivated herb, which can easily be grown under rainfed upland condition. It has been grown all over the world for thousands of years and today its major production areas are the tropics and subtropics of Asia, Africa, East and Central America.

Langham and Wiemers (2006) stated that Sesame crop is the queen of vegetable oils. It's oil has high degrees of stability and resistance to rancidity. Sesame is a versatile crop with high quality edible oil having diversified usage. Due to varietal difference it contains 37 to 63% oil, 14 to 20% carbohydrate and 20% protein (BINA, 2004). It also contain 0.156-0-0.288% S, 1.12-1.51% reducing sugars, 5.6-7.25% total sugar, 0.8-1.4% Ca, 0.41-0.71% P, 0.4-0.95% K and 40.4-52.7% protein on oil free basis (Dhindsa and Gupta, 1973). Sesame oil taste and odour is pleasant because of presence of aldehyde and acetylpyragin. It also contain more than 80% unsaturated fatty acid for human body including large amount of olic and linoleic acid (BINA, 2004). Sesame oil is used mostly for edible purpose and has notable demand in confectionery and illumination. It is also used for manufacture of margarine, soap, paint, perfumery products and pharmaceutical as an ingredient for drugs and as dispersing agent for different kinds of insecticides.

Bangladesh faces an acute shortage of edible oil. The total production of edible oil in the country is not sufficient to meet its requirement. The area and production of oil seed crops in Bangladesh during 2007-08 were 33,540 hectare and 27,043 metric tons, respectively (BBS, 2008). This production only ensures 4 g of oil per capita. People can consume only 10 g of oil day^{-1} summing local production and foreign import. But the expert says, an adult should consume 22 g oil day^{-1} for better health. So at present the country is experiencing 70% deficit in edible oil (Wahhab, 2002).

In a view of population growth, the requirement of edible oil is increasing day by day. It is, therefore, highly expected that the production of edible oil should he increased considerably to fulfil the increasing demand. The production may be increased either by increasing cropping area under oil crop or increasing yield per unit area. But in the present condition, scope of expansion oil cropped area is narrow. So, there is a general consensus that increasing yield per unit area is most reasonable way to increase total production.

Sesame can play an important role to fulfil the local demand of edible oil. As sesame is short duration and photoinsensitive crop with wider adaptability, it can be cultivated in both rabi and kharif seasons. But yield of sesame per unit area in our country is very low, compared to other sesame producing countries of the world. The average production of sesame in farmers level is only 0.55 ton ha^{-1} (BARI, 1998). The main reasons for poor yield are lack of high yielding varieties, proper management practices improper use of fertilizer and insect control. Proper package of improve management practices can increase the productivity of sesame up to considerable extent (Mukherji, 1982). In India, packages of production practices for increasing the productivity have been worked out and experimental results of the research works have shown that the crop has potential for increasing production (Sharma, 1994). Moreover, in view of high price of sesame seed in the market and its low cost of cultivation, sesame appears to be highly remunerative crop for farmers (Bhan, 1979).

Sesame is grown in a small scale throughout the country mostly in the kharif-1 season compared to other oil crops. Cultivation of sesame could be prospective if it is planted after transplanted aman rice harvest. In the rabi season, competition of crops are high but in kharif-1, this condition is reverse. Yield of sesame is poor mostly because the Bangladesh farmers do not consider it as a major cash earning crop. Thus, weeding in kharif-1 season is not considered. However critical period of weed control was found to be 20 days after emergence in sesame as indentified by Hossain *et al.* (1993) earlier. Since sesame seeds are sown during the rainy season, during that time weeds also emerge and grow vigorously, and compete with the crop for nutrient, space and solar radiation resulting in yield reduction (Nieto *et al.*, 1968). No systematic research on sesame was conducted in the past; as a result, this crop is raised under little care and minimum management. Beside this, so far no management package is identified and recommended to increase the yield of this crop.

Therefore, the research work was undertaken keeping in mind the following objectives:

1. To determine the effect of varying levels of management practices in growth and yield of sesame under broadcast and line sowing.
2. To observe the weed density and losses of sesame yield due to weed infestation.

CHAPTER 2

REVIEW OF LITERATURE

Chapter 2

REVIEW OF LITERATURE

The present experiment was carried out to study the response of sesame under different management practices. The research works related to the present study are scanty in Bangladesh although some relevant researches have been done in other countries of the world. Thus, the research works relevant to the present study have been reviewed and presented in this chapter.

Krishnaprabu and Kalyanasundaram (2007) conducted an experiment on weeding to study weed density and its effect on seed yield of sesame (cv. VRI 1) and they stated that the weed control treatments significantly reduced the weed density and enhanced the seed yield of sesame.

Gnanavel and Anbhazhagan (2006) conducted an experiment on weed management on sesame. They used hand weeding and herbicide for weed control and got highest weed control index (92.7%) and seed yield (0.92 t ha^{-1}) at 0.15 kg oxyflourfen ha^{-1} with one HW at 30 DAS.

Biswas (2006) stated that one spray of Diazinon 60 EC applied at the capsule formation stage of sesame 50-55 DAS gave the highest benefit cost ratio (4.20).

Ravender *et al.* (2006) stated that application of recommended fertilizers (100 kg N, 150 kg P_2O_5, 50 kg K_2O) resulted in the tallest plant, maximum number of branches, dry matter, leaf area index, root length, number of capsules $plant^{-1}$, number of seeds $capsule^{-1}$, 1000-seed weight and seed yield.

Ahuja *et al.* (2005) conducted an experiment on sesame (cv. RT-46) to evaluate the efficacy of integrated pest management (IPM) modules our farmers' practice (control) for cultivation of sesame cv. RT-46. The IPM modules comprised monocrop of sesame and 2 sprays of azadirachtin at 0.030% at vegetative and flowering stage of the crop (M_1), and one spray of azadirachtin at 9 ppm at flowering stage (M_2). The farmers' practice comprised sole sesame without any plant protection. The percentage capsule damage due to it was also decreased significantly in both the modules in comparison to the untreated control plot. The yield of sesame was higher than farmers practice.

Kumar and Thakur (2005) conducted an experiment on sowing method and weed control on sesame. They reported that line sowing increased the yield by 10.6% over broadcasting and highest sesame seed yields were obtained with 1.5 kg alachlor ha^{-1} singly (460 kg ha^{-1}) or in combination with hand weeding (684 kg ha^{-1}).

Ali *et al.* (2005) reported that higher number of capsules per plant and more seeds $capsule^{-1}$ and seed yield of sesame was increased with an increased in row spacing from 30 to 45 cm.

Yadav (2004) conducted an experiment on sesame (cv. RT-46) to determine the suitable integrated method for weed control. He stated that the lowest weed dry matter and highest weed control efficiency, number of capsules $plant^{-1}$, pooled mean seed yield, gross returns, net returns and incremental benefit cost ratio were obtained with preplant incorporation (PPI) of 0.5 kg fluchloralin ha^{-1} + HW at 40 DAS over control.

Sukhadia *et al.* (2004) conducted an experiment with sesamum cv. Gujarat Til-2 and stated that branches and capsule $plant^{-1}$ as well as seed and stalk yields ha^{-1} were highest in weeding once than unweeding.

Caliskan *et al.* (2004) stated that row planting had positive effects on the yield and yield components of sesame and produced around 34% higher seed yield compared to broadcast planting. Thanki *et al.* (2004) reported that the highest plant height (104 cm), test weight, oil content and pooled yield (1290 kg ha^{-1}) of sesame increased with increasing rates of P_2O_5 (150 kg ha^{-1}).

Abdel *et al.* (2003) reported that the length of the first branch and first capsule, as well as the length of the fruiting zone, highest seed and oil yields of sesame were obtained at 80 kg N ha^{-1}.

Vaiyapuri *et al.* (2003) evaluated the effects of sulphur (0, 15, 30 and 45 kg ha^{-1}) and organic amendments (10 t ha^{-1} each of farmyard manure, poultry manure and press mud) on the seed quality and nutrient uptake of sesame (cv. TMV 3). They reported that application of 45 kg S ha^{-1} gave the best result in terms of seed quality, yield and yield attributing characters and nitrogen, phosphorus, potassium and sulphur uptake. Application of poultry manure resulted in the highest oil content, oil yield and crude protein content of sesame.

Liu *et al.* (2003) studied the effects of Mo and B, alone or in combination, on seed quality of pod growth soybean cultivars Zhechum 3, Zhechun 2, and 3811. Application of Mo and/or B increased the content of protein, in dispensable amino acids, total amino-acids (excluding proline), N, P, K and decreased the content of Ca and oil in seeds.

Hegde (2003) conducted a field experiment in Tamil Nadu, India with sesame grown with S fertilizer (0, 20, 40, 60 and 80 kg ha^{-1}) and boron levels (0, 1, 2, 3 and 4 kg ha^{-1}) during 2000. S at 40 and 60 kg ha^{-1} with 2 kg B ha^{-1}gave comparable yields, whereas S at 80 kg ha^{-1} with 1, 3 or 4 kg B ha^{-1} registered a lower yield, indicating that 40 kg S ha^{-1} and 2 kg B ha^{-1} were optimum for sesame in this study. The seed oil content was not markedly affected by the various amendments. Among the treatment combinations, 40 kg S ha^{-1} applied with 2 kg B ha^{-1} represented maximum plant height, branches $plant^{-1}$, dry matter accumulation, seed yield, stover yield, harvest index and oil content of sesame.

Sharma and Gupta (2003) conducted an experiment on sesame using four sulphur rates (0, 20, 40 and 60 kg ha^{-1}) and reported that application of sulphur at 40 kg ha^{-1} increased plant height and dry matter accumulation. They also reported that this treatment gave higher number of capsules $plant^{-1}$ and seed number $capsule^{-1}$, 1000 seed weight and seed yield of sesame up to 27% over control. Application of 60 kg S ha^{-1} gave statistically similar result with 40 kg S ha^{-1}.

The effect of different N levels viz., 0, 40 and 80 kg ha^{-1} on the productivity of sesame cv. TS-3 under different plant geometry flat sowing paired row planting, ridge sowing and bed sowing was evaluated. N at 80 kg ha^{-1} produced the highest yield (0.79 t ha^{-1}), 1000 seed weight (3.42 g) and seed oil content (Malik *et al.*, 2003).

Kathiresan (2002) conducted a field trial with sandy loam soil on sesame (TMV-3 and TMV-4) in India with different fertilizer levels: (control, 100% recommend NPK of 35: 23: 23 kg ha^{-1} and 150% recommended NPK of 52:35: 35 kg ha^{-1}). He reported that higher dose of nutrient significantly increased seed yield (1522 kg ha^{-1}) during summer than the lower levels of nutrient. Variety TMV-4 produced significantly higher plant height, capsule bearing length, branches $plant^{-1}$, capsule length, seeds $capsule^{-1}$, seed yield, oil and protein content.

A field experiment was conducted by Dayanand *et al.* (2002) to study the effects of sulphur on nutrient uptake, yield and food value of sesame (*Sesamum indicum*). They reported that nitrogen content of straw, the total nitrogen uptake and oil yield of sesame increased significantly up to 40 kg S ha^{-1}. They also found that biomass production, nitrogen content, seed yield, straw yield, protein and oil content of sesame significantly increased with 60 kg S ha^{-1}.

Sarkar and Banik (2002) conducted an experiment on sesame (cv. B67) with different levels of sulphur (at the rate of 0, 25 and 50 kg S ha^{-1}). They stated that planting in north south direction and applying 50 kg S ha^{-1} were effective in improving leaf area index, crop growth rate, relative growth rate, net assimilation rate, yield attributes and yield of sesame than planting in east-west direction and applying 25 kg S ha^{-1}.

Allam (2002) carried out a field experiment at Pakistan on three levels of gypsum (0, 500 and 1000 kg ha^{-1}) and nitrogen (45, 60 and 75 kg ha^{-1}) on sesame (cv. Gizn 32). He found that increasing gypsum (500 kg ha^{-1}) and nitrogen (75 kg ha^{-1}) increased plant height, length of fruiting zone, number of oil percentage and oil yield of sesame. He also found that seed yield and capsule lengths were highest with 60 and 75 kg N ha^{-1}.

Singaravel *et al.* (2002) reported that combined application of recommended NPK along with 25 kg ha^{-1} $ZnSO_4$ and 5 kg ha^{-1} $MnSO_4$ was significantly superior in enhancing the growth, yield and nutrient uptake of sesame.

Field experiments were conducted to study the effect of times and methods of N and K application on the growth and yield of sesame. The fifteen treatments tested were combinations of a basal application and top dressing through soil as well as through foliage of 150 percent recommended level of N and K (53 kg N ha^{-1} and 35 kg K_2O ha^{-1}). These splits were given exclusively for nitrogen and potassium. The application of 50 percent of N and K as basal + 50 percent through one percent foliar spray on 40 DAS and the remaining as a top dressing on 20 and 30 DAS through soil on equal splits recorded the maximum growth attributes viz., plant height, dry matter production, leaf area index (LAI) and number of branches plant^{-1}. Similarly growth characters, yield attributes such as capsules plant^{-1}, 1000 seed weight and seed yield were higher with the same treatment. This treatment also gave higher gross and net returns as well as return per rupee invested (Kalaiselvan *et al*., 2002.)

Tomar *et al*. (2002) reported that 116% increase in yield (765 kg ha^{-1}) of sesame was obtained with improved technology over the farmer's practices (353 kg ha^{-1}). A maximum contribution towards seed yield of 84% was obtained with fertilizer application followed by weed control (71%) and plant protection (62%) over farmer's practices. There was an additional net income 354 Rs ha^{-1} with fertilizer application, 2970 Rs. ha^{-1} with weed control, 2440 Rs ha^{-1} with plant protection and 4500 Rs ha^{-1} in full package of managements given.

Four sesame genotypes namely T-89, TS-3, 92001 and 90005 to NP levels of 0-0, 25-25 and 50-50 kg ha^{-1} was studied under field conditions during 1996. The genotype TS-3 gave significantly higher seed yield than the other three genotypes due to higher capsules plant^{-1}, seeds capsule^{-1} and 1000-seed weight. TS-3 also proved better in oil contents. Yield and yield components were also influenced significantly by NP application. Maximum increase of 113% in seed yield was recorded at NP level of 50-50 kg ha^{-1}. Oil contents were also influenced significantly by NP application being maximum (48.48%) at NP level of 50-50 kg ha^{-1} (Sharar *et al*., 2002).

Seed yield of sesame (CV. 92001 and TS-3) may be influenced by row spacing (Ahmed *et al*., 2000). They found that the maximum yield (0.7147 t ha^{-1}) was obtained from 30 cm row spacing. They also reported that variety TS-3 gave 110% higher seed yield and 1.37% oil than variety 92001.

Radhamani *et al*. (2001) studied the effect of different level of sulphur on seed yield of sesame and found that 20 kg sulphur ha^{-1} produced the tallest plants and the highest dry matter with 100 ppm salicylic acid (SA). At harvest, the tallest pants were recorded for 20 kg S ha^{-1} at 100 ppm SA + 1.5% potassium chloride while 20 kg S ha^{-1} singly or in combination with 100 ppm SA and 100 ppm SA + 0.5 KCl and 20 kg S ha^{-1} + 100 ppm SA + 0.5% potassium chloride gave the highest capsules $plant^{-1}$, seeds $capsule^{-1}$, seed yield and oil content.

Om *et al.* (2001) carried out a field experiment with four levels of N (0, 30, 60 and 90 kg ha^{-1}) on sesame crop. They reported that highest capsules $plant^{-1}$, seed $capsule^{-1}$, 1000 seed weight, seed yield, straw yield and harvest index of sesame were obtained from 90 kg N ha^{-1}.

In India (Orissa) Patra (2001) conducted a field experiment on sesame (cv. Kalika) with four levels of nitrogen (0, 30, 60 and 90 kg ha^{-1}). He reported that plant height, branches $plant^{-1}$, capsules $plant^{-1}$, seeds $capsule^{-1}$, capsule length, 1000-seed weight and seed yield significantly increased with increasing nitrogen rate up to 60 kg ha^{-1}. He also reported that nitrogen uptake increased with increasing rates of nitrogen up to 90 kg ha^{-1} but oil yield increased with increasing nitrogen rate up to 60 kg ha^{-1}.

Ahmed *et al.* (2001) carried out a field experiment during the summer seasons of 1996-97 in Pakistan to study the response of two sesame genotypes (92001and TS3) to different rates of nitrogen (0, 40, 80 and 120 kg ha^{-1}). They also reported that application of nitrogen at 120 kg ha^{-1} significantly increased the seed and stalks yield, and protein and oil content of cv. TS3 than in 92001.

An experiment on integrated nutrient management in rainfed sesame (*Sesamum indicum* L.) was conducted at Oilseeds Research Station, Jalgaon from 1995 to 1997 under rainfall conditions. Application of organic manure as castor cake at the rate of 1.0 t/ha or farm yard manure (FYM) at 5.0 t ha^{-1} together with the recommended level of nitrogen (50 kg N ha^{-1}) applied as 25 kg N ha^{-1} at sowing and 25 kg N ha^{-1} three weeks after sowing, was found to be the most effective strategy to maximise the productivity of sesame under assured rainfall conditions (Narkhede *et al.*, 2001)

Prasad and Kendra (2001) reported that that supplying the single critical input nitrogen (40 kg ha^{-1}) through urea increased the average seed yield of sesame (var. Gujarat-1) by 21.90 per cent. Improved seed and phosphorus application (20 kg ha^{-1}) increased yield by

14.15 percent. Application of potash (K_2O) resulted in 10.6 percent increase in productivity. Combining of all components (improved seed + phosphorus + potassium) increased the productivity by 166 percent and 59 percent during 1998-99 and 1999-2000, respectively. The average increase of the productivity was 112.87 percent. Average return on per rupee extra invested was up to Rs. 2.41.

Ashfaq *et al.* (2001) conducted an experiment with 2 sesame genotypes (92001 and TS-3) with four levels of N and P (0, 40, 80 and 120 kg ha^{-1}). They reported that grain yield, yield components and harvest index increased with increasing N rates. The highest yields were obtained with 120 kg N and 40 P kg ha^{-1}.

Tiwari *et al.* (2000) in a field experiment nitrogen (15, 30 or 60 kg ha^{-1}) and sulphur (0, 15 or 30 kg ha^{-1}) were applied to sesame varieties (TKG21, TKG22 and Rs226) in Madhya Pradesh, India to investigate optimum dose of nitrogen and sulphur. They found that significant improvement in growth and yield (plant height, seeds $capsule^{-1}$, 1000-seed weight and seed and straw yield) was observed for nitrogen at 60 kg ha^{-1} compared with 15 kg ha^{-1}. Sulphur at 30 kg ha^{-1} resulted significant increase only in the capsules $plant^{-1}$, seed $capsule^{-1}$, 1000-seed weight and seed yield, compared with sulphur at 0 and 15 kg ha^{-1}. Plant height, capsules $plant^{-1}$, seeds $capsule^{-1}$, length of capsule bearing area, 1000-seed weight, seed yield, stover yield, oil yield, protein yield and net return were statistically highest in cv. TKG 21 grown with 60 kg N ha^{-1} and 30 kg S ha^{-1}. Seed oil decreased and seed protein content increased significantly with increasing nitrogen, while sulphur application enhanced both seed oil and seed protein.

Ghosh *et al.* (2000) found that oilseed crops are responsive to sulphur. Approximately 12 kg S is required to produce one ton of oilseed. Though, productivity of oilseeds is still very low (842 kg ha^{-1}). The response of S application in oilseed crops is marked, ranging from 15 to 62 kg S ha^{-1}. Gypsum has been found an effective source of sulphur for the crops like groundnut, castor and sesame. Water scarcity is the biggest constraint in oilseed growing regions. Suitable package involving minimum use of water with adequate fertilizer S in conjunction with N and P and other limiting nutrients is needed for increasing yield of oilseeds.

Narkhede *et* al. (2000) stated that of 2 hands weeding and hoeing carried out at 20 and 30 days after sowing of sesame produces significantly higher grain yield. Kavimani *et* al. (2000) also stated that low weed infestation and higher yield of sesame were obtained from line sowing over broadcast method.

Moula *et al.* (2000) carried out a field experiment at Zamalpur district of Bangladesh on nine management practices, viz. Broadcast sowing (BS) without post sowing care, BS + hand weeding (HW) at 20 DAE; BS + fertilizer (F); BS + F + HW; Line sowing (LS) without post care; LS + HW at 20 DAE; LS + F; LS + F + HW and LS + HW + F + insect control (IC) on sesame (Var. T-6). They found that sowing method i.e. broadcast or line sowing failed to bring any yield advantage. Application of fertilizer gave good respond when one hand weeding was done. Line sowing with fertilizer, hand weeding and insect control produces the highest grain yield which was statistically identical to fertilizer application with hand weeding irrespective of sowing method.

A field experiment was conducted to study response of sesame to varying levels of management practices in Jessore during kharif 1993 and 1995. The treatments included in this experiment were method of sowing (broadcast and line sowing) and management practices (without post-sowing care, hand weeding at 20 days after emergence, fertilizer application and fertilizer and hand weeding at 20 days after emergence). The result showed that weed population and weed dry matter per unit area were significantly higher in unweeded plot compared to that in weeded plots and seed yield was significantly highest (1287 kg ha^{-1}) in treatment with both fertilizer application and hand weeding were done in line sowing plots. Removal of weeds and application of fertilizer enhanced the capsules $plant^{-1}$ and dry matter production (Alom *et al.*, 1999).

Subrahmaniyan *et al.* (1999) treated sesame cv. TMV-4 plants with 35kg S, 10 kg $ZnSO_4$, 10 kg $MgSO_4$ and 10 kg B ha^{-1} singly or in combination with 5 t FYM ha^{-1} in field experiment conducted in Tamil Nadu, India during the summer seasons of 1996-1997. Sole application of sulphur, trace elements and farmyard manure (FYM) increased the branches and capsules $plant^{-1}$ and seed yield compared to the control in both years. The highest seed yield was recorded with the application 35 kg sulphur + 5 t FYM ha^{-1}.

Meng *et al.* (1999) studied the effects of sulphur application on sesame and rapeseed in field trials in 1997 in Zhejiang Chaina. They applied sulphur at the rate of 0, 20 or 40 kg ha^{-1} as gypsum and found that application of sulphur increased seed yield of sesame and rape, and soil available sulphur with SSP giving the best results. Sulphur fertilization significantly increased the contents of nitrogen, sulphur and oil in sesame seeds.

Mitra and Pal (1999) in a field experiment in West Bengal, India observed that dry matter production $plant^{-1}$, capsules $plant^{-1}$, seeds $capsule^{-1}$ and seed yield of sesame were significantly increased up to 100 kg N ha^{-1}. Further increase in nitrogen decreased the seed yield and yield contributing characters. For seed yield, the response to apply nitrogen was shown to be quadratic in nature and maximum response (0.90 kg seed kg^{-1} N) was observed at 100 kg N ha^{-1}.

A field experiment was conducted during the Kharif seasons from 1995 to 1997 to identify the appropriate integrated weed management practice in the rainfed sesame cultivar Padma for medium black soil in an assured rainfall zone. The results showed that of two hand weedings and hoeings at 20 and 30 days after sowing of sesame produced significantly higher grain yield (1239 kg ha^{-1}) and gave significantly more gross monetary returns (Rs. 26,519 ha^{-1}) with highest benefit cost ratio (6.64) and weed control efficiency (85.3%) than the rest of the integrated weed management practices and non-weeded controls (Narkhede *et al.*, 1999).

Parihar *et al.* (1999) conducted a field experiment on N of sesame and reported that yield of sesame increased with increasing nitrogen rate up to 80 kg ha^{-1}.

Tiwari *et al.* (1998) observed that sesame genotypes (TKG9, TKG21, JLC8 and JL7) differed in nitrogen uptake in seed and straw. Nitrogen levels up to 90 kg ha^{-1} significantly increased NPK uptake in seed and straw. Among the genotypes, the newly released TKG21 grown with 90 kg N ha^{-1} produced maximum seed yield and total dry matter which is significantly distinct than others.

Seed, oil and protein yields of sesame increased significantly with application of nitrogen and P_2O_5 (Thakur *et al.*, 1998). They applied 30, 45 or 60 kg nitrogen and 20, 30 or 40 kg

P_2O_5 ha^{-1} and found that 45 kg N ha^{-1} and 30 kg P ha^{-1} was suitable for optimum yield of sesame.

Raja and Sreemannarayana (1998) observed that pulse and oilseed crops showed responses to applied sulphur, the magnitude of response being dependent on native status. Sesame and sunflower showed highest response with applied sulphur. The crops required application of 40 and 60 kg S ha^{-1} in Versitol and Alfisol soil. The seed yields of crops were maximum when N: S ratio in plant was 10:4. Sesame showed a response at 60 kg S ha^{-1} applied as gypsum. Sulphur application also improved the crude protein content and oil contents of seed.

El-Serogy (1998) stated that taller plants, lower stem height to the first capsule, and higher fruiting zone, capsules $plant^{-1}$, seed weight $plant^{-1}$, 1000-seed weight, seed yield and oil percentage of sesame were obtained with using 60 Kg N ha^{-1}.

Bennett *et al.* (1998) reported that sesame biomass increased with N rate up to 80 kg ha^{-1} and in conventionally tilled plots was about twice that in no-till plots and total weed biomass was significantly higher in the no-till plots and sesame seed yields were 1387 kg ha^{-1} and 528 kg ha^{-1} in the conventional and no-till plots, respectively.

Miller and Donahue (1997) observed that boron is essential for growth of new cells of sesame. Without, adequate supply of boron, the number and retention of flowers reduces, and pollen tube growth is less; consequently less fruits are developed. Adequate supply of boron increase leaves dry weight, petiole dry weight, capsule dry weight and above all yield is increased significantly.

Singh *et al.* (1997) in a field experiment on a sandy clay loam soil at Madhya Pradesh, India found that sesame (cv. JT7) performed better in terms of mean seed yield and net returns with 10 t ha^{-1} poultry manure alone than 40, 80 or 120 kg N ha^{-1} or combination of 10 ton poultry manure with them.

Mondol *et al.* (1997) conducted a field trials at Kalyani, West Bengal with five levels of nitrogen (0, 30, 60, 90 or 120 kg ha^{-1}) on sesame and observed that plant height, dry matter accumulation, capsules plant^{-1}, seeds capsule^{-1}, 1000-seed weight, seed yield and protein yields were increased significantly with increasing nitrogen rates but harvest index and oil content were not significantly affected.

Tiwari and Namdeo (1997) conducted a field experiment on N fertilization of sesame (*Sesamum indicum* L.) and reported that application of 90 kg N ha^{-1} produced the highest seed yield. Seed oil and protein contents were also increased with increasing nitrogen rate. Ravinder *et al.* (1996) stated that the seed yield of sesame was highest with 100 kg N ha^{-1}. Uptakes of nitrogen, phosphorus and potassium were positively correlated with yield.

Sesame cv. Raleshwari was grown in 0, 50 or 100 kg N ha^{-1}. Seed yield was highest 923 kg ha^{-1} (1992) and 884 kg ha^{-1} (1993) and mean seed yield was highest with 100 kg N ha^{-1} (870 kg) (Satyanarayana *et al.*, 1996). Sesame cv. Rama was given 0, 60 or 120 kg N ha^{-1}. The application of 120 kg N ha $^{-1}$ gave highest seed yield and was the highest gross return (Dutta *et al.*, 1996).

Ashok *et al.* (1996) obtained highest sesame seed yield when it was treated with 90 kg N ha^{-1} in 1990 and 60 kg N ha^{-1} in 1991.

Chaplot (1996) observed in a field experiment where sesame was given 20, 40 or 60 kg P_2O_5 ha^{-1} as DAP (Diammonium phosphate) or SSP (Single superphosphate) with or without 50 kg S ha^{-1}. Application of 40 or 60 kg P_2O_5 ha^{-1} gave the best growth and yield. P source was not significant. The highest net return and benefit: cost ratio was obtained with the application of S in combination with 40 kg P_2O_5 ha^{-1} as DAP.

Yadav *et al.* (1996) found in an experiment, the response of sesame cv. Pratap to different sources of sulfur applied through ammonium sulphate, gypsum, pyrites and elemental sulfur was studied on an alkaline sandy loam soil. Seed and stalk yields, S uptake and oil content of sesame increased significantly with increasing levels of sulfur. Amongst the sources of S tested, ammonium sulfate and gypsum were the best followed by pyrites and elemental sulfur in respect of yield, oil content and S uptake.

Chaplot (1996) conducted a field experiment in kharif season; Rajasthan, India, sesame was given 20, 30, 40, 50 kg S ha^{-1} application of 1, 2 and 3 kg B ha^{-1}. It was observed that there was a significant effect on growth and yield of sesame. 30 kg S ha^{-1} with 2 kg B ha^{-1} gave the best growth results (increased plant height, dry matter production, branches $plant^{-1}$ and leaf area index) and yield contributing characters (increased capsules $plant^{-1}$, seeds $capsule^{-1}$, capsules length, 1000 seed weight and grain yield) and oil content of sesame. The highest net return and benefit: cost ratio was obtained with the application of 30 kg S ha^{-1} in combination with 2 kg B ha^{-1}.

Ramirez and Linares (1995) observed that B deficiency caused yellowing of shoots and of the youngest leaves of sesame. Upper leaves became dark green, coriaceous, with edges curved down. B - deficiency symptoms were related to 30 day old youngest leaf which fully expanded leaf. Dry matter production of leaves, stems, and roots were severely decreased when B in the leaf tissue was below to its required level; however seed oil content and dry weight were decreased when B concentration of leaf was decreased.

The NP application to sesame has been reported to increase capsules $plant^{-1}$, seeds capsule, 1000-seed weight, biological yield, seed yield, oil contents, plant height, number of primary branches $plant^{-1}$ and protein contents (Malik *et al.*, 1990; Sinharoy *et al.*, 1990; Jadhav *et al.*, 1992; Ishwar *et al.*, 1994; Mankar *et al.*, 1995). Nageshwar *et al.* (1995) used 40, 80 and 120 kg N ha^{-1} in five selected varieties of sesame. Seed yield was highest in 120 kg N ha^{-1} (1.82 t ha^{-1}) with net return highest.

Sakal *et al.* (1994) evaluated the direct and residual effect of varying levels of B (0, 8, 16, 32 and 64 kg Borax ha^{-1}) and FYM (0.25 and 5.0 t ha^{-1}) alone and in combinations on crops in maize-lentil cropping system. Increasing levels of B upto 16 kg broax ha^{-1} significantly increased the yield of crop and higher levels of B decreased the yield of first crop. Application of 16 kg Borax ha^{-1} in conjunction with 5 t FYM ha^{-1} was an ideal combination which appreciably enhanced the cumulative grain yield response, and sustained the productivity of four crops in this cropping system.

Chandrakar *et al.* (1994) reported that seed yield of sesame increased with increasing nitrogen rates (0, 50, 100 or 150 kg N ha^{-1}). Rao *et al.* (1993) observed seed yields of sesame increased with increasing nitrogen application from 0, 40 and 80 kg N ha^{-1}.

Tiwari *et al.* (1994) conduct a field experiment with no fertilizer, 60 kg N ha^{-1}, 60 kg N + 30 kg P + 0 or 20 kg N or 60 kg N + 30 kg P + 20 kg + 25 kg Zn in sesame. They reported that highest highest seed were obtained (0.53 t ha^{-1}) with the application of 60 kg N+30 kg P + 20 kg K.

Ishwar *et al.* (1994) reported sesame given 0, 30 and 60 kg N ha^{-1} which gave mean seed yield of 470, 531 and 590 kg ha^{-1}. Pawar *et al.* (1993) used 0, 40, 80 or 120 kg N ha^{-1} in sesame and reportedSeed yield increased up to 120 kg N ha^{-1}.

Mondal *et al.* (1993) observed the crop sesame cv. B67 given 75 or 100% of recommended rates of NPK + S with or without either crop residues or 10 t FYM ha^{-1}, the highest dry matter was obtained with 75% fertilizer + S + crop residues, and this treatment also gave maximum capsules $plant^{-1}$ and 1000 seed weight. Highest seed yield of 1.40 t/ha was obtained with 75% NPK + S + FYM, followed by 100% NPK + S (1.36 t ha^{-1}) and 75% NPK + S + crop residues (1.35 t ha^{-1}), while the lowest yield was given by 75% NPK without S (0.9 t ha^{-1}).

A field experiment was conducted to study the effect of duration of weed competition and weed control on the yield of sesame during kharif-1 season. The result showed that highest seed yield (1345 ka ha^{-1}) was found when the plots were weeded up to 20 days after emergence and critical period of crop-weed competition was third week after seedling emergence (Hossain *et al.*, 1993).

Kumar and Prasad (1993) in a field trial found that seed yield of sesame increased with nitrogen fertilizer rate from 0.13 t ha^{-1} (without nitrogen) to 0.92 t ha^{-1} with 90 kg N ha^{-1} but seed oil concentration was highest (47%) with 30 kg N ha^{-1} and after this oil content was in decreasing trend.

Shrivastava and Tripathi (1992) in a field experiment at Raipur, Madya Pradesh. India observed that nitrogen rates (30, 60 or 90 kg ha^{-1}) increased the seed yield of sesame from 0.87 t ha^{-1} with 30 kg N ha^{-1} to 1.27 t ha^{-1} with 90 kg N ha^{-1}.

Jadhav *et al.* (1992) stated that seed yield and protein content of sesame increased with increasing nitrogen rate up to 120 kg ha^{-1} in sesame variety CV Punjab 1. But higher nitrogen dose increased the susceptibility *to Fusarium.*

Gnanmurthy *et al.* (1992) conducted a trial with five spacing (30 cm x 10 cm, 30cm x 15cm, 30cm x 20cm, 30cm x 25cm and 30cm x 30cm) in sesame in 1987 and 1988. They observed that the branches $plant^{-1}$ were significantly greater at medium spacing (30 cm x 15 cm, 30 cm x 20 cm) in both the years.

Chaplot *et al.* (1992) stated that yield of sesame cv. TC 25 grows at Udaipur; India was 0.66 t ha^{-1} with the application 0 kg S ha^{-1} whereas it was significantly high 0.76 t ha^{-1} when receiving 50 kg S ha^{-1}. The residual effects of sulphur in the next season wheat increased the grain yield markedly.

Oil yield of sesame was increased significantly by the application of sulphur (at the rate of 0 to 50 kg S ha^{-1}) and by increasing phosphorus rates (from 0 to 40 kg P_2O_5 ha^{-1}) but not affected by the source of them (Chaplot *et al.*, 1991). Nitrogen, phosphorus and sulphur uptakes by seed were increased by the application of phosphorus and sulphur on sesame. Seed concentration of oil, nitrogen and sulphur were slightly but significantly increased by phosphorus and sulphur fertilization.

Sinha *et al.* (1991) studied the response of boron on five kharif crops, viz. onion, groundnut, sesame, maize, sweet potato and yard long bean as well as five rabi crops, viz. mustard, onion, lentil, maize and sunflower to boron application on boron deficient calcareous soils under field condition. Boron was applied as borax @ 0, 1.5 and 2.5kg B ha^{-1}. All the crops responded to boron, but the magnitude of yield response differed from crop to crop. The optimum level of B for kharif as well as rabi crops was 1.5 kg ha^{-1}.

Samui *et al.* (1990) found that dry matter production and N, P and K uptake in 3 sesame cultivars increased when 30 or 60 kg N ha^{-1} was applied. Puste and Maiti (1990) obtained 632, 775, 885 and 919 kg ha^{-1} yield when it was treated with 0, 40, 80 and 120 kg N ha^{-1}, respectively.

Patel *et al.* (1988) carried out an experiment in summer sesame with three spacing (30, 45 and 60 cm apart rows with 15 cm plant to plant distance) and observed that the closest spacing (30 cm x 15 cm) produced the highest seed yield.

Vijay *et al.* (1987) found that application of nitrogen at 40 kg ha^{-1} to sesame cv. C-6 increased seed yield from 0.73 to 0.98 t ha^{-1}, seed oil content from 48.1 to 56.3% and protein content from 19.4 to 20.9%, further increases in nitrogen rates to 120 kg ha^{-1} produced linear increases in protein contents but had no effect on other parameters. Increasing sulphur rates (0-120 kg ha^{-1}) produced linear increase in protein and oil contents but no significant effects on other parameters.

Tomar and Choudhury (1987) reported that tallest plant and more number of siliqua plant^{-1} were found when weed control measure taken. Seo *et al.* (1986) conducted an experiment with 0-180 kg N ha^{-1} and obtained highest yield 1.01 kg ha^{-1} when it was treated with 80 kg N ha^{-1}.

Effects of nitrogen, phosphorus and potassium fertilizer rates were studied by Lee *et al.*, (1986) in sesame and the best fertilizer rates were found to be 80 kg N, 60 kg P_2O_5 and 80 kg K_2O.

Jain *et al.* (1985) reported that the lowest number of branches plant^{-1}, number of capsule plant^{-1}, seeds capsule^{-1} and seed yield was found due to competition between weed and crop plant for nutrient and moisture of sesame.

Chakraborty *et al.* (1984) reported that increasing nitrogen rates from 0 to 120 kg ha^{-1} in sesame increased seed yields from 238 to 990 kg ha^{-1}. Bhan (1979) reported that application of fertilizer was gave good response when one hand weeding was performed at 20 days after emergence.

CHAPTER 3

MATERIALS AND METHODS

Chapter 3

MATERIALS AND METHODS

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka during the period from March to June, 2008. This chapter deals with a brief description on experimental site, climate, soil, land preparation, layout, experimental design, intercultural operations, data recording and their analyses.

3.1 Experimental site

The experimental site was located under the Agro-ecological zone 28 (Madhupur Tract) having the red brown trace soils and acid basin clay.

3.2 Soil

The soil of the experimental site was well drained and medium high. The physical and chemical properties of soil of the experimental site were examined prior to experimentation from 0-15 cm depth. The soil was sandy loam in texture and having soil pH varied from 5.46 to 5.61. Organic matter content was very low (0.83%). The physical composition such as sand, silt, clay content were 40%, 40% and 20%, respectively. The chemical properties of experimental soil are presented in Appendix II.

3.3 Climate

The climate of the experimental field was sub-tropical and was characterized by high temperature, heavy rainfall during Kharif-l season (March - June) and scanty rainfall during Rabi season (October - March) associated with moderately low temperature. The monthly average temperature, humidity, rainfall and sunshine hours prevailed at the experimental area during the cropping season are presented in Appendix III.

3.4 Planting material

The variety of sesame used for the present study was BARI Til-3. The seeds of this variety were collected from the Bangladesh Agricultural Research Institute (BARI), Gazipur. The important characteristics of these variety is mentioned below:

BARI Til 3: Plants are of average 100 -110 cm height. Leaves are darker green and rough. Stem is branched and contains 3 – 5 branches. Number of capsule plant^{-1} is 60 – 65 and seeds capsule^{-1} is 50 – 55. Maximum yield is 1200 - 1400 kg ha^{-1}. Seeds contain 42 - 50% oil and 25% protein.

3.5 Land preparation

The land was first opened with the tractor drawn disc plough. Ploughed soil was then brought into desirable fine tilth by 4 operations of ploughing and harrowing with country plough and ladder. The stubble and weeds were removed. The first ploughing and the final land preparation were done on 9 March and 16 March 2008, respectively. Experimental land was divided into unit plots following the design of experiment. The plots were spaded with basal dose of fertilizers and incorporated thoroughly before planting.

3.6 Fertilizer application

The land was fertilized with 46 kg N, 72 kg P_2O_5, 30 kg K_2O, 20 kg S, 2 kg B and 1 kg Zn ha^{-1} as urea, triple super phosphate (TSP) and muriate of potash (MOP), Gypsum, Boric and Zinc Sulphate, respectively. Half amount of Urea and whole amount of TSP, MOP, Gypsum, Boric acid and Zinc Sulphate fertilizers were applied as basal dose during final land preparation following treatment variables. Rest amount of urea was applied as top dressing at the time of 1st irrigation at 30 DAS.

3.7 Experimental treatments

The following ten treatments were tested:

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

3.8 Experimental design and layout

The experiment was laid out in a Randomized Complete Block Design. Each treatment was replicated four times. The size of a unit plot was 4.2 m x 2.5 m. The distance between two adjacent replications (block) was 1.5 m and plot to plot distance was 75 cm. The inter block and inter row spaces were used as footpath and irrigation or drainage channels.

3.9 Sowing of seeds

Seeds were sown on 15th March, 2008 in lines continuously following line to line distance as 30 cm and broadcast by hand. Seeds were placed 2 cm depth of furrows and then furrows were covered with loose soil properly.

3.10 Intercultural operations

3.10.1 Weeding

The crop field was weeded once; following treatment variables. Weeding was done at 20 DAS. The different weeds found in the plots were recorded and shown in the Appendix X.

3.10.2 Thinning

Thinning was done once in all the unit plots with care so as to maintain plant to plant distance as 5 cm.

3.10.3 Irrigation

Light irrigation was applied to maintain uniform germination. After sowing two irrigations were done during crop growth period. First irrigation and second irrigation were applied at 30 DAS and 45 DAS, respectively.

3.10.4 Application of insecticides

The crops were attacked by hawkmoth at capsule initiation stage (45 DAS). It was controlled by Malathion 57 EC at the rate of 2 ml/litre of water only in the insect control plots. The spraying was done in the afternoon while the pollinating bees were away from the field.

3.11 Harvesting and threshing

The crop was harvested on 18th June, 2008 when leaves, stem and capsules became yellowish in colour. Pre demarked 3 m^2 area was harvested and yield was recorded per unit plot. The harvested plants were tied into bundles and carried to the threshing floor. The crops were sun dried by spreading on the threshing floor. The seeds were separated from the capsules by beating with bamboo sticks and later were cleaned, dried and weighed. The weights of the dry stover were also taken.

3.12 Sampling

The first crop sampling was done at 15 DAS and it was continued at an interval of 15 days, viz. 30, 45, 60, 75 DAS and at harvest. At each harvest, ten plants were selected randomly from each plot. The selected plants of each plot were collected by cutting plants at ground level. The heights of plants were measured with a meter scale placed on the ground level to top of the leaves. The number of leaves, branches and capsules were recorded separately. The components of plants were oven dried at 70 °C for 48 hours to record constant dry weights. Above ground dry matter was determined by recording the dry weight of plants except root. The weight of the stovers were taken from each plot.

3.13 Data collection

The data on the following parameters of ten plants were recorded at each harvest.

A. Growth Data

All data of growth parameters were collected 15 days intervals starting from 15 DAS.

1. Plant height (cm)
2. Branches $plant^{-1}$
    a. Primary branch
    b. Secondary branch
3. Leaves $plant^{-1}$
4. Leaf area index (LAI)
5. Above ground dry weight (g $plant^{-1}$)
6. Crop growth rate (CGR)
7. Relative growth rate (RGR)
8. Net assimilation rate (NAR)

B. Yield Data

1. Capsules branch^{-1}
2 Capsules plant^{-1}
3. Seeds capsule^{-1}
4. Length of capsule
5.1000-seed weight (g)
6. Seed yield (t ha^{-1})
7. Stover yield (t ha^{-1})
8. Harvest index (%)

C. Weeds Data

1. Weeds population m^{-2}
2. Total weeds dry mass (g m^{-2})

3.14 Procedure of data collection

3.14.1 Plant height (cm)

The heights of ten plants were measured with a meter scale from the ground level to the top of the plants and the mean height was expressed in cm.

3.14.2 Branches plant^{-1}

The number of branches plant^{-1} was counted from preselected ten plants and mean values were taken.

3.14.3 Leaves plant^{-1}

The number of leaves plant^{-1} was counted from preselected ten plants and mean values were taken.

3.14.4 Leaf area index (LAI)

LAI is the ratio of leaf area to its ground area. It was determined by the following formula:

$$LAI = \frac{LA}{A}$$

Where,

LA = Leaf area (cm^2)

A = Unit land area (cm^2)

Leaf area index (LAI) was measured from preselected ten plants and mean value was determined.

3.14.5 Above ground dry weight plant^{-1} (g)

For measuring the dry matter plant^{-1}, the parts of the plants were separated and dried in oven at 70 ^{0}C for 48 hours and weight was taken carefully. The weight of separated plant parts were taken separately. The sum of the dry plant parts constituted the total dry matter of a single plant.

3.14.6 Crop Growth Rate (CGR)

It is the increase in dry matter of plant per unit ground area per unit time. The CGR values have been computed by the following formula of Brown (1984).

$$CGR = \frac{W_2 - W_1}{T_1 - T_2} \times \frac{1}{GA} \quad (g\ m^{-2}\ day^{-1})$$

Where,

W_1 = Weight of dry matter (g) per plant at time T_1

W_2 = Weight of dry matter (g) per plant at time T_2

GA = Ground area (m^2)

3.14.7 Relative Growth Rate (RGR)

The relative growth rate of a plant is the increase in dry matter per unit of material present per unit of time and is calculated by the following formula of Radford (1967).

$$RGR = \frac{LnW_2 - LnW_1}{T_1 - T_2} \quad (g\ g^{-1}\ day^{-1})$$

Where,

W_1 = Weight of dry matter (g) per plant at time T_1

W_2 = Weight of dry matter (g) per plant at time T_2

Ln = Natural logarithm

3.14.8 Net Assimilation Rate (NAR)

It is the dry matter accumulation per unit of leaf area per unit of time. The calculation was done by the formula given by the Radford (1967).

$$NAR = \frac{Ln\ LA_2 - Ln\ LA_1}{LA_2 - LA_1} \times \frac{W_2 - W_1}{T_1 - T_2}\ (g\ m^{-2}\ day^{-1})$$

Where,

LA_1 = Leaf area (cm^2) per plant at time T_1

LA_2 = Leaf area (cm^2) per plant at time T_2

W_1 = Weight of dry matter (g) per plant at time T_1

W_2 = Weight of dry matter (g) per plant at time T_2

Ln = Natural logarithm

3.14.9 Capsules branch^{-1}

Capsules of pre selected ten branch from each unit plot were noted and the mean number was recorded. The mean number was expressed on per plant basis.

3.14.10 Capsules plant^{-1}

Capsules of pre selected ten plants from each unit plot were noted and the mean number was recorded. The mean number was expressed on per plant basis.

3.14.11 Seeds capsule^{-1}

Seeds were counted randomly taking ten capsules from each sample of each plot as per treatment and averaged them to take seeds capsule^{-1}.

3.14.12 Length of capsule (cm)

The length of capsule was measured from talking the ten capsules of each treatment. Capsules were taken from middle to bottom and then averaged. The average length of capsule was then determined.

3.14.13 Weight of 1000-seeds (g)

One thousand cleaned dried seeds were counted randomly from each harvested sample and weighed by using a digital electric balance and the mean weight was expressed in gram.

3.14.14 Seed yield (t ha^{-1})

Weight of seed of the demarcated area (3.0 m^2) at the centre of each plot was taken and then converted to the yield in t ha^{-1} at 12% moisture level.

3.14.15 Stover yield (t ha^{-1})

Stover yield was the total weight of plant except the seed yield and expressed as t ha^{-1}.

3.14.16 Biological yield (t ha^{-1})

The summation of grain yields and stover yields were considered as biological yields. Biological yield was calculated by using the following formula,

Biological yield = Grain yield + stover yield (dry weight basis)

3.14.17 Harvest index (%)

The harvest index was calculated on the ratio of grain yield to biological yield and expressed in terms of percentage. It was calculated by using the following formula-

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

3.15 Analysis of data

The data collected on different parameters were statistically analyzed to obtain the level of significance using the MSTATC computer package program developed by Russel (1986). Mean difference among the treatments were tested with Least Significant Difference (LSD) at 5% level of significance.

CHAPTER 4

RESULTS AND DISCUSSION

Chapter 4

RESULTS AND DISCUSSION

The experiment was conducted with response of various management practices on sesame. The results regarding the effect of different treatment enclosed with sowing method, fertilization, weed management and insect control on growth and yield parameters have been presented and discussed under separate heads and sub-heads as follows.

4.1 Crop Characters of Sesame

4.1.1 Plant height

Plant height is one of the most important growth characteristics of sesame. Plant height increased gradually over time attaining the highest at harvest. The rate of increase, however, varied depending on the days after emergence or growth stage. Plant height was significantly affected among the treatments (Appendix IV & Table 1). At 15 DAS the tallest plant (5.57 cm) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) which was significantly different from all other treatments. The next highest plant height 5.30 cm was noted from treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) treatment. Treatment T_8 (Line sowing + recommended fertilizer), treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) gave statistically similar plant height (5.10 cm). The shortest plant was (4.15 cm) found in treatment T_1 (Broadcast sowing without post sowing care). Plant height was increased by 32.34% in treatment T_{10}, 27.71% in T_9 and 22.89% T_8 over control (T_1).

At 30 DAS the plant tallest (21.30 cm) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) and T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) showed statistical similar heights (19.05 and 18.83 cm). The smallest plant height (13.13 cm was) found in treatment T_1 (Broadcast sowing without post sowing care). Plant height was increased by 62.22% in treatment T_{10}, 45.08% in T_9 and 43.41% T_5 over control (T_1).

At 45 DAS the tallest plant (46.05 cm) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) which was significantly superior to all other treatments. Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was next treatment to have maximum plant height of 42.88 cm. Treatment T_5 and T_8 were produced statistically identical plant height. The shortest plant height was (33.05 cm) found in treatment T_1 (Broadcast sowing without post sowing care) at 45 DAS. Plant height was increased by 39.33% in treatment T_{10} and 29.74% in T_9 over control (T_1).

At 60 DAS the tallest plant (55.53 cm) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS).The second highest plant height (52.20 cm) was obtained from T_9 treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS). T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS), T_7 (Line sowing + 1 HW at 20 DAS) and T_8 (Line sowing + recommended fertilizer) and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) gave statistically similar plant heights (48.92, 48.25, 47.38 and 47.33 cm). The lowest plant height (41.88 cm) was found in T_1 treatment (Broadcast sowing without post sowing care). Plant height was increased by 32.59% in treatment T_{10} and 24.64% in T_9 over control (T_1).

At 75 DAS the tallest plant (75.35 cm) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + one given hand weeding 20-25 DAS + insect control at 45 DAS). The next effective treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) had plant height of 70.95 cm. Treatment T_7 (Line sowing + 1 HW at 20 DAS) and T_8 (Line sowing + recommended fertilizer) gave statistical at par plant heights (65.78 and 64.70 cm). The shortest plant height (56.65 cm) was found in T_1 (Broadcast sowing without post sowing care) at 75 DAS. Plant height was increased by 33.01% in treatment T_{10} and 25.24% in T_9.

At harvest the maximum plant height (93.38 cm) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and significantly superior to all the treatments. Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) with 87.68 cm plant height registered as next influenced treatment. The lowest plant height (70.10 cm) was found in T_1 treatment (Broadcast sowing without post sowing care). Plant height was increased by 33.20% in treatment T_{10} and 25.07% in T_9 over control (T_1).

The plant height was increased due to different types of fertilizer at optimum rates with weed and insect control. The line sowing combination gave favourable environment to the plant than broadcast sowing to have maximum plant growth increases to plant height. Similar result was also found by Thanki *et al.* (2004), Caliskan *et al.* (2004) and Tiwari *et al.* (2000) when they applied different fertilizer at recommended dose to the sesame.

Table 1: Effect of different management practices on plant height of sesame at different days

Treatment	Plant height (cm)					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At Harvest
T_1	4.15	13.13	33.05	41.88	56.65	70.10
T_2	4.50	13.77	35.47	43.22	58.85	72.07
T_3	4.80	15.20	36.85	44.75	60.85	71.60
T_4	5.10	18.05	39.25	47.33	63.22	77.88
T_5	5.10	18.83	40.88	48.92	63.17	81.80
T_6	4.45	14.05	34.15	45.10	60.65	73.68
T_7	4.75	15.95	38.15	48.25	65.78	76.18
T_8	5.10	18.10	40.38	47.38	64.70	80.40
T_9	5.30	19.05	42.88	52.20	70.95	87.68
T_{10}	5.57	21.30	46.05	55.53	75.35	93.38
$LSD_{0.05}$	0.11	0.23	0.25	2.45	1.50	1.28
CV %	1.55	3.02	1.45	3.56	1.62	1.13

T_1= Broadcast sowing without post sowing care (control)
T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS
T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})
T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS
T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS
T_6= Line sowing without post sowing care T_7= Line sowing + 1 HW at 20 DAS
T_8= Line sowing + recommended fertilizer
T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS
T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.1.2 Leaves plant^{-1}

Leaves plant^{-1} is an important growth parameter for sesame and it maximized at harvest with gradually increasing from early date. Leaves plant^{-1} was significantly affected among the treatments (Appendix IV & Table 2). At 15 DAS the maximum number of leaves plant^{-1} (5.60) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + one given hand weeding 20-25 DAS + insect control at 45 DAS). Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) resulted with next maximum leaves plant^{-1} (5.25) and followed by T_8 treatment (Line sowing + recommended fertilizer) which was 5.17. The lowest number of leaves plant^{-1} (4.05) was found in T_1 treatment (Broadcast sowing without post sowing care) which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS) and T_3 (Broadcast sowing + recommended fertilizer) and T_6 (Line sowing without management). Leaves plant^{-1} was increased by 38.27% in treatment T_{10}, 29.62% in T_9 and 27.65 in T_8 over treatment T_1 (control).

At 30 DAS the highest leaves plant^{-1} (8.22) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). The next maximum leaves plant^{-1} was recorded with T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 7.82. The lowest leaves plant^{-1} (6.25) was found in treatment T_1 treatment (Broadcast sowing without management). Leaves plant^{-1} was increased by 31.52% in treatment T_{10} and 25.12 % in T_9 over control (T_1).

At 45 DAS the treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) produced maximum number of leaves plant^{-1} (23.58) which was significantly higher than the other treatments. The second highest (19.60) was obtained by T_9 treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS). The lowest number of leaves plant^{-1} (12.55) was found in T_1 (Broadcast sowing without post sowing care). Number of leaves plant^{-1} was increased by 87.89% in treatment T_{10} and 56.17 % in T_9 over treatment T_1 (control).

At 60 DAS the highest number of leaves plant^{-1} (95.30) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and it was statistically similar to T_9 treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS) and was 89.55 cm and treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) gave 85.75 leaves plant^{-1} and was statistically similar to T_8 treatment (Line sowing + recommended fertilizer), 83.57. The lowest number of leaves plant^{-1} (50.10) found in T_1 treatment (Broadcast sowing without post sowing care). Leaves plant^{-1} was increased by 90.21% in treatment T_{10} and 78.74% in T_9 over control (T_1).

At 75 DAS the highest (134.2) leaves plant^{-1} was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) produced next highest leaves plant^{-1} (125.1). The lowest leaves plant^{-1} (89.88) found in T_1 (Broadcast sowing without post sowing care). Leaves plant^{-1} was increased by 49.31% in treatment T_{10} and 39.18 % in T_9 over control (T_1).

At harvest the maximum number of leaves plant^{-1} (150.1) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). The second highest leaves plant^{-1} (147.4) was from T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS). The lowest number of leaves plant^{-1} (123.9) was found in T_1 (Broadcast sowing without post sowing care). Leaves plant^{-1} was increased by 21.14% in treatment T_{10} and 18.96 % in T_9 over treatment T_1 (control). The number of leaves was higher in treatment T_{10} because plant got more free space, weed free environment and optimum fertilizer which were most needed for crop growth.

Table 2: Effect of different management practices on leaves plant^{-1} of sesame at different days

Treatment	Leaves plant^{-1}					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At Harvest
T_1	4.05	6.25	12.55	50.10	89.88	123.9
T_2	4.15	6.65	13.55	58.48	96.80	125.8
T_3	4.20	7.15	13.98	66.78	103.1	128.0
T_4	4.55	7.25	14.75	78.93	108.3	131.9
T_5	4.95	7.55	15.38	85.75	113.9	135.4
T_6	4.15	6.65	13.57	63.85	97.70	128.0
T_7	4.72	7.25	14.43	70.85	111.6	140.7
T_8	5.17	7.55	17.70	83.57	119.6	142.9
T_9	5.25	7.82	19.60	89.55	125.1	147.4
T_{10}	5.60	8.22	23.58	95.30	134.2	150.1
CV %	2.99	1.72	1.03	6.13	3.07	0.89
$LSD_{0.05}$	0.20	0.17	0.23	6.60	1.97	1.74

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.1.3 Leaf area index (LAI)

Leaf area index (LAI) is also an important growth parameter for sesame. Leaf area index (LAI) was significantly influenced by different treatments (Appendix V & Table 3). At 15 DAS the highest leaf area index (0.21) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by T_9 treatment (0.20) (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 0.21 and T_5 treatment (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) was 0.19. The lowest leaf area index (0.05) was found in T_1 (Broadcast sowing without post sowing care) which was statistically similar to T_6 treatment (Line sowing without post sowing care). Leaf area index was increased by 320% in treatment T_{10}, 300% in T_9 and 280% in T_5 over control (T_1).

At 30 DAS the highest leaf area index (0.41) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by T_9 (0.39) (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 0.39. Treatment T_8 (Line sowing + recommended fertilizer) showed next valued of 0.36. The lowest leaf area index was (0.20) found in T_1 treatment (Broadcast sowing without management) which was statistically similar to T_6 treatment (Line sowing without post sowing care) and T_2 (Broadcast sowing + one hand weeding 20-25 DAS). Leaf area index was increased by 105% in treatment T_{10} and 95% in T_9 over control (T_1).

At 45 DAS the highest leaf area index (0.59) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 0.56. T_8 (Line sowing + recommended fertilizer) gave the second value as 0.52. The lowest leaf area index was (0.38) found in T_1 (Broadcast sowing without post sowing care) which was statistically similar to T_6 (Line sowing without management), T_2 (Broadcast sowing + one hand weeding at 20 DAS), T_6 (Line sowing without post sowing care) and T_7 (Line sowing + 1 HW at 20 DAS). Leaf area index was increased by 55.26% in T_{10} and 47.36% in T_9 over control (T_1).

At 60 DAS the highest leaf area index (0.81) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 0.78 and T_5 treatment (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) was 0.77. The lowest leaf area index (0.61) was found in T_1 treatment (Broadcast sowing without post sowing care) which was statistically similar to T_6 treatment (Line sowing without post sowing care) and T_2 treatment (Broadcast sowing + one hand weeding at 20 DAS). Leaf area index was increased by 32.79% in treatment T_{10} and 27.87% in T_9 over control (T_1).

At 75 DAS the highest leaf area index (0.91) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by T_9 treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 0.81, T_8 treatment (Line sowing + recommended fertilizer), treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) was 0.87 and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS). The lowest leaf area index (0.78) was found in T_1 (Broadcast sowing without management) which was statistically similar to T_6 (Line sowing without post sowing care) and T_7 treatment (Line sowing + 1 HW at 20 DAS) and T_2 (Broadcast sowing + one hand weeding at 20 DAS). Leaf area index was increased by 16.67% in treatment T_{10}, 14.10% in T_9 and T_8 over control (T_1).

At harvest the highest leaf area index (0.92) was recorded in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by T_9 treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 0.91, T_8 (Line sowing + recommended fertilizer) was 0.92. The lowest leaf area index (0.81) was found in treatment T_1 (Broadcast sowing without management) which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS) and T_6 treatment (Line sowing without post sowing care). Leaf area index was increased by 13.58% in T_{10} over control (T_1). Likewise plant height, leaf number and leaf area index of sesame was favoured by the maximum management under line sown conditions. Similar findings were reported by Kalaiselvan *et al*. (2002) and Chaplot (1996).

Table 3: Effect of different management practices on leaf area index (LAI) of sesame at different days

Treatment	Leaf Area Index (LAI)					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At Harvest
T_1	0.05	0.20	0.38	0.61	0.78	0.81
T_2	0.10	0.22	0.40	0.65	0.82	0.83
T_3	0.11	0.28	0.47	0.69	0.83	0.86
T_4	0.14	0.29	0.51	0.72	0.87	0.89
T_5	0.19	0.33	0.52	0.77	0.87	0.88
T_6	0.09	0.21	0.39	0.63	0.80	0.84
T_7	0.12	0.28	0.41	0.68	0.82	0.88
T_8	0.17	0.36	0.52	0.74	0.89	0.92
T_9	0.20	0.39	0.56	0.78	0.89	0.91
T_{10}	0.21	0.41	0.59	0.81	091	0.92
CV %	23.25	10.42	5.08	4.51	3.32	3.42
$LSD_{0.05}$	0.001	0.458	0.045	0.458	0.045	0.045

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.1.4 Primary branches plant^{-1}

The result showed that the primary branches plant^{-1} was also significantly affected among different treatments at 30, 45, 60, 75 DAS and at harvest (Appendix V & Table 4). At 30 DAS the maximum primary branch plant^{-1} (2.95) was recorded in treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) followed by treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) was 2.87. Treatment T_8 (Line sowing + recommended fertilizer) and treatment T_7 (Line sowing + 1 HW at 20 DAS) and T_4 treatment (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) resulted with second highest branches plant^{-1}and they were 2.67, 2.55 and 2.55, respectively. The lowest primary branches plant^{-1} (2.02) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_5 (Broadcast sowing + recommended fertilizer + one given hand weeding 20-25 DAS + insect control at 45 DAS), T_6 (Line sowing without post sowing care) and T_2 (Broadcast sowing + one hand weeding at 20 DAS). Primary branches plant^{-1} was increased by 46.03% in treatment T_9 and 42.08% in T_{10} over control (T_1).

At 45 DAS the highest number of primary branch plant^{-1} (5.80) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) and T_6 (line sowing without) and T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and T_8 (Line sowing + recommended fertilizer) gave similar primary branches plant^{-1} and were 5.55, 5.45 and 5.37 as next highest, respectively. The lowest primary branches plant^{-1} (4.15) was found in treatment T_1 (Broadcast sowing without post sowing care). Primary branches plant^{-1} was increased by 39.75% in treatment T_{10} over control (T_1) at 45 DAS.

At 60 DAS significantly highest primary branches plant^{-1} (5.95) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) gave second maximum primary branches of 5.67. The lowest primary branches plant^{-1} (4.12) was found in treatment T_1

(Broadcast sowing without post sowing care). Primary branch plant^{-1} was increased by 44.42% by treatment T_{10} over control (T_1).

At 75 DAS the highest primary branches plant^{-1} (6.07) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS), treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) and T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) produced as 5.85, 5.75 and 5.65 branches palnt^{-1} which are statistically similar. The lowest primary branches plant^{-1} (4.45) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS). Primary branches plant^{-1} was increased by 36.40% in treatment T_{10} over control (T_1) at 75 DAS.

At harvest highest primary branches plant^{-1} (6.15) was recorded in post sowing care treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 5.90. Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) produce the next highest primary branches plant^{-1} value of 5.68. The lowest primary branches plant^{-1} (4.45) was found in treatment T_1 (Broadcast sowing without post sowing care) was 4.55 which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS). Primary branches plant^{-1} was increased by 35.16% in T_{10} over control (T_1) at 75 DAS. The findings of Sigaraval *et al.* (2002) is same agreement of this observation.

Table 4: Effect of different management practices on primary branches plant^{-1} of sesame at different days

Treatment	Primary branch plant^{-1}				
	30 DAS	45 DAS	60 DAS	75 DAS	At Harvest
T_1	2.02	4.15	4.12	4.45	4.55
T_2	2.15	4.55	4.52	4.65	4.85
T_3	2.35	4.75	5.07	5.15	5.13
T_4	2.55	5.05	5.37	5.65	5.25
T_5	2.10	5.45	5.67	5.85	5.68
T_6	2.15	4.65	4.85	4.95	4.98
T_7	2.55	5.32	5.05	5.32	5.08
T_8	2.67	5.37	5.27		5.20
T_9	2.95	5.55	5.45	5.75	5.90
T_{10}	2.87	5.8	5.95	6.07	6.15
$LSD_{0.05}$	0.17	0.19	0.18	0.20	0.35
CV %	5.04	2.64	2.47	2.63	4.68

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.1.5 Secondary branches plant^{-1}

The result showed that the secondary branches plant^{-1} was also significantly affected among different treatments at 45, 60, 75 DAS and harvest (Appendix VI & Table 5). At 45 DAS the highest secondary branches plant^{-1} (1.57) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 1.55. The lowest number of secondary branch plant^{-1} (0.75) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically found in T_6 (Line sowing without post sowing care), treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS), treatment T_3 (Broadcast sowing + recommended fertilizer) and treatment T_7 (Line sowing + 1 HW at 20 DAS). Secondary branches plant^{-1} was increased by 106.67% in treatment T_{10} over control (T_1) at 45DAS.

At 60 DAS the highest secondary branches plant^{-1} (1.92) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 1.87, treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control) was 1.75 and treatment T_8 (Line sowing + recommended fertilizer) was 1.72. The lowest secondary branches plant^{-1} (0.82) was found in treatment T_6 (Line sowing without post sowing care). Secondary branches plant^{-1} was increased by 134.15% in treatment T_{10} over control (T_1).

At 75 DAS the highest secondary branches plant^{-1} (2.72) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 2.55. Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control) gave the next value was 2.35. The lowest secondary branches plant^{-1} (1.22) was found in treatment T_6 (Line sowing without post sowing care). Secondary branch plant^{-1} was increased by 122.95% in treatment T_{10} over control (T_1).

At harvest the highest secondary branches plant^{-1} (2.85) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) showed the next highest value of 2.58 which was statistically similar to T_8 (Line sowing + recommended fertilizer) and treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS). The lowest secondary branches plant^{-1} (1.48) was found in treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS) which was statistically similar to treatment T_1 (Broadcast sowing without post sowing care). Secondary branch plant^{-1} was increased by 66.45% in treatment T_{10} over control (T_1). Sukhadia *et al.* (2004) found secondary branches plant^{-1} as highest when they gave one weeding compare to unweeding plots.

Table 5: Effect of different management practices on secondary branches $plant^{-1}$ of sesame at different days

Treatment	Secondary branches $plant^{-1}$			
	45 DAS	60 DAS	75 DAS	At Harvest
T_1	0.75	1.12	1.52	1.55
T_2	0.85	1.27	1.62	1.48
T_3	0.92	1.45	1.85	1.93
T_4	1.07	1.55	2.20	2.20
T_5	1.35	1.75	2.35	2.58
T_6	0.77	0.82	1.22	1.98
T_7	0.95	1.35	1.75	2.23
T_8	1.22	1.72	2.25	2.33
T_9	1.55	1.87	2.55	2.50
T_{10}	1.57	1.92	2.72	2.85
$LSD_{0.05}$	0.21	0.20	0.20	0.28
CV %	13.44	9.42	7.05	9.00

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.1.6 Above ground dry weight (AGDW) (g)

Plant dry weight is an important growth parameter of sesame that regulates the crop yields. The accumulation of above ground dry matter started slowly at the initial stage of the crop growth and it was increased rapidly from 45 DAS to attain maximum weight at harvest. Plant dry weight was also significantly affected among different treatments (Appendix VI & Table 6). At 15 DAS the highest plant dry weight (9.89 g) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was statistically at par producing 8.97 and 8.60 g AGDM plant^{-1} that was second highest value. The lowest plant dry weight (4.82 g) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to T_6 (Line sowing without post sowing care). Plant dry weight was increased by 105.18% by treatment T_{10} and 86.09% in T_5 over control (T_1).

At 30 DAS the highest plant dry weight (19.23 g) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). The next maximum values 16.23 g and 16.17 g AGDM plant^{-1} were also recorded in treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) and treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) which were statistically similar. The lowest plant dry weight (9.96 g) was found in treatment T_1 (Broadcast sowing without post sowing care). Plant dry weight was increased by 93.07% in treatment T_{10} and 62.96% in T_9 over control (T_1).

At 45 DAS the highest plant dry weight (28.41 g) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) gave statistically similar dry weight 26.50 g and 26.28 g as second maximum. The lowest plant dry weight (17.96 g) was found in treatment T_1 (Broadcast sowing without post sowing care). Plant dry weight was increased by 58.18% by treatment T_{10} and 47.55% in T_5 over control (T_1).

At 60 DAS the highest plant dry weight (37.90 g) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) appear with next greater dry matter plant^{-1} as 36.33 g. The lowest plant dry weight (29.32 g) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_6 (Line sowing without post sowing care). Plant dry weight was increased by 29.26% in treatment T_{10} and 24.93% in T_5 over control (T_1).

At 75 DAS the highest plant dry weight (47.81 g) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). The second highest dry matter plant^{-1} (46.08 g) was given by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) and at par with treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) was 45.98 g. The lowest plant dry weight (39.60 g) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_6 (Line sowing without post sowing care) at 75 DAS. Plant dry weight was increased by 20.73% by treatment T_{10} and 16.36% in T_9 over control (T_1).

At harvest the highest plant dry weight (54.29 g) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). The second highest plant dry weight was obtained from treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS). Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and treatment T_8 (Line sowing + recommended fertilizer) yielded with statistical similar plant dry weights which were 50.26 and 48.93, respectively. The lowest plant dry weight (41.50 g) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS), treatment T_3 (Broadcast sowing + recommended fertilizer) and treatment T_6 (Line sowing without post sowing care). Plant dry weight was increased by 30.81% in T_{10} and 23.92% in T_9 over control (T_1). Plant dry weight was higher when 100 kg N ha^{-1} was given and similar findings was found by Mitra and Pal (1999) and growth of sesame was higher when 60 Kg P_2O_5 and 50 kg S ha^{-1} were given (Chaplot, 1996). Removal of weeds and application of fertilizer enhanced the dry matter production resulting higher seed yield in sesame and this result also supported by Alom *et al.* (1999). Above all line sowing cropping stimulated plant for maximum dry matter production with favourable environment over broadcast method of sowing.

Table 6: Effect of different management practices on above ground plant dry weight (g) plant^{-1} of sesame at different days

Treatment	Plant dry weight plant^{-1} (g)					
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At Harvest
T_1	4.82	9.96	17.96	29.32	39.60	41.50
T_2	5.64	11.19	21.46	31.55	39.47	43.16
T_3	6.91	12.95	23.96	33.42	40.68	44.08
T_4	7.79	15.08	25.17	34.42	42.80	47.12
T_5	8.97	16.17	26.50	36.33	45.98	50.26
T_6	4.94	10.92	19.01	30.22	38.26	43.08
T_7	6.03	12.15	21.68	32.38	39.59	46.14
T_8	6.88	13.94	24.56	34.67	41.67	48.93
T_9	8.60	16.23	26.28	35.15	46.08	51.43
T_{10}	9.89	19.23	28.41	37.90	47.81	54.29
$LSD_{0.05}$	0.48	0.76	1.03	0.99	1.78	2.60
CV %	4.71	3.82	3.04	2.05	2.94	3.82

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.1.7 Crop Growth Rate (CGR)

Crop growth rate (CGR) is an important parameter for analyzing the growth rate of sesame. Crop growth rate was also significantly affected among different treatments (Appendix VII & Fig. 1). At 15-30 DAS the highest crop growth rate (33.15 g m^{-2} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) was statistically similar to producing 32.54 and 33.39 g m^{-2} day^{-1} crop growth rate that was second highest value. Treatment T_8 (Line sowing + recommended fertilizer) and treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was statistically similar to crop growth rate. The lowest crop growth rate (22.75 g m^{-2} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS). Crop growth rate was increased by 85.27% in treatment T_{10} over control (T_1).

At 30-35 DAS the highest crop growth rate (48.80 g m^{-2} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) which gave the second highest value. Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS), treatment T_8 (Line sowing + recommended fertilizer), treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) and treatment T_3 (Broadcast sowing + recommended fertilizer) gave the statistically at par crop growth rate were 44.90, 44.19, 42.84 and 41.80 g m^{-2} day^{-1} respectively. The lowest crop growth rate (35.63 g m^{-2} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS). Crop growth rate was increased by 36.96% in T_{10} over control (T_1).

At 45-60 DAS the highest crop growth rate (52.36 g m^{-2} day^{-1}) was recorded in treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS). Treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS), treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS), treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20

DAS + insect control at 45 DAS) and treatment T_8 (Line sowing + recommended fertilizer) gave similar crop growth rate and were 52.36, 51.15, 50.94 and 49.67 g m^{-2} day^{-1} as next highest value. The lowest crop growth rate (45.11 g m^{-2} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_3 (Broadcast sowing + recommended fertilizer). Crop growth rate was increased by 16.62% in treatment T_{10} over control (T_1).

At 60-75 DAS the highest crop growth rate (59.34 g m^{-2} day^{-1}) was recorded in T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) produces the next highest value of crop growth rate was 56.23 g m^{-2} day^{-1} which was statistically similar to treatment T_7 (Line sowing + 1 HW at 20 DAS). The lowest crop growth rate (46.76 g m^{-2} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care). Crop growth rate was increased by 26.90% in treatment T_{10} and 20.25% in treatment T_9 over control (T_1).

At 75-93 DAS the highest crop growth rate (41.20 g m^{-2} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 39.97 g m^{-2} day^{-1} which represent the second highest value. Treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS), treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and treatment T_8 (Line sowing + recommended fertilizer) gave statistically at par producing crop growth rate were 38.73, 35.65 and 35.78 g m^{-2} day^{-1}, respectively. The lowest crop growth rate (31.84 g m^{-2} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS). Crop growth rate was increased by 29.39 in treatment T_{10} over control (T_1).

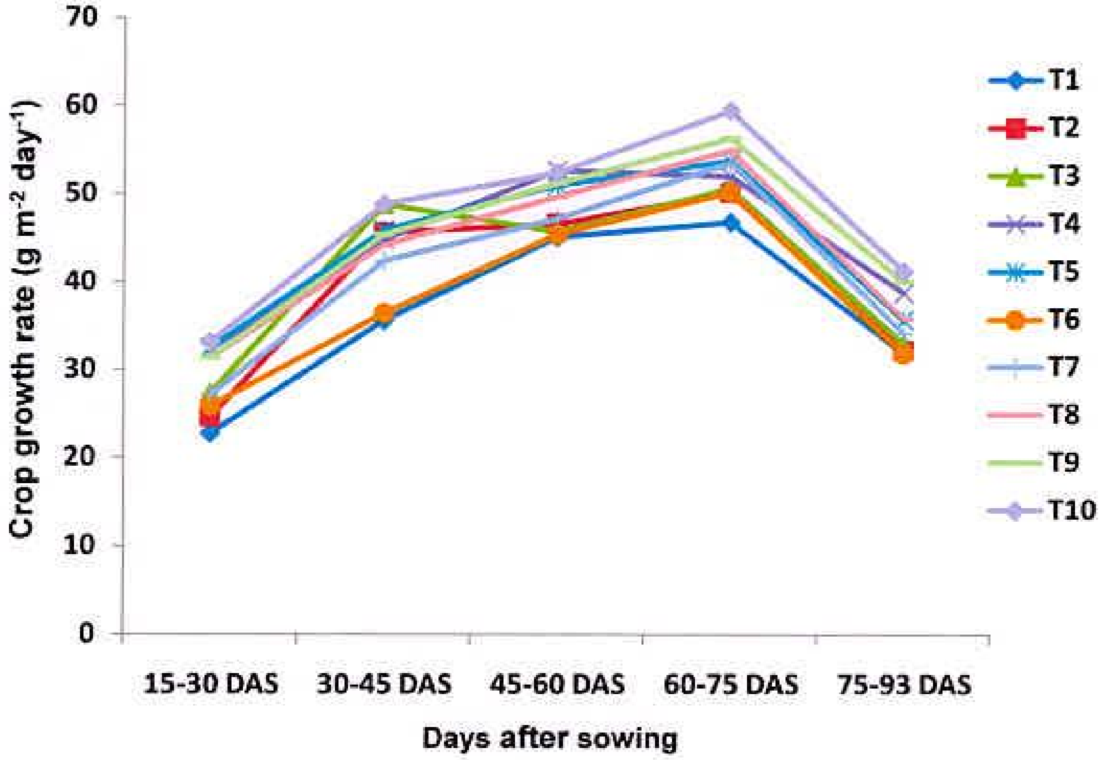


Figure 1. Effect of different management practices on crop growth rate plant^{-1} of sesame at different days (LSD $_{0.05}$ = 4.021, 5.031, 3.301, 2.027 and 5.096 at 15-30, 30-45, 45-60, 60-75 and 75-93 days after sowing, respectively)

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.1.8 Relative Growth Rate (RGR)

Relative growth rate was important to measure to growth rate that stimulate the yield of sesame. Relative growth rate was also significantly affected among different treatments (Appendix VII & Fig. 2). At 15-30 DAS the highest relative growth rate (0.17 g g^{-1} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 0.15 g g^{-1} day^{-1} which indicate the second highest value. Treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) and treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) gave the statistically similar relative growth rate was 0.12 g g^{-1} day^{-1}. The lowest relative growth rate (0.05 g g^{-1} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS). Relative growth rate was increased by 12% in treatment T_{10} over control (T_1).

At 30-45 DAS the highest relative growth rate (0.27 g g^{-1} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 0.23 g g^{-1} day^{-1} which indicate second highest value. Treatment T_8 (Line sowing + recommended fertilizer), treatment T_7 (Line sowing + 1 HW at 20 DAS), T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) gave statistically similar relative growth rate were 0.22, 0.20 and 0.19 g g^{-1} day^{-1} as next highest value. The lowest relative growth rate (0.11 g g^{-1} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS). Relative growth rate was increased by 145.45 in treatment T_{10} over control (T_1).

At 45-60 DAS the highest relative growth rate (0.35 g g^{-1} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer

+ 1 HW at 20 DAS) was 0.31 g g^{-1} day^{-1} which indicate the second highest value. Treatment T_8 (Line sowing + recommended fertilizer), treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) gave statistically similar relative growth rate were 0.27, 0.28 and 0.28 g g^{-1} day^{-1} as next highest value. The lowest relative growth rate (0.13 g g^{-1} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_6 (Line sowing without post sowing care). Relative growth rate was increased by 22 % in treatment T_{10} over control (T_1).

At 60-75 DAS the highest relative growth rate (0.47 g g^{-1} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 0.44 g g^{-1} day^{-1} which indicate the second highest value. Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) and treatment T_8 (Line sowing + recommended fertilizer) gave statistically similar relative growth rate were 0.42, 0.40 and 0.40 g g^{-1} day^{-1} as next highest value. The lowest relative growth rate (0.28 g g^{-1} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_6 (Line sowing without post sowing care). Relative growth rate was increased by 67.87% in treatment T_{10} over control (T_1).

At 75-93 DAS the highest relative growth rate (0.39 g g^{-1} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 0.38 g g^{-1} day^{-1} which indicate the second highest value. Treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) produces next highest relative growth rate was 0.33 g g^{-1} day^{-1}. The lowest relative growth rate (0.21 g g^{-1} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_6 (Line sowing without post sowing care) and treatment T_7 (Line sowing + 1 HW at 20 DAS). Relative growth rate was increased by 85.71% in treatment T_{10} over control (T_1).

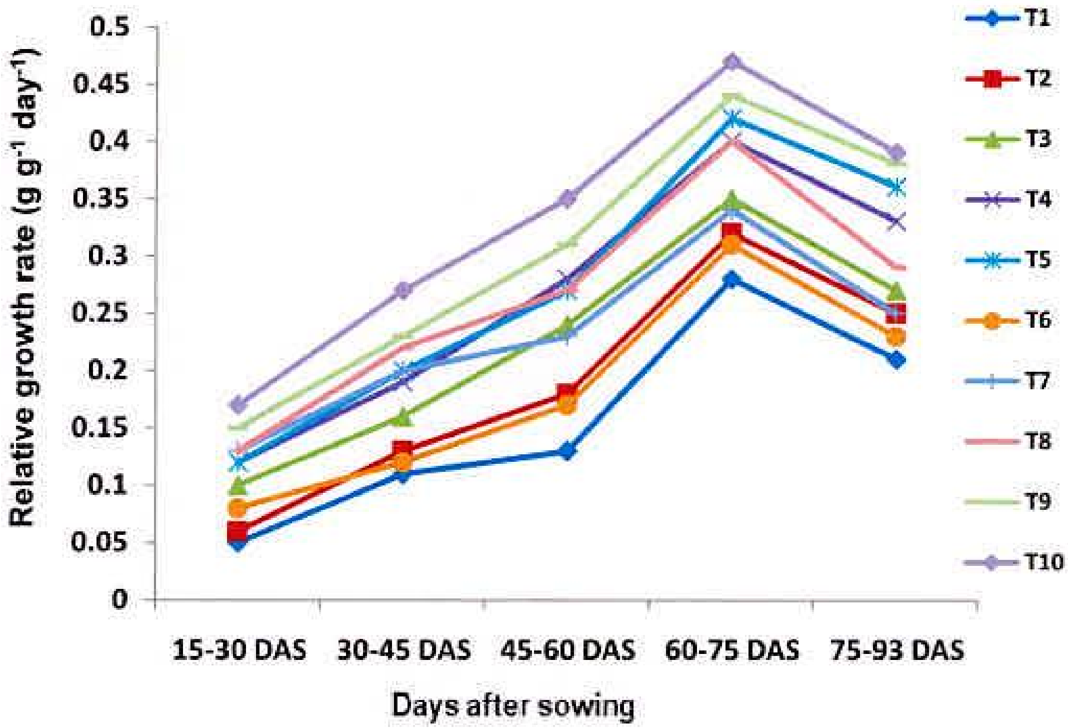


Figure 2. Effect of different management practices on relative growth rate plant^{-1} of sesame at different days (LSD $_{0.05}$ = 0.0448 at 15-30, 30-45, 45-60, 60-75 and 75-93 days after sowing, respectively)

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.1.9 Net Assimilation Rate (NAR)

Net Assimilation Rate was also significantly affected among different treatments (Appendix VII & Fig. 3). At 15-30 DAS the highest net assimilation rate (3.56 g m^{-2} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 3.29 g m^{-2} day^{-1} which indicate the second highest value. Treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS), treatment T_8 (Line sowing + recommended fertilizer) and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) gave the statistically similar net assimilation rate were 3.21, 3.11 and 32.99 g m^{-2} day^{-1}. The lowest (2.25 g m^{-2} day^{-1}) net assimilation rate was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS). Net assimilation rate was increased by 58.22% in treatment T_{10} over control (T_1).

At 30-45 DAS the highest net assimilation rate (4.05 g m^{-2} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) and treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) gave the statistically similar net assimilation rate were 3.98 and 3.94 g m^{-2} day^{-1} which indicate the second highest value. The lowest net assimilation rate (3.09 g m^{-2} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_6 (Line sowing without post sowing care). Net assimilation rate was increased by 31.06% in treatment T_{10} over control (T_1).

At 45-60 DAS the highest net assimilation rate (6.84 g m^{-2} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) gave the second highest value of 6.25 g m^{-2} day^{-1}. The lowest net assimilation rate (3.25 g m^{-2} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care). Net assimilation rate was increased by 31.06% in treatment T_{10} over control (T_1).

At 60-75 DAS the highest net assimilation rate (8.01 g m^{-2} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) gave the second highest value of 7.62 g m^{-2} day^{-1}. The lowest net assimilation rate (4.63g m^{-2} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care). Net assimilation rate was increased by 73.00% in treatment T_{10} over control (T_1).

At 75-93 DAS the highest net assimilation rate (5.36 g m^{-2} day^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) gave the second highest value of 4.75 g m^{-2} day^{-1}. Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS), T_8 (Line sowing + recommended fertilizer) and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) gave the statistically similar net assimilation rate were 4.49, 4.28 and 4.15 g m^{-2} day^{-1} which indicate the next highest value. The lowest net assimilation rate (1.25g m^{-2} day^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_6 (Line sowing without post sowing care). Net assimilation rate was increased by 328.8% in treatment T_{10} over control (T_1). Sarkar and Banik (2002) suggested the similar findings.

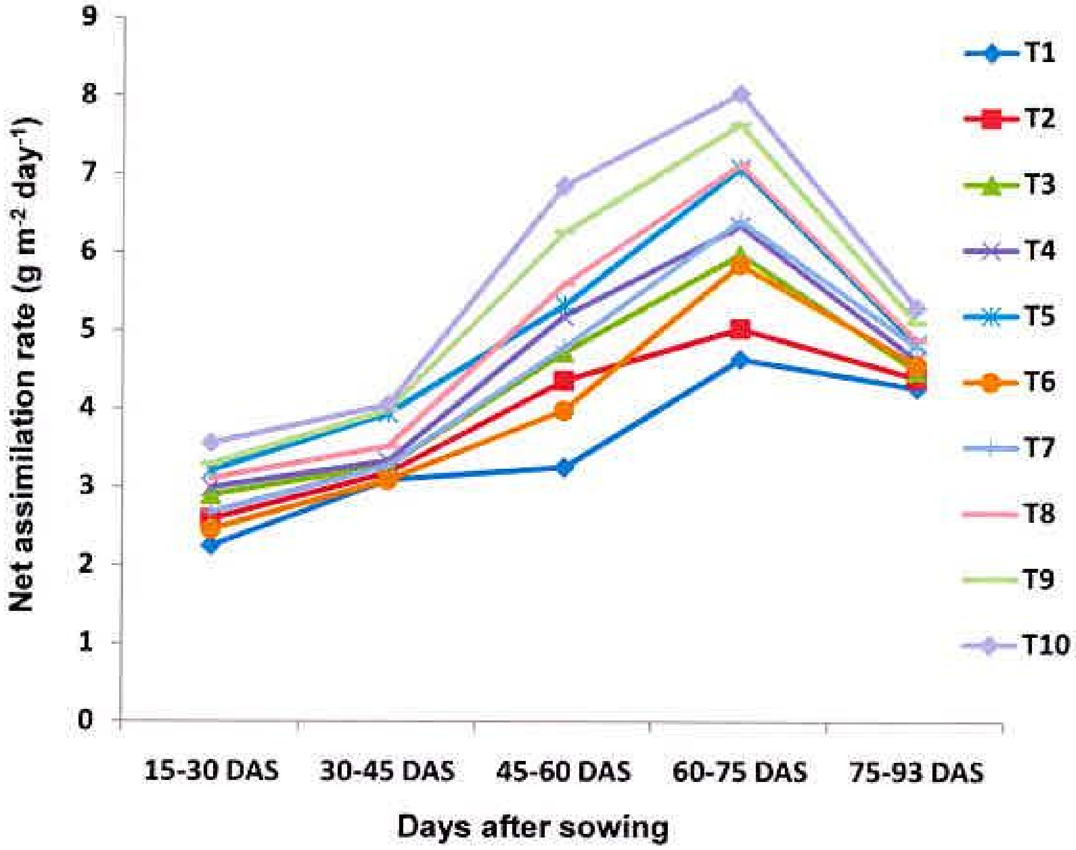


Figure 3. Effect of different management practices on net assimilation rate plant^{-1} of sesame at different days (LSD $_{0.05}$ = 0.3494, 0.1376, 0.3464, 0.2555 and 0.6407 at 15-30, 30-45, 45-60, 60-75 and 75-93 days after sowing, respectively)

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.2 Yield and yield contributing characters of Sesame

4.2.1 Capsule branch^{-1}

Capsule branch^{-1} is an important parameter for yield of sesame. The result showed that the capsule branch^{-1} was also significantly affected among different treatments (Appendix VIII & Table 7). The highest capsule branch^{-1} (10.88) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). The next highest capsules branch^{-1} was found from treatment T_6 (Line sowing without post sowing care) was 10.38 might be statistically similar to T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS), treatment T_7 (Line sowing + 1 HW at 20 DAS) and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS). The lowest (9.28) capsules branch^{-1} was found in treatment T_3 (Broadcast sowing + recommended fertilizer). Capsule branch^{-1} was increased by 17.24% in treatment T_{10} over control (T_1).

4.2.2 Capsules plant^{-1}

Capsules plant^{-1} was significantly affected among the treatments (Appendix VIII & Table 7). The highest (58.45) number of capsule plant^{-1} was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) appeared as second influent treatment for greater capsules plant^{-1} (54.78). The lowest number of capsule plant^{-1} (40.45) was found in treatment T_1 (Broadcast sowing without post sowing care). Capsule plant^{-1} was increased by 44.50% in treatment T_{10} over control (T_1). Line sown crop fertilized with optimum rate and given weeding 20 DAS and insect control was stimulated to produce maximum dry matter that supported for producing greater number of capsules plant^{-1} and similar results was suggested by Yadav (2004), Sharar *et al.* (2002) and Alom *et al.* (1999).

4.2.3 Length of capsule (cm)

Length of capsule is also an important parameter for yield as they support the maximum number of seeds in a capsule. Length of capsule was significantly affected among the treatments (Appendix VIII & Table 7). The highest length of capsule (2.95 cm) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing +

recommended fertilizer + 1 HW at 20 DAS) which was 2.91 cm. Treatment T_8 (Line sowing + recommended fertilizer) gave the next maximum value (2.86 cm). The lowest length of capsule (2.57 cm) was found in T_1 (Broadcast sowing without post sowing care). Length of capsule plant^{-1} was increased by 14.78% by T_{10} and 13.23% in treatment T_9 over control (T_1). This result was an agreement of Moula *et al.* (2000).

4.2.4 Seeds capsule^{-1}

Seeds capsule^{-1} is important for higher yield of oil percentage for sesame. Seeds capsule^{-1} was significantly affected among the (Appendix VIII & Table 7). The highest seeds capsule^{-1} 69.17) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). The next value 67.25 was recorded from treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS). The lowest (59.19) seeds capsule^{-1} was found in treatment T_1 (Broadcast sowing without post sowing care). Seed capsule^{-1} was increased by 16.86% in treatment T_{10} and 13.62% in treatment T_9 over control (T_1). The findings of Sharar *et al.* (2002) was confirmed by this present result.

4.2.5 1000-seed weight (g)

Thousand seed weight is an important parameter for yield of sesame. 1000 seed weight was significantly affected among the treatments (Appendix VIII & Table 7). The highest 1000-seed weight (3.72 g) was recorded in treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_7 (Line sowing + 1 HW at 20 DAS) and treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) were similar in producing equal size and shape of seeds (1000-seed weight, 3.41 g and 3.35 g) were appeared as second important treatment. The lowest 1000-seed weight (3.07 g) was found in treatment T_8 (Line sowing + recommended fertilizer) and treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS). 1000-seed weight was increased by 21.17% in treatment T_5, 11.07% in treatment T_7 and 4.36% in treatment T_{10} over control (T_{10}). 1000-seed weight was greatly influenced by fertilizer and weed free condition and similar results was observed by Malik *et al.* (2003), Sharar *et al.* (2002) and Alom *et al.* (1999).

Table 7: Effect of different management practices on yield contributing characters of sesame

Treatments	Capsules $branch^{-1}$ (no.)	Capsules $plant^{-1}$ (no.)	Length of capsule (cm)	Seeds $capsule^{-1}$ (no.)	1000 seed weight (g)
T_1	9.85	40.45	2.57	59.19	3.21
T_2	9.77	42.60	2.57	60.47	3.20
T_3	9.28	43.92	2.66	62.74	3.14
T_4	9.97	47.47	2.62	63.28	3.12
T_5	9.83	49.85	2.73	64.35	3.72
T_6	10.38	43.88	2.76	65.43	3.15
T_7	10.32	48.13	2.81	65.82	3.41
T_8	10.15	47.50	2.86	65.61	3.07
T_9	10.35	54.78	2.91	67.25	3.07
T_{10}	10.88	58.45	2.95	69.17	3.35
$LSD_{0.05}$	0.38	0.35	0.04	0.52	0.18
CV %	2.63	1.60	0.82	0.56	4.00

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.2.6 Seed yield (t ha^{-1})

Seed yield was significantly varied among the treatments (Appendix VIII & Fig. 4). The highest seed yield (1.33 t ha^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) produce next highest yield 1.22 t ha^{-1} and treatment T_8 (Line sowing + recommended fertilizer) was 0.98 t ha^{-1}. The lowest seed yield (0.45 t ha^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care). Seed yield was increased by 195% by T_{10}, 171.11% in treatment T_9 and 117.78% in treatment T_8 over control (T_1). The maximum seed yield was attributed due to greater capsule $plant^{-1}$ with longer size having many seeds in each capsule. Broadcast and line sowing method without post sowing care produced the lowest seed yield. The results may appear due to competition between weed and crop plants for moisture and nutrient resulting significant reduction in crop growth and yield components. Line sowing with fertilizer application, hand weeding at 20 DAS and insect control produces highest seed yield and this findings was also reported by Moula *et al.* (2000), Alom *et al.* (1999), Caliskan *et al.* (2004), Kathiresan (2002), Ahmed *et al.* (2002), Deasarkar *et al.* (2001), Prasad and Kendra (2001), Narkhede *et al.* (1999), Ravinder *etal.* (1996), Dutta *et al.* (1996) and Tiwari *et al.* (1994).

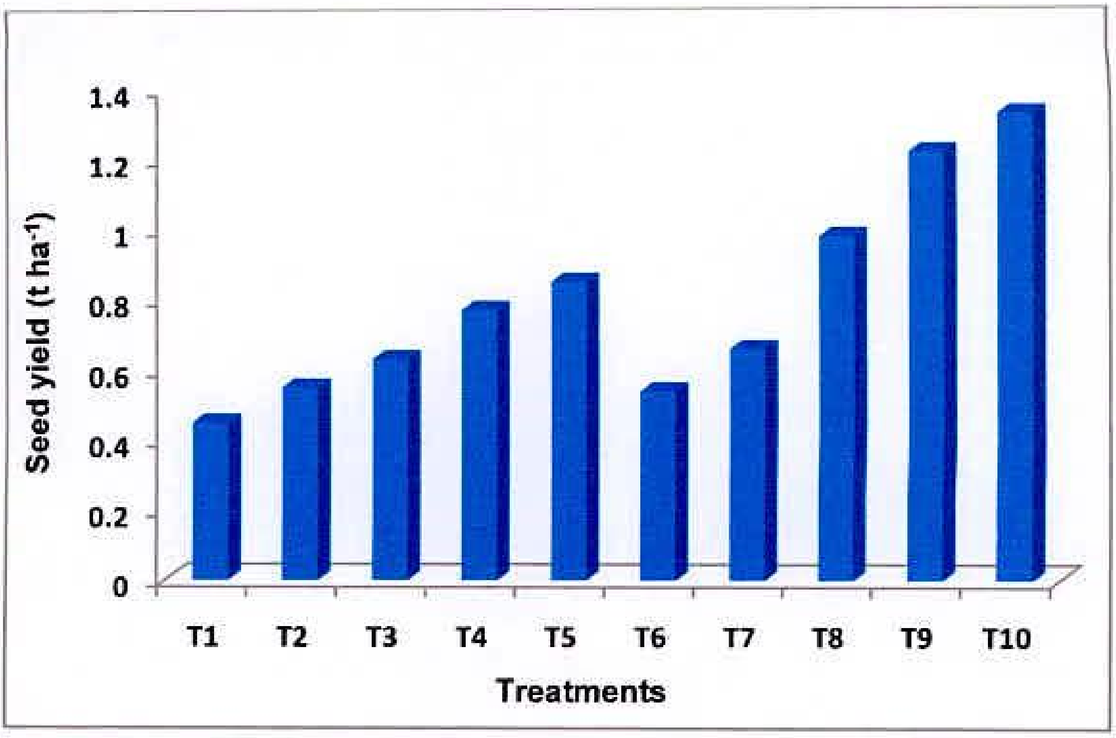


Figure 4. Effect of different management practices on seed yield of sesame ($LSD_{0.05}$ = 0.079)

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.2.7 Stover Yield (t ha^{-1})

Stover yield was significantly measured among the treatments (Appendix VIII & Fig. 5). The highest stover yield (2.74 t ha^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + one given hand weeding 20-25 DAS) was 2.58 t ha^{-1}. The lowest stover yield (1.83 t ha^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care). Stover yield was increased by 49.73% in treatment T_{10} and 41.53% in treatment T_9 over control (T_1). Stover yield was highest in weeding once than unweeding and 120 kg N ha^{-1} increased the stover yield and this result also was an agreement with Sukadia *et al.* (2004) and Ahmed *et al.* (2001).

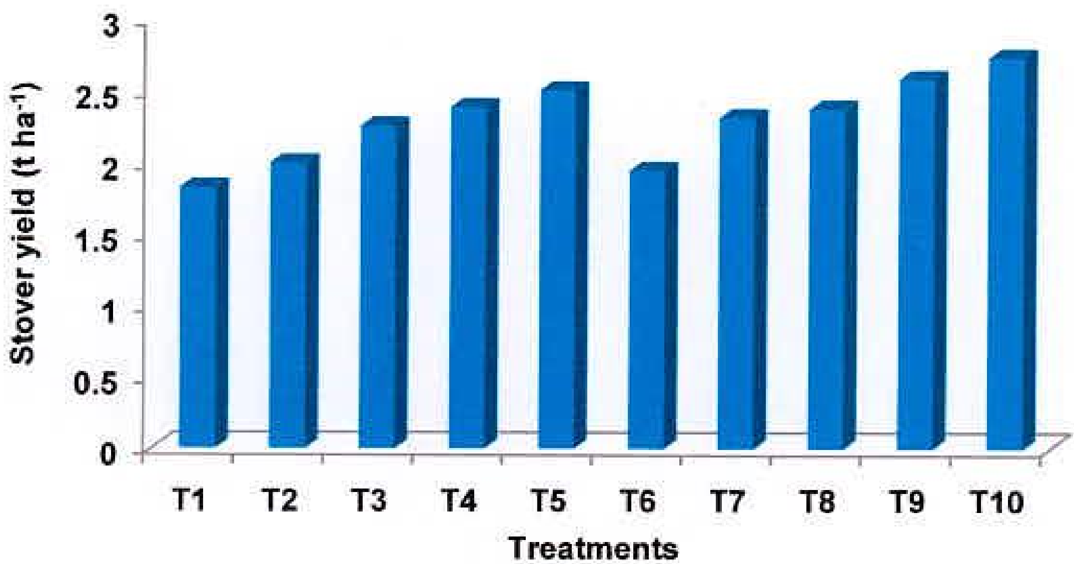


Figure 5. Effect of different management practices on stover yield of sesame ($LSD_{0.05}$ = 0.210)

T_1= Broadcast sowing without post sowing care (control)
T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS
T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})
T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS
T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS
T_6= Line sowing without post sowing care
T_7= Line sowing + 1 HW at 20 DAS
T_8= Line sowing + recommended fertilizer
T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS
T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.2.8 Biological Yield (t ha^{-1})

Biological yield was significantly affected among the treatments (Appendix VIII & Fig. 6). The highest biological yield (4.07 t ha^{-1}) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) gave the next value as 3.69 t ha^{-1}. The lowest biological yield (2.29 t ha^{-1}) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to treatment T_6 (Line sowing without post sowing care). Biological yield was increased by 77.73% in treatment T_{10}, 61.14% in treatment T_9 over control (T_1).

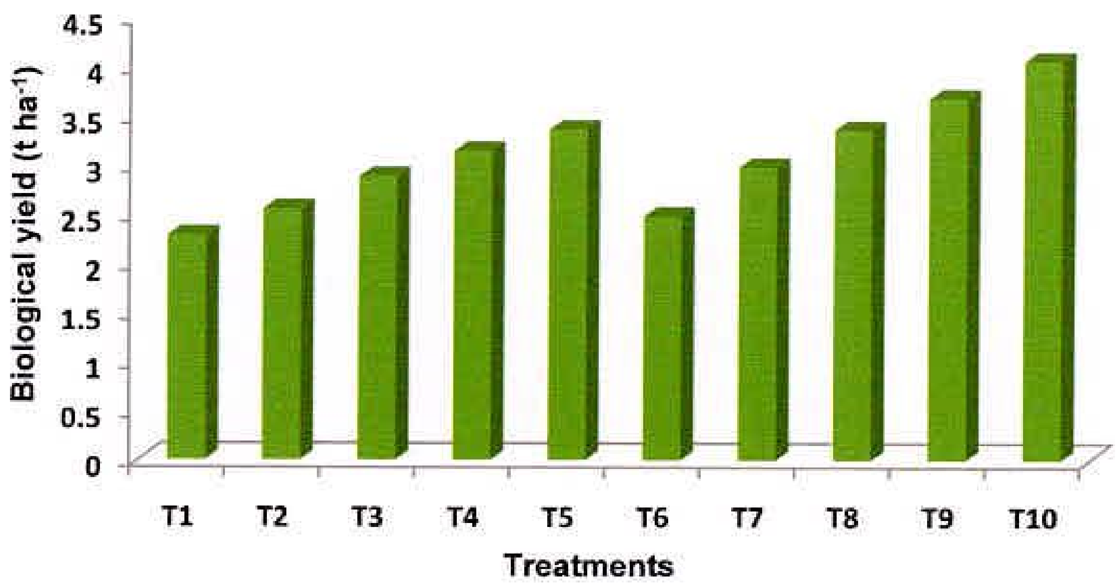


Figure 6. Effect of different management practices on biological yield of sesame ($LSD_{0.05}$ = 0.233)

T_1= Broadcast sowing without post sowing care (control)
T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS
T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})
T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS
T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS
T_6= Line sowing without post sowing care
T_7= Line sowing + 1 HW at 20 DAS
T_8= Line sowing + recommended fertilizer
T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS
T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.2.9 Harvest Index (%)

Harvest index was significantly affected among the treatments (Appendix VIII & Fig. 7). The highest harvest (32.62 %) was recorded in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) followed by treatment T_9 (Line sowing + recommended fertilizer + 1 HW at 20 DAS) was 32.01 % and treatment T_8 (Line sowing + recommended fertilizer) was 29.23 %. Treatment T_{10} was statistically similar to treatment T_9. The lowest harvest index (19.75 %) was found in treatment T_1 (Broadcast sowing without post sowing care) which was statistically similar to T_2 (Broadcast sowing + one hand weeding at 20 DAS) and treatment T_6 (Line sowing without post sowing care). Harvest index was increased by 65.16% by treatment T_{10}, 62.08% in treatment T_9 and 48% in treatment T_8 over control (T_1). Harvest index was higher with increasing of nitrogen and phosphorus fertilizer and this findings also supported by Om *et al.* (2001) and Ashfaq (2001).

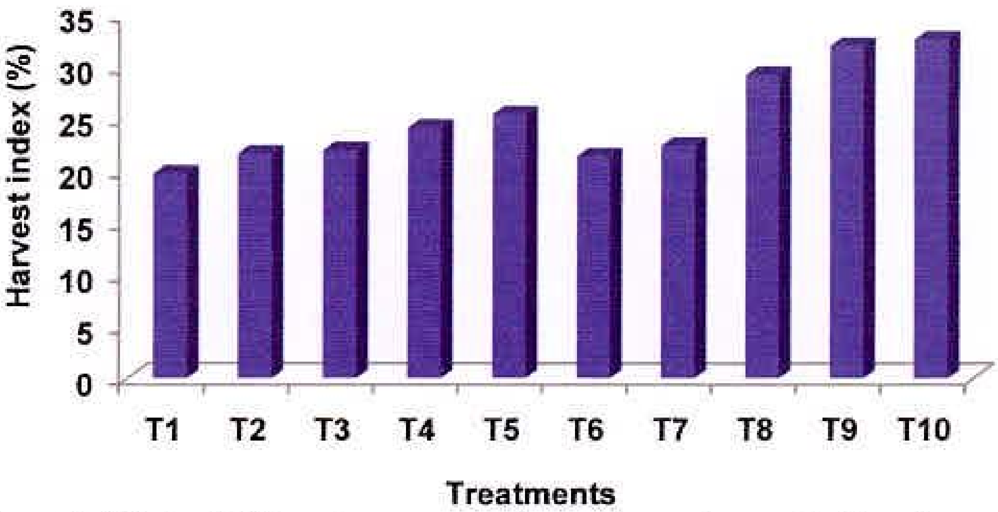


Figure 7. Effect of different management practices on harvest index of sesame ($LSD_{0.05}$ = 2.112)

T_1= Broadcast sowing without post sowing care (control)
T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS
T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})
T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS
T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS
T_6= Line sowing without post sowing care
T_7= Line sowing + 1 HW at 20 DAS
T_8= Line sowing + recommended fertilizer
T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS
T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.3 Weeds Data

4.3.1 Weeds m^{-2}

Weed is one of the major constrains to crop production. They compete with plant for nutrient, light, space and others. So, crops to be kept weed free up to their critical growth period from weed competition point of view. The different weeds found in the experimental plots are given in the Appendix X Weeds m^{-2} was significantly affected among different treatments (Appendix IX & Fig. 8). At 20 DAS the highest weeds m^{-2} (30.50) was recorded in treatment T_3 (Broadcast sowing + recommended fertilizer). The plots treated with treatment T_8 (Line sowing + recommended fertilizer), T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) and treatment T_5 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) produced next highest weeds m^{-2} which were (27.50, 25.50 and 25.75, respectively) was statistically similar. The lowest weeds m^{-2}(15.50) was found in T_6 (Line sowing without post sowing care). Weeds m^{-2} was increased by 96.77% by T_3 and 77.42% in T_8 over treatment T_{10}.

At harvest the highest weeds m^{-2} (125.3) was recorded in treatment T_3 (Broadcast sowing + recommended fertilizer). The next highest weeds m^{-2} measured from treatment T_8 (Line sowing + recommended fertilizer) was 110.8. The lowest weed m^{-2} (93.75) was found in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS). Weeds m^{-2} was increased by 33.65% by treatment T_3 and 18.19% in treatment T_8 over weed free plots (T_{10}).

Treatment T_3 showed maximum weed population over treatment T_1 as the weeds were nourished with the supplied nutrients those were not given in treatment T_1 and the same observation was applied for treatment T_6 and treatment T_{10}. Weed control treatments at 20 DAS significantly reduced the weed density and enhanced the yield of sesame. So, 20 DAS is appeared to be most critical period for crop-weed competition in sesame. Similar findings were suggested by Krishnaprabu and Kalyanasundaram (2007) and Hossain *et al*. (1993) and Alom *et al*. (1999).

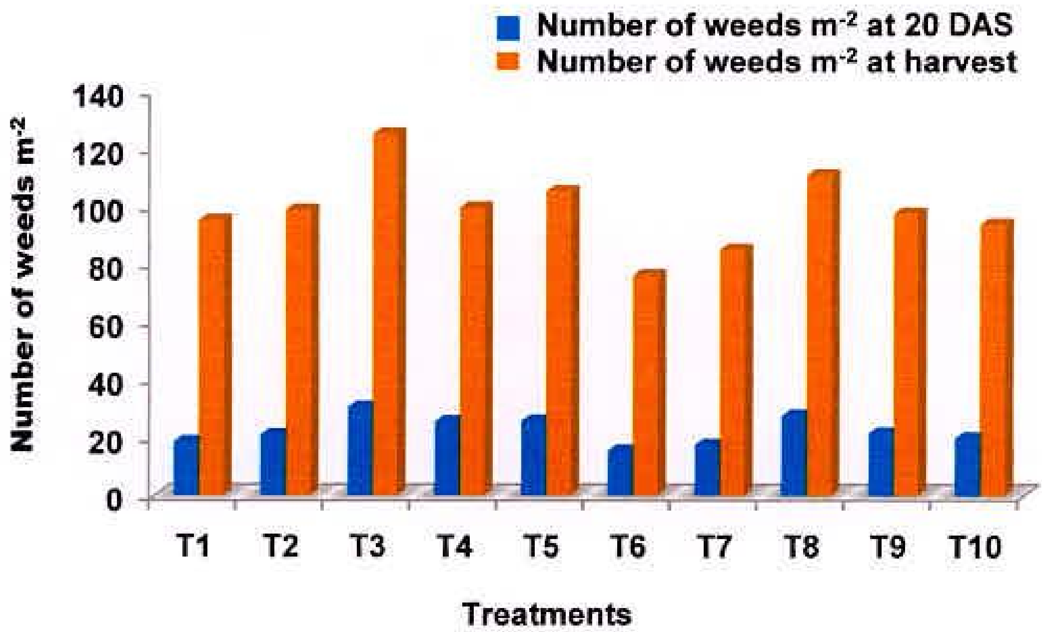


Figure 8. Effect of different management practices on number of weeds m^{-2} at 20 DAS and at harvest (LSD$_{0.05}$ = 2.314 and 3.495 at 20 DAS and harvest, respectively)

T_1= Broadcast sowing without post sowing care (control)

T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS

T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})

T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS

T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

T_6= Line sowing without post sowing care

T_7= Line sowing + 1 HW at 20 DAS

T_8= Line sowing + recommended fertilizer

T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS

T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

4.3.2 Weed dry matter m^{-2} (g)

Weed dry matter is an important parameter for investigating the crop nutrient loss by weed. Weed dry matter m^{-2} was significantly affected among different treatments (Appendix IX & Fig. 9). At 20 DAS the highest weed dry matter m^{-2} (6.74 g) was recorded in treatment T_3 (Broadcast sowing + recommended fertilizer). Treatment T_8 (Line sowing + recommended fertilizer) and treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) showed statistically similar weed dry matter m^{-2} which were 5.38 g and 4.89 g as the second highest value. The lowest weed dry matter m^{-2} (2.16 g) was found in treatment T_6 (Line sowing without post sowing care) at 20 DAS which was statistically similar to T_7 (Line sowing + 1 HW at 20 DAS). Weed dry matter m^{-2} (g) was increased by 212.03% in treatment T_3 and 149.07% in treatment T_8 over weed free plots (T_{10}).

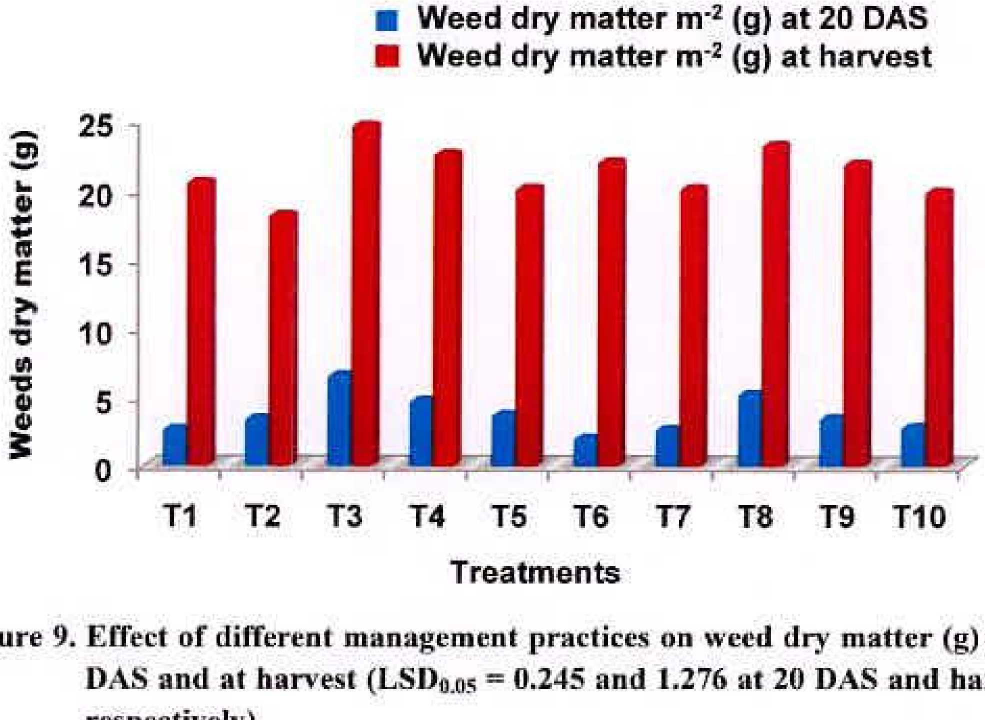


Figure 9. Effect of different management practices on weed dry matter (g) at 20 DAS and at harvest ($LSD_{0.05}$ = 0.245 and 1.276 at 20 DAS and harvest, respectively)

T_1= Broadcast sowing without post sowing care (control)
T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS
T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn ha^{-1})
T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS
T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS
T_6= Line sowing without post sowing care
T_7= Line sowing + 1 HW at 20 DAS
T_8= Line sowing + recommended fertilizer
T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS
T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS

At harvest the highest weed dry matter m^{-2} (24.83 g) was recorded in treatment T_3 (Broadcast sowing + recommended fertilizer). Treatment T_4 (Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS) and treatment T_6 (Line sowing without management) gave the statistically similar weed dry matter m^{-2} were 22.76 g and 22.20 g which indicate the second highest value. The lowest weed dry matter m^{-2} (2.16 g) was found in treatment T_2 (Broadcast sowing + one hand weeding at 20 DAS). Weed dry matter m^{-2} was increased by 35.02% by treatment T_3 and 27.30% in treatment T_8 over weed free treatment (T_{10}). Higher dry matter of weeds from the plot where weeds were allowed to compete with the crop continuously was due to higher weed population per unit area and similar findings was suggested by Hossain *et al.* (1993).

Chapter 5

SUMMARY AND CONCLUSION

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka during the period from March to June, 2008 to study the response of sesame in various levels management practices. The experiment comprised of ten treatments viz, T_1= Broadcast sowing without post sowing care (control), T_2= Broadcast sowing + one hand weeding (1 HW) at 20 DAS, T_3= Broadcast sowing + recommended fertilizer (46-72-30-20-2-1 kg N, P_2O_5, K_2O, S, B and Zn), T_4= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS, T_5= Broadcast sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS, T_6= Line sowing without post sowing care, T_7= Line sowing + 1 HW at 20 DAS, T_8= Line sowing + recommended fertilizer, T_9= Line sowing + recommended fertilizer + 1 HW at 20 DAS , T_{10}= Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS.

The experiment was set up in Randomized Complete Block Design (RCBD) with 4 replications. The experimental plot was fertilized at the rate of 46 kg N, 72 kg P_2O_5, 30 kg K_2O, 20 kg S, 2 kg B and 1 kg Zn, respectively. Sesame seed (cv. BARI Til 3) were sown on 22 March 2008 and harvested on 25 June 2008. Data on different growth and yield parameters of sesame and weed population were recorded and statistically analyzed and the means were adjudged by LSD at 5% level of significance.

Results showed that the effect of different management practices were significant on various plant characters and weed population.

Plant heights of sesame were influenced significantly by the different management practices at all growth stages. Plant height was obtained from in T_{10} treatment (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and the lowest with control.

Leaves plant^{-1}, leaf area index (LAI), primary branches plant^{-1}, secondary branches plant^{-1}, above ground dry weight plant^{-1} crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR) of sesame was also influenced significantly by the different management practices at all dates of observations. Highest leaves plant^{-1}, leaf area index (LAI), primary branches plant^{-1}, secondary branches plant^{-1}, above ground dry matter plant^{-1}, crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR) of sesame were observed in treatment T_{10} (Line sowing + recommended fertilizer + 1 HW at 20 DAS + insect control at 45 DAS) and the lowest from control (T_1).

Yield and yield contributing characters of sesame were also responded significantly to different management practices. The highest capsules branch^{-1} (10.88), capsules plant^{-1} (58.45), length of capsule (2.95 cm), seeds capsule^{-1} (69.17), seed yield (1.33 t ha^{-1}), stover yield (2.74 t ha^{-1}), biological yield (4.07) and harvest index (32.62) were observed in treatment T_{10} and lowest with control. But in respect of 1000 seed weight, it was not significantly influenced in treatment $T_{10.}$ Highest 1000 seed weight was found in treatment T_5.

Line sown sesame crop had maximum growth and yield performance with a package of optimum nutrients, weed control at 20 DAS and insect control at 45 DAS.

This result could be further verified doing the same research in different agro-ecological zone that represents the area for sesame cultivation.

CHAPTER 5
SUMMARY AND CONCLUSION

REFERENCES

Abdel, R.K.A., Allam, A.Y., Galal, A.H. and Bakry, B.A. (2003). Response of sesame to sowing dates, nitrogen fertilization and plant populations in sandy soil. *Assiut J. Agric. Sci.* **34**(3): 1-13.

Ahmed, A. Hussain, A., Akhtar, M. Ehsanullah and Musaddique, M. (2002). Yield and quality of two sesame varieties as affected by different row spacing. Pakistan *J. Agril. Sci.* **38** (1-2): 9-13.

Ahmed, A. Hussain, A., Akhtar, M. Ehsanullah and Musaddique, M. (2001). Yield and quality of two sesame varieties as affected by different rates of nitrogen and phosphorus. Pakistan *J. Agril. Sci.* **38** (1-2): 4-7.

Ahuja, D.B., Kalyan, R.K. and Srivastava, N. (2005). Evaluation of integrated pest management modules in sesame (*Sesamum indicum* L.). *Indian J. Ento*. **67**(3): 231-233.

Ali. A., Tanveer, A., Nadeem, M.A. and Bajwa, A.L. (2005). Effect of sowing dates and row spacings on growth and yield of sesame. *J. Agric. Res. Lahore.* **43**(1): 19-26.

Allam, A.Y. (2002). Effect of gypsum, nitrogen fertilization and hill spacing on seed and oil yields of sesame cultivated on sandy soils. *Assiut J. Agril. Sci.* **33**(1): 1-16.

Alom M.S., Biswas, M., Hossain, M.A. and Salahuddin, A.B.M. (1999). Response of sesame to varying levels of management practices. *Bangladesh J. Agril. Res.* **24**(2): 335-341.

Ashfaq, A. Abid, H., Mahaboob, A. and Mahammad, M. (2001). Yield and quality of two sesame varieties as affected by different rates of nitrogen and phosphorus. *Pakistan J. Agril. Sci.* **38**(12): 4-7.

Ashok, K., Prasad, T.N. and Prasdad, U.K. (1996). Effect of irrigation and nitrogen on growth, yield, oil content, nitrogen uptake and water use of summer sesame (*Sesamum indicum* L.). *Indian J. Agron.* **41**(1): 111-115.

BARI (Bangladesh Agricultural Research Institute). (1998). Til Fasalar Chas. Oil Res. Centre, Agril Res. Inst., Joydebpur, Gazipur. (In Bangla).

BARI (Bangladesh Agricultural Research Institute). (2001). Til Fasalar Chas. Oil Res. Centre, Agril Res. Inst., Joydebpur, Gazipur. (In Bangla).

BBS (Bangladesh Bureau of Statistics). (2008). Statistical Yearbook of Bangladesh Bur. Stat., Div., Mini. Plan. Govt. People's Repub. Bangladesh. pp. 264

Bennett, M., Estrange, D. and Routley, G. (1998). Sesame research report 1996-97 wet season Katherine. Technical Bulletin Northern Territory, Department of Primary Industry and Fisheries. (274): 46

Bhan, S. (1979). Get Better Returns from sesame. *Indian Farming* (May). pp. 9-11.

BINA (Bangladesh Institute of Nuclear agriculture). (2004). Unnato Krishi Projukti Parichiti. Bangladesh Inst. Nucl. Agric., Mymensingh (In Bangla) pp.31-36.

Biswas, G.C. (2006). Incidence and management of hairy caterpillar (*Spilarctia obliqua* Walker) on sesame. *J. Agric.* **4**(1/2): 95-100.

Brown, R.H. (1984). **In**: Growth of the green plant. Physiological basis of crop growth and development. Teasar, M.B. (Ed.). Madison, Wiscosin, pp. 153-173.

Caliskan, S., Arslan, M., Arioglu, H. and Isler, N. (2004). Effect of planting method and plant population on growth and yield of sesame (*Sesamum indicum* L.) in a Mediterranean type of environment. *Asian J. Plant Sci.* **3**(5): 610-613

Chaplot, P.C., Jain, G.L. and Bansal, K.N. (1992). Effect of sulphur and phosphorus on sesame (*Sesamum indicum*) and its residual effect on wheat (Triticum aestivum). *Indian J. Agron.* **37**(2): 340.341.

Chakraborty, P.K., Maiti, S. and Chatterjee, B.N. (1984). Growth analysis and agronomic appraisal of sesamum. *Indian J. Agric. Sci.* **54**(4): 291-295.

Chandrakar, B.L., Sekhar, N., Tuteza, S.S. and Tripathi, R.S. (1994). Effect of irrigation and nitrogen on growth and yield of summer sesame (*Sesamum indicum*). *Indian J. Agron.* **39**(4): 701-702.

Chaplot, P. C. (1996). Effect of sulphur and phosphorus on the growth and yield attributes of sesame (*Sesamum indicum* L.). *Intl. J. Trop. Agric.* **14**(1/4): 255-258.

Chaplot, P. C., Jain, G. L. and Bansal, K. N. (1991). Effect of phosphorus and sulphur on the oil yield and uptake of B, P and S in sesame and residual effect on wheat. *Intl. J. Trop. Agric.* **9**(3): 190-193.

Chaplot, P.C. (1996). Effect of sulphur and phosphorus on the growth and yield attributes of sesame (*Sesamum indicum* L.) *Intl. J. Agric.* **14**(1-4): 255-258.

Dayanand; Meena, N.L. and Shivran, A.C. (2002). Influence of intercrops and sulphur as nutrient uptake and food quality of sesame. *Indian J. Agril Sci.* **72**(10): 594-596.

Dhindsa and Gupta, S.K., (1973). Variability in chemical composition of sesame (*Sesamum indicum* L.). *Haryana Agril. Univ. J. Res.* **3**(4): 197-201.

Dutta, D., Sounda, G., Panda, P.K. and Ghosh, P. (1996). Response of N and P on oil yield of sesame and economics of fertilizer application. *Environ. and Ecol.* **14**(3): 777-778.

El-Serogy, S. T. (1998). Effect of thinning time, nitrogen application and sowing dates on sesame yield under middle Egypt conditions. *Egyptian J. Agric. Res.* **76**(2): 639-649.

Ganamurthy, P., Xavler, H. and Balasubramaniyan, P. (1992). Spacing and nitrogen requirement of sesame (*Sesamum indicum*). *Indian J. Agron.* **37**(4): 858-859.

Ghosh, P.K., Hati, K.M., Mandal, K,G., Misra, A.K., Chaudhary, R.S. and Bandyopadhyay, K.K. (2000). Sulphur nutrition in oilseeds and oilseed-based cropping systems. Indian Institute of Soil Science, Madhya Pradesh, India. *Fertilizer News*. **45**(8): 27 – 40.

Gnanavel, I. and Anbhazhagan, R. (2006). Integrated weed management in sesame (Sesamum indicum L.). Karnal, India: Agricultural Research Communication Centre.

Hegde, D.M. (2003). Response of sesame to sulphur and boron fertilization. Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, *India. J. Ecobiol.* **18**(4): 391-394.

Hegde, D.M. and Babu, S.N.S. (2004). Balanced fertilisation for nutritional quality in oilseeds. Directorate of Oilseeds Res., Rajendranagar, India. *Fertiliser-News.* **49**(4): 57-62, 65-66, 93.

Hossain M.A., Ahmed, A., Torofder, G.S., Mondal, M.R.I., Alom, M.S. and Rahman, M.M. (1993). Effect of duration of weed competition and weed control on the yield of sesame. *Bangladesh J. Sci. Res.* **11**(2): 199-204.

Ishwar, S., Nagda, B.L. and Chaudhary, L.S. (1994). Response of sesame (*Sesamum indicum* L.) varieties to nitrogen and phosphorus. *Ann. Agri. Res.* **15**: 250–251.

Ishwar, S., Nagda. B.L. and Choudhury, L.S. (1994). Response of sesame (*Sesamum indicum*) varieties to nitrogen and phosphorus. *Ann. Agril. Res. Rajastan* Agril. Univ., India. **15**(2): 137-140.

Jadav, A.S., Chavan, G.V. and Chavan, D.A. (1992). Response of summer sesame (*Sesamum indicum*) to nitrogen and phosphorus. *Indian J. Agron.* **37**(3): 604-605.

Jain, G.L., Singh, S.M., Sahu, M.P. and Sharma, G.L. (1985). Sesame production in Rajastan. Oil seed production-constrains and opportunities. New Delhi. pp: 181-198.

Kalaiselvan, P., Subrahmaniyan, K. and Balasubramanian, T.N. (2002). Effect of split application of n and k on the growth, yield attributes and yield of sesame. *Sesame and safflower newsletter*. **17**: 62-65.

Kathiresan, G. (2002). Response of sesame (*Sesamum indicum*) genotypes to levels of nutrient and spacing under different seasons. *Indian J. Agron.* **47**(1): 145-147.

Kavimani, R., Vijayabaskaran, S. and Annadurai, K. (2000). Nutrient uptake by sesame (Sesamum indicum L.) and associated weeds under different methods of sowing and weed management. *Madras Agric. J.* **87**(10/12): 709-711

Krishnaprabu, S. and Kalyanasundaram, D. (2007). Influence of chemical and mechanical methods on weed control and productivity of sesame in rice fallow. Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalainagar (Tamil Nadu), India. *Plant Archives.* 7(2): 787-789.

Kumar, A. and Prasad, T.N. (1993). Response of summer sesame (*Sesamum indicum*) to irrigation and nitrogen in calcareous soil. *Indian J. Agron.* **28** (1): 145-147.

Kumar, A. and Thakur, K.S. (2005). Effect of sowing method and weed control practices on production potential of sesamum (*Sesamum indicum*)based intercropping system under rainfed condition. *Indian J. Weed Sci.* **37**(1/2): 133-134.

Langham, R. and Wiemers., T. (2006). Sesame Production Information. Sesame Production in Texas. htm. 1-17.

Lee, S.T., Lee, J.I., Kang, C.W. and Ryn, K.H. (1986). Effect of fertilizer levels on agronomic characteristics and yield in Mulched Sesame Cultivation. Research Reports, RDA, *Crops*: **27**:180-184.

Liu, P., Yang, Y. and Yang, Y. A. (2003). Effect of molybdenum and boron on quality of soyabean. *Sci. Agric. Sinica.* **36**(2): 184-189.

Malik, M.A., Arugh, O.H. and Ramzan, M. (1990). Effect of row spacings and fertility levels on quantity and quality of *Sesamum indicum* L. *J. Agri. Res.*, **30**: 213–8.

Malik, M.A., Saleem, M.F., Cheema, M.A. and Ahmed, S. (2003). Influence of different nitrogen level on productivity of sesame (*Sesamum indicum* L.) under varying planting patterns. *Int. J. Agric. and Biol.* **5**(4): 490-492.

Mankar, D.D., Satao, R.N., Solanke V.M. and Ingole, P.G. (1995). Effect of nitrogen and phosphorus on quality, uptake and yield of sesame. *PKV Res. J.* **19**: 69–70.

Meng, C. F., Zhu, B. L. and Wang, Z. L. (1999 a). Effect of application of sulphur on the yield of sesame and rape on a red sandy soil in western Zhejiang. *Acta Agriculture Zhejiangensis*. **11**(3):133-135.

Meng, C.F., Lu, X.H., Zhu, B.L., Xi, X.J., Li, C.Y. and Wang, Z.L. (1999 b). Effect of application of sulphur and the yields of sesame and rape on a red sandy soil in western Zhejiang. *Acta Agriculturae Zhejiangensis.* **11**(3): 133-135.

Miller, W.R., Donahue, L.R. (1997). Soils in Our Environment. Prentice-Hall of India Pvt. Ltd., New Delhi, India. 7^{th} edn. pp. 302-315.

Mitra, S. and Pal, A.K. (1999). Water use and productivity of summer sesame as influenced by irrigation and nitrogen. *J. Indian Soc. Soil Sci.* **47**(3): 400-404.

Mondal, D.K., Sounda, G., Panda, P.K., Ghosh, P., Maitra, S. and Roy, D.K. (1997). Effect of different irrigation levels and nitrogen doses on growth and yield of sesame (*Sesamum indicum* L.). *Indian Agriculturist.* **41**(1): 15-21.

Mondal, S.S., Mondal, T.K., Sarkar, S. and Pradhan, B.K. (1993). Integrated nutrient management with sulphur bearing fertilizer, F. Y. M. and crop residue on the yield attributes and yield of sesame. Department of Agronomy, BCVK, Mohanpur, India. *Indian Agriculturist.* **37**(3): 175-180.

Moula, M.G., Rahman, M.M., Hossain, M.A. and Begum, S. (2000). Yield maximization of sesame through management practices under AEZ-9. *Bangladesh J. Agril. Sci.* **27**(1): 1-4.

Mukherji, D.K. (1982). Pulses and Oilseeds in West Bengal. Directorate od Agriculture. Government of West Bengal, Calcutta. pp. 323.

Nageshwar, L., Sarwgi, S.K., Tripathi, R.S., Bhambri, M.C. and Lal, N. (1995). Effect of nitrogen, potassium and sulphur on seed yield, nutrient uptake, quality and economics of summer sesame (*Sesamum indicum*). *Indian J. Agron.* **40**(2): 333-335.

Narkhede, T.N., Wadile, S.C., Attarde, D.R. and Suryawanshi, R.T. (2001). Integrated nutrient management in rainfed sesame *(sesamum indicum* L.) in assured rainfall zone. *Sesame and safflower newsletter.* **16**: 57-59.

Narkhede, T.N., Wadile, S.C., Shinde, Y.M. and Attarde, D.R. (1999). Integrated weed management in sesame under rainfed conditions. *Sesame and safflower newsletter.* **14**: 50-54.

Narkhede,T. N., Wadile, S. C., Attarde, D. R. and Suryawanshi, R.T. (2000). Integrated weed management in sesame under rainfed condition. *Indian J. Agric. Res.* **34**(4): 247-250

Nieto, J. Brando, M.L. and Gongales, J.T. (1968). Critical period of crop growth cycle for competition from weeds PCNS. **14**: 159-166.

Om P., Singh, B. P, Singh and P. K. (2001 a). Effect of weed-control measures and nitrogen fertilization on yield and yield attributes of sesame (Sesamum indicum) under rainfed condition. *Indian J. Agric. Sci.* **71**(9): 610-612

Om, P., Singh, B.P., Singh, P.K. and Prakash, O. (2001 b). Effect of weed control measures and nitrogen fertilization on yield and yield attributes of sesame (*Sesamum indicum*) under rainfed condition. *Indian. J. Agric. Sci.* **71**(9): 610-612.

Om, P.K., Singh, R.S. and Shukla, P.C. (2001 c). Effect of nitrogen on yield components and yield of sesame. *Indian J. Agril. Sci.* **71**(9): 52-55.

Parihar, S.S., Pandey, D. and Shukla, R.K. 1999. Response of summer sesame (*Sesamum indicum* L.) to irrigation schedule and nitrogen level in clay loam soil. *Intl. J. Trop. Agric.* **17**(1-4): 189-193.

Patel, T.D., Patel, Z.J., Patel, H.C. and Patel, B.S. (1988). Investigation on the optimum spacing for different varieties of sesamum in summer season under South Guzrat conditions. *Guzrat Agric. Univ. Res. J.* **13**(2): 1-3. [Quoted from Field Crop Abst., 43 (5): 449. 1990]

Patra, A.K. (2001). Yield and quality of sesame (*Sesamum indicum*) as inflused by N and P during post rainy season. *Ann. Agril. Res.* **22**(2): 249-252.

Prasad, S. and Kendra, K.V. (2001). Response of sesame to improved management practices at farmer's fields. Sesame and safflower newsletter. **16**: 62-63.

Puste, A.M. and Maiti, A. (1990). Response of fertilizer on seed yield of sesame (*Sesamum indicum*). *Environ. and Ecol.* **8**(3): 349-351.

Radford, D.J. (1967). Growth analysis formulae: their use and abuse. *Crop Sci.* **7**: 171-175.

Radhamani, S., Balasubramanian, A. and Chinnusamy, C. (2001). Effect of sulphur application and foliar spray of nutrient and growth regulators on seed yield and oil content of sesame. *Madras Agric. J.* **88**(10/12): 732-733.

Raja, A.S. and Sreemannarayana, B. (1998). Sulphur in crop production in southern Telangana Zone of Andhra Pradesh. *Fert. News.* **43**(3): 47-56.

Ramirez, R. and Linares, J. C. (1995). Boron deficiency symptoms and dry matter production of sesame under greenhouse conditions. Communications in Soil Science and Plant Analysis, Venezuela. **26**(17/18): 3043-3049.

Rao, V.P., Raikhelkar, S.V. and Sondge, V.D. (1993). Seed yield, nutrient uptake and fertilizer use efficiencies in sesame (*Sesamum indicum* L.) as influenced by irrigation and fertilization. *Fert. News.* **38**(10): 23-25.

Ravender, S., Kannan, K., Kundu, D.K. (2006). Effect of irrigation regimes and nutrient management on yield and water use of summer sesame (Sesamum indicum L.) in coastal Orissa. *Indian J. Soil Conserv.* **34**(1): 77-79

Ravinder, N. Satyanarayana, V., Rao, V.P., Latchanna, A. and Varaprasad, P.V. (1996). Influence of irrigation and nitrogen fertilization on seed yield, nutrient uptake and fertilizer use efficiencies in summer sesame (*S. indicum* L.). *J. Oilseed Res.* **13**(22): 173-177.

Russell, D. F. (1986). MSTAT-C package programme. Crop and Soil Science Dept. Michigan State Univ. USA.

Sakal, R., Singh, R.B. and Singh, A.P. (1994). Effect of boron application on blackgram and chickpea production in calcarious soil. *Fert. News.* **37**(5): 31-32.

Samui, R.C., Sinharoy, A., Ahasan, A.K.M.M. and Roy, B. (1990). Dry matter production, nutrient content and uptake of sesame varieties at different levels and source of nitrogen application. *Environ. Ecol.* **8**(1A): 239-243.

Sarkar, R. K. and Banik, P. (2002). Effect of planting geometry, direction of planting and sulphur application on growth and productivity of sesame (*Sesamum indicum*). University College of Agriculture, West Bengal, India. *Indian J. Agric. Sci.* **72**(2): 70-73.

Satyanarayana, V., Ravinder, N., Rao, V.P. and Latchanna, A. (1996). Influence of irrigation and nitrogen fertilization on seed yield, nutrient uptake and fertilizer use efficiencies in summer sesame (*Sesamum indicum*). *Annual Agril. Res.* Dept. Agron. Agril. Univ. Rajendranagar, Hyderabad. **17**(3): 286-291.

Seo, G.S., Jo, J.S. and Chobi, C.Y. (1986). The effect of fertilization level on the growth and oil quality in sesame. *Korean J. Crop Sci.* **31**(1): 24-29.

Sharar, S.M, Singh, B. P. and Sumathi, V. (2002). Effect of different levels of nitrogen and phosphorus on yield and oil content of summer sesame (*Sesamum indicum*). *Indian J. Agron.* **22**(2): 365-369.

Sharma, H. R. and Gupta, A. K. (2003). Effect of sulphur on growth paramiters and yield of some selected crops. *Annal. Agril. Res.* **24**(1): 136-138.

Sharma, N.N. (1994). Response of sesame (*Sesamum indicum*) varieties to levels of nitrogen and spacing. *Annal. Agril. Res.* **15**(1): 107-109.

Shrivastava, G.K., Tripathi, R.S. (1992). Effect of irrigation, mulch, and nitrogen levels on growth and yield of summer sesame (*Sesamum indicum*). *Indian J. Agron.* **37**(3): 602-604.

Singaravel, R., Imayavaramban, V., Thanunathan, K. and Shanmughapriya, V. (2002). Effect of micronutrients on yield and nutrient uptake of sesame (*sesamum indicum* l.) in a vertisol soil. *Sesame and safflower newsletter.* **17**: 46-48.

Singh, V., Chauhan, Y. S. and Tripathi, N. K. (1997). Comparative efficacy of levels of nitrogen and sulphur in production and biochemical values of till (*Sesamum indicum*). *Res. and Dev. Report.* **4**(2): 213-217.

Sinha, R. B., Sakal, R. and Bhogal, N. S. (1991). Response of some field crops to boron application in calcarious soil. *J. Indian Soc. Soil Sci.* **39**: 117-122.

Sinharoy, A., Samui, R.C., Ahsan, A.K.M.M. and Roy, B. (1990). Effect of different sources and levels of nitrogen on yield and yield attributes of sesame cultivars. *Environment and Ecology* **8**: 211–5.

Subrahmaniyan, K., Arulmozhi, N. (1999). Response of summer sesame (*Sesamum indicum*) to plant population and nitrogen under irrigated condition. *Indian J. Agron.* **44**(2): 413-415.

Sukhadia, N. M., Ramani, B. B., Mathukia, R. K., Khanpara, V. D. (2004). Integrated weed management in kharif sesamum. *Indian J. Weed Sci.* **36**(3/4): 239-242.

Sumathi, V. and Jaganadham, A. 1999. Effect of nitrogen levels on the yield, dry matter abd nitrogen uptake by sesamum (*Sesamum indicum* L.) varieties. *J. Res. ANGRAU.* **27**(3): 63-66.

Thakur, D.S., Patel, S.R., Nageshwar, L. and Lal, M. (1998). Yield and quality of sesame (*Sesamum indicum* L.) as influenced by nitrogen and phosphorus in light textured inceptisols. *Indian J. Agron.* **43**(2): 325-328.

Thanki, J. D., Patel, A. M. and Patel, M. P. (2004). Effect of date of sowing, phosphorus and biofertilizer on growth, yield and quality of summer sesame (*Sesamum indicum* L.). *J. Oilseeds Res.* **21**(2): 301-302.

Tiwari, K. P., Namdeo, K. N., Girish, J. and Jha, G. (2000). Effect of nitrogen and sulphur on growth, yield and quality of sesame (*Sesamum indicum* L.) varieties. *Res. on Crops*. **1**(2): 163-167.

Tiwari, K.P. and Namdeo, K.N. (1997). Response of sesame (*Sesamum indicum*) to planting geometry and nitrogen. *Indian J. Agron.* **42**(2): 365-369.

Tiwari, K.P., Namdeo, K.N. and Patel, S.B. (1998). Dry matter production and nutrient uptake of sesame (*S. indicum*) genotypes as influenced by planting geometry and nitrogen level. *Crop Res.* **12**(3): 291-293.

Tiwari, K.P., Namdeo, K.N. and Tripathi A. (1994). Production potential of sesame cultivars under different fertility levels. *Crop Res. (Hisar)*. **7** (1): 34-38. [Field Crop Abst. 1994. 48 (2): 134].

Tomar, R.K.S., Pathak, K.N., Rai, H.S. and Sharma, P. (2002). Studies on the contribution of different production technologies to sesame (*sesamum indicum* L.) under front line demonstration. *Sesame and safflower newsletter.* **17**: 66-68.

Tomar, S.R.S. and Chaudhary H.B. (1987). Analysis of seed and seedling characters in short duration wheat genotypes. Seed research. **15** (2): 128-132.

Vaiyapuri, V., Amudha, A. and Ravichandran, M. (2003). Effect of S levels and organics on seed quality and nutrient uptake of sesame. *Res. on Crops*. **4**(3): 327-330.

Vajay, S., Chauhan, Y.S., Tripati, N.K. and Singh, V. (1987). Comparative efficacy of levels of nitrogen and sulphur in production and biochemical values of Til (*Sesamum indicum* L.) var. C6. Res. and Dev. Report. **4**(2): 213-217.

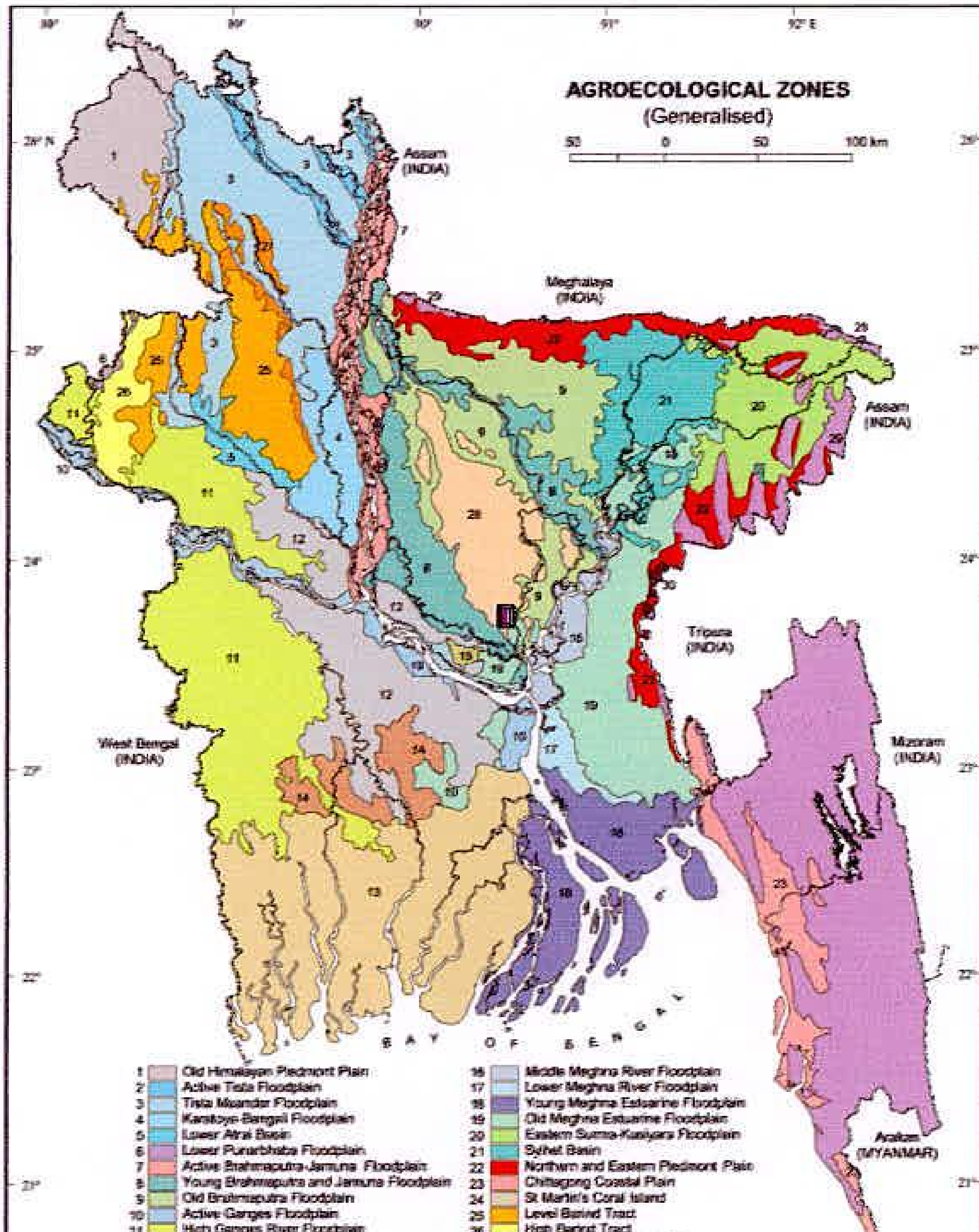
Wahab, M.A. (2002). Status of oil crop production in Bangladesh. Bangladesh Agril. Res. Inst. Joydebpur, Gazipuer. pp. 1.

Yadav, N.P.S., Vinay, S. and Mehta, V.S. (1996). Effect of different levels and sources of sulphur on yield, quality and uptake of sulphur by sesame. Department of Agricultural Chemistry and Soil Science, R.B.S. College, Agra, India. *J. Oilseeds Res*. **13**(1): 22-25.

Yadav, S.S. (2004). Integrated weed management in sesame (*Sesamum indicum* L.) under rainfed conditions of Rajasthan. *Haryana J. Agron*. **20**(1/2): 120-121.

APPENDICES

Appendix I. Map showing the experimental site under study



The experimental site under study

Appendix II. The Morphological characteristics, physical properties and chemical composition of soil of the experimental plot

A. Morphological Characteristics of the Soil

1.	Location	:	Agronomy Research field, SAU, Dhaka
2.	Soil tract	:	Madhupur Tract
3.	Land type	:	Medium high land
4.	General soil type	:	Red brown trace soils and acid basin clay
5.	Soil series	:	Nodda
6.	Agro-ecological zone	:	AEZ-28

B. Physical Properties of the initial Soil (0-15 cm depth)

	Constituent		Results
1.	Particle size analysis		
	i) Sand (2.00-0.02mm)	:	40%
	ii) Silt (0.02-0.002 mm)	:	40%
	iii) Clay (<0.002 mm)	:	20%
2.	Textural class	:	Sandy loam

C. Chemical Composition of the initial Soil (0-15 cm depth)

1.	pH	:	5.46 – 5.61
2.	Organic matter (%)	:	0.83
3.	Total N (ppm)	:	0.41
4.	Available P (ppm)	:	21
5.	Exchangeable K(me/100 g soil)	:	0.42
6.	Available S (ppm)	:	221
7.	Boron (ppm)	:	1.72
8.	Copper (µg/g soil)	:	3.56
9.	Iron (µg/g soil)	:	262.9
10.	Manganese (µg/g soil)	:	163.0
11.	Zinc (µg/g soil)	:	3.31

Source: Soil Resources Development Institute (SRDI), Dhaka-1207.

Appendix III. Monthly average air temperature, relative humidity, rainfall and sunshine hours during the experimental period (March, 2008 to July, 2008) at the experimental area

Month	Year	Monthly average air temperature (^0C)			Average relative humidity (%)	Total rainfall (mm)	Total sunshine (hours)
		Maximum	Minimum	Mean			
March	2008	34.6	16.5	26.6	67	45	67
April	2008	36.9	19.6	29.2	64	91	64
May	2008	36.7	20.3	29.3	70	205	70
June	2008	35.4	22.5	28.7	80	577	80

Source: Bangladesh Meteorological Department (Climate Division), Agargaon, Dhaka – 1212.

Appendix IV: Summary of analysis of variance (mean square) for plant height and leaves plant^{-1} of sesame

Source of variance	Degrees of freedom	Mean squares											
		Plant height (cm)						Leaves plant^{-1}					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
Treatment	9	0.86**	29.47**	64.91**	67.71**	126.10**	225.99**	1.20**	1.42**	46.87**	855.95**	756.58**	352.27**
Replication	3	0.05	0.42	0.66	7.43	5.52	2.67	0.03	0.04	0.03	36.82	5.51	1.72
Error	27	0.01	0.27	0.32	2.86	1.09	0.79	0.02	0.02	0.03	20.73	1.87	1.45

** Significant at 1% level of probability, * Significant at 5% level of probability

Appendix V: Summary of analysis of variance (mean square) for leaf area index (LAI) and primary branches palnt^{-1} of sesame

Source of variance	Degrees of freedom	Mean squares										
		Leaf Area Index (LAI)						Primary branches plant^{-1}				
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
Treatment	9	0.011**	0.021**	0.023**	0.018**	0.007**	0.007**	0.44**	1.09**	1.16**	1.13**	0.97**
Replication	3	0.001	0.002	0.003	0.007	0.005	0.001	0.04	0.01	0.04	0.02	0.97
Error	27	0.001	0.001	0.001	0.001	0.001	0.001	0.02	0.02	0.02	0.02	0.06

** Significant at 1% level of probability, * Significant at 5% level of probability

Appendix VI: Summary of analysis of variance (mean square) for secondary branches plant^{-1}, above ground plant dry weight (g) of sesame

Source of variance	Degrees of freedom	Mean squares									
		Secondary branches plant^{-1}				Above ground plant dry weight (g)					
		45 DAS	60 DAS	75 DAS	At harvest	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
Treatment	9	0.38**	0.49**	0.96**	0.77**	12.07**	33.74**	45.87**	29.21**	55.13**	69.71**
Replication	3	0.02	0.01	0.01	0.01	0.15	0.59	1.10	1.99	2.83	7.62
Error	27	0.59	0.02	0.02	0.04	0.11	0.28	0.51	0.47	1.52	3.23

** Significant at 1% level of probability, * Significant at 5% level of probability

Appendix VII: Summary of analysis of variance (mean square) for crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR) of sesame

Source of variance	Degrees of freedom	Mean squares														
		Crop Growth Rate (CGR)					Relative Growth Rate (RGR)					Net Assimilation Rate (NAR)				
		15-30 DAS	30-45 DAS	45-60 DAS	60-75 DAS	75-93 DAS	15-30 DAS	30-45 DAS	45-60 DAS	60-75 DAS	75-93 DAS	15-30 DAS	30-45 DAS	45-60 DAS	60-75 DAS	75-93 DAS
Treatment	9	122.75 **	78.56**	17.41**	51.48* *	48.33*	0.06**	0.011**	0.018*	0.016**	0.017**	0.57*	5.16**	4.08*	4.68**	7.50**
Replication	3	9.82	11.74	9.54	3.17	119.87	0.001	0.01	0.001	0.001	0.001	0.12	0.04	0.19	0.12	0.03
Error	27	7.68	12.02	26.02	1.952	12.34	0.001	0.001	0.001	0.001	0.001	0.01	0.25	0.06	0.03	0.20

Appendix VIII: Summary of analysis of variance (mean square) for plant characters of sesame

Source of variance	Degrees of freedom	Mean squares								
		Number of capsule branch^{-1}	Total number of capsule plant^{-1}	Length of capsule (cm)	Number of seed capsule^{-1}	1000 seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Treatment	9	0.75**	123.54**	0.07**	36.42**	0.16**	3.20*	0.34**	1.26**	85.93**
Replication	3	0.15	1.38	0.001	0.14	0.02	0.02	0.02	0.04	6.00
Error	27	0.07	0.58	0.001	0.13	0.02	0.01	0.02	0.03	2.12

** Significant at 1% level of probability, * Significant at 5% level of probability

Appendix IX: Summary of analysis of variance (mean square) for weeds m^{-2} and weed dry matter m^{-2} (g) of sesame

Source of variance	Degrees of freedom	Mean squares			
		Weeds m^{-2}		Weed dry matter m^{-2} (g)	
		20 DAS	At Harvest	20 DAS	At Harvest
Treatment	9	92.88**	726.43**	7.84**	14.09**
Replication	3	1.27	0.60	0.19	0.82
Error	27	2.54	5.50	0.25	0.77

** Significant at 1% level of probability, * Significant at 5% level of probability

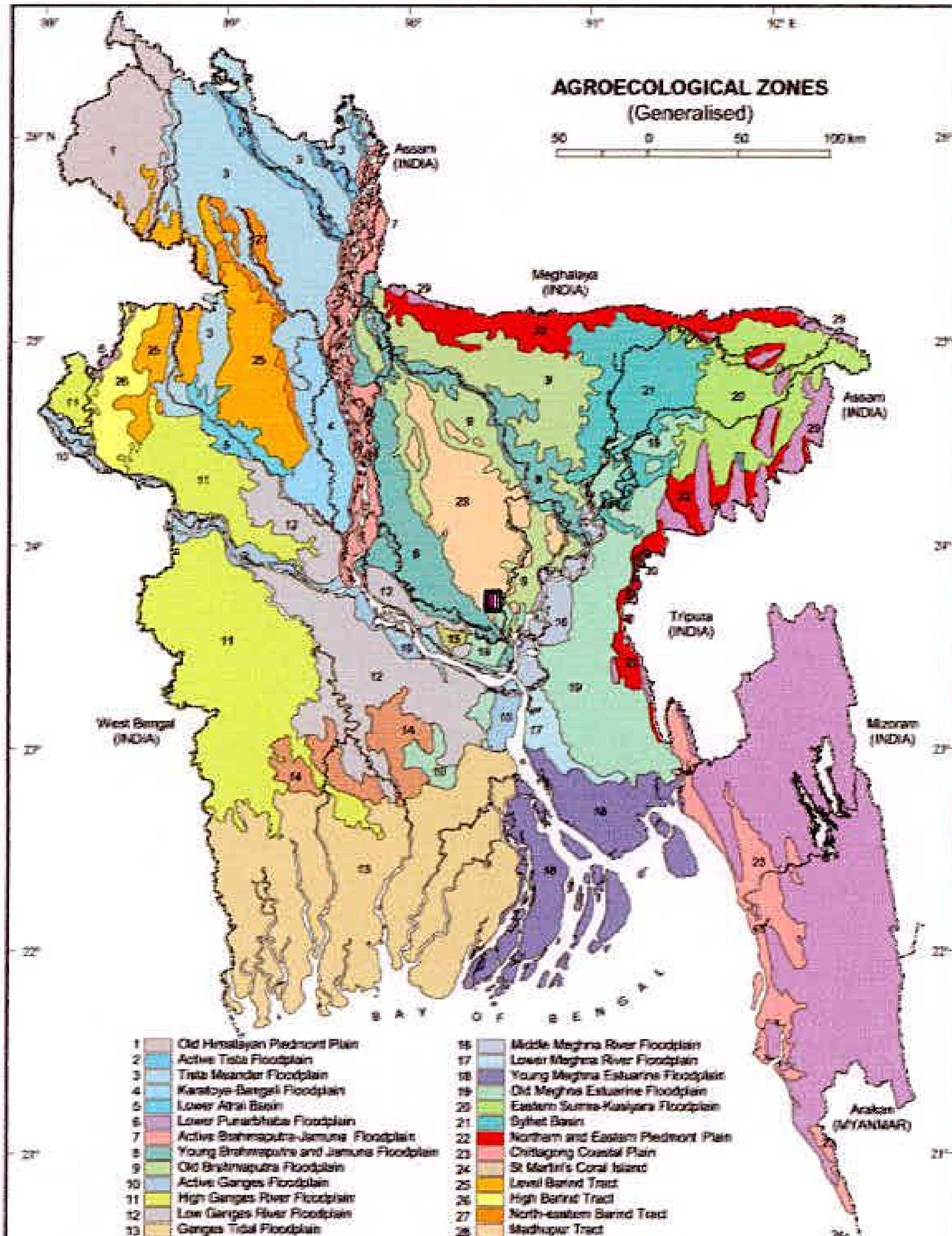
Appendix X: List of weed species found in the experimental plot

Bengali Name	Scientific Name	Family
Anguli ghas	*Digitaria sanguinalis*	Gramineae
Khudey shama	*Echinochloa colonum*	Gramineae
Durba	*Cynodon dactylon*	Gramineae
Shama	*Echinochloa crusgalli*	Gramineae
Chapra	*Elusine indica*	Gramineae
Ban sharisha	*Brassica kaber*	Crusiferae
Mutha	*Cyperus rotundus*	Cyperaceae
Nakphulee	*Cyperus michelianus*	Cyperaceae
Kata begoon	*Solanum carolinense*	Solanaceae
Ban masur	*Vicia sativa*	Leguminosae
Bathua	*Chenopoduin album*	Chenopodiaceae
Kanaibashi	*Commelina bengalensis*	Commeliaceae
Chanchi	*Alternanthera sessilis*	Amaranthaceae
Malancha	*Alternanthera pungens*	Amaranthaceae

APPENDICES

APPENDICES

Appendix I. Map showing the experimental site under study



■ **The experimental site under study**

Appendix II. The Morphological characteristics, physical properties and chemical composition of soil of the experimental plot

A. Morphological Characteristics of the Soil

1.	Location	:	Agronomy Research field, SAU, Dhaka
2.	Soil tract	:	Madhupur Tract
3.	Land type	:	Medium high land
4.	General soil type	:	Red brown trace soils and acid basin clay
5.	Soil series	:	Nodda
6.	Agro-ecological zone	:	AEZ-28

B. Physical Properties of the initial Soil (0-15 cm depth)

	Constituent		Results
1.	Particle size analysis		
	i) Sand (2.00-0.02mm)	:	40%
	ii) Silt (0.02-0.002 mm)	:	40%
	iii) Clay (<0.002 mm)	:	20%
2.	Textural class	:	Sandy loam

C. Chemical Composition of the initial Soil (0-15 cm depth)

1.	pH	:	5.46 – 5.61
2.	Organic matter (%)	:	0.83
3.	Total N (ppm)	:	0.41
4.	Available P (ppm)	:	21
5.	Exchangeable K(me/100 g soil)	:	0.42
6.	Available S (ppm)	:	221
7.	Boron (ppm)	:	1.72
8.	Copper (μg/g soil)	:	3.56
9.	Iron (μg/g soil)	:	262.9
10.	Manganese (μg/g soil)	:	163.0
11.	Zinc (μg/g soil)	:	3.31

Source: Soil Resources Development Institute (SRDI), Dhaka-1207.

Appendix III. Monthly average air temperature, relative humidity, rainfall and sunshine hours during the experimental period (March, 2008 to July, 2008) at the experimental area

Month	Year	Monthly average air temperature (^{0}C)			Average relative humidity (%)	Total rainfall (mm)	Total sunshine (hours)
		Maximum	Minimum	Mean			
March	2008	34.6	16.5	26.6	67	45	67
April	2008	36.9	19.6	29.2	64	91	64
May	2008	36.7	20.3	29.3	70	205	70
June	2008	35.4	22.5	28.7	80	577	80

Source: Bangladesh Meteorological Department (Climate Division), Agargaon, Dhaka – 1212.

Appendix IV: Summary of analysis of variance (mean square) for plant height and leaves plant^{-1} of sesame

Source of variance	Degrees of freedom	Mean squares											
		Plant height (cm)						Leaves plant^{-1}					
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
Treatment	9	0.86**	29.47**	64.91**	67.71**	126.10**	225.99**	1.20**	1.42**	46.87**	855.95**	756.58**	352.27**
Replication	3	0.05	0.42	0.66	7.43	5.52	2.67	0.03	0.04	0.03	36.82	5.51	1.72
Error	27	0.01	0.27	0.32	2.86	1.09	0.79	0.02	0.02	0.03	20.73	1.87	1.45

** Significant at 1% level of probability, * Significant at 5% level of probability

Appendix V: Summary of analysis of variance (mean square) for leaf area index (LAI) and primary branches palnt^{-1} of sesame

Source of variance	Degrees of freedom	Mean squares										
		Leaf Area Index (LAI)						Primary branches plant^{-1}				
		15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
Treatment	9	0.011**	0.021**	0.023**	0.018**	0.007**	0.007**	0.44**	1.09**	1.16**	1.13**	0.97**
Replication	3	0.001	0.002	0.003	0.007	0.005	0.001	0.04	0.01	0.04	0.02	0.97
Error	27	0.001	0.001	0.001	0.001	0.001	0.001	0.02	0.02	0.02	0.02	0.06

** Significant at 1% level of probability, * Significant at 5% level of probability

Appendix VI: Summary of analysis of variance (mean square) for secondary branches plant^{-1}, above ground plant dry weight (g) of sesame

Source of variance	Degrees of freedom	Mean squares									
		Secondary branches plant^{-1}				Above ground plant dry weight (g)					
		45 DAS	60 DAS	75 DAS	At harvest	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	At harvest
Treatment	9	0.38**	0.49**	0.96**	0.77**	12.07**	33.74**	45.87**	29.21**	55.13**	69.71**
Replication	3	0.02	0.01	0.01	0.01	0.15	0.59	1.10	1.99	2.83	7.62
Error	27	0.59	0.02	0.02	0.04	0.11	0.28	0.51	0.47	1.52	3.23

** Significant at 1% level of probability, * Significant at 5% level of probability

Appendix VII: Summary of analysis of variance (mean square) for crop growth rate (CGR), relative growth rate (RGR), net assimilation rate (NAR) of sesame

Source of variance	Degrees of freedom	Mean squares														
		Crop Growth Rate (CGR)					Relative Growth Rate (RGR)					Net Assimilation Rate (NAR)				
		15-30 DAS	30-45 DAS	45-60 DAS	60-75 DAS	75-93 DAS	15-30 DAS	30-45 DAS	45-60 DAS	60-75 DAS	75-93 DAS	15-30 DAS	30-45 DAS	45-60 DAS	60-75 DAS	75-93 DAS
Treatment	9	122.75 **	78.56**	17.41**	51.48* *	48.33*	0.06**	0.011**	0.018*	0.016**	0.017**	0.57*	5.16**	4.08*	4.68**	7.50**
Replication	3	9.82	11.74	9.54	3.17	119.87	0.001	0.01	0.001	0.001	0.001	0.12	0.04	0.19	0.12	0.03
Error	27	7.68	12.02	26.02	1.952	12.34	0.001	0.001	0.001	0.001	0.001	0.01	0.25	0.06	0.03	0.20

Appendix VIII: Summary of analysis of variance (mean square) for plant characters of sesame

Source of variance	Degrees of freedom	Mean squares								
		Number of capsule $branch^{-1}$	Total number of capsule $plant^{-1}$	Length of capsule (cm)	Number of seed $capsule^{-1}$	1000 seed weight (g)	Seed yield ($t\ ha^{-1}$)	Stover yield ($t\ ha^{-1}$)	Biological yield ($t\ ha^{-1}$)	Harvest index (%)
Treatment	9	0.75**	123.54**	0.07**	36.42**	0.16**	3.20*	0.34**	1.26**	85.93**
Replication	3	0.15	1.38	0.001	0.14	0.02	0.02	0.02	0.04	6.00
Error	27	0.07	0.58	0.001	0.13	0.02	0.01	0.02	0.03	2.12

** Significant at 1% level of probability, * Significant at 5% level of probability

Appendix IX: Summary of analysis of variance (mean square) for weeds m^{-2} and weed dry matter m^{-2} (g) of sesame

Source of variance	Degrees of freedom	Mean squares			
		Weeds m^{-2}		Weed dry matter m^{-2} (g)	
		20 DAS	At Harvest	20 DAS	At Harvest
Treatment	9	92.88**	726.43**	7.84**	14.09**
Replication	3	1.27	0.60	0.19	0.82
Error	27	2.54	5.50	0.25	0.77

** Significant at 1% level of probability, * Significant at 5% level of probability

Appendix X: List of weed species found in the experimental plot

Bengali Name	Scientific Name	Family
Anguli ghas	*Digitaria sanguinalis*	Gramineae
Khudey shama	*Echinochloa colonum*	Gramineae
Durba	*Cynodon dactylon*	Gramineae
Shama	*Echinochloa crusgalli*	Gramineae
Chapra	*Elusine indica*	Gramineae
Ban sharisha	*Brassica kaber*	Crusiferae
Mutha	*Cyperus rotundus*	Cyperaceae
Nakphulee	*Cyperus michelianus*	Cyperaceae
Kata begoon	*Solanum carolinense*	Solanaceae
Ban masur	*Vicia sativa*	Leguminosae
Bathua	*Chenopoduin album*	Chenopodiaceae
Kanaibashi	*Commelina bengalensis*	Commeliaceae
Chanchi	*Alternanthera sessilis*	Amaranthaceae
Malancha	*Alternanthera pungens*	Amaranthaceae