EFFECT OF WEEDING FREQUENCY AND POPULATION DENSITY ON THE GROWTH AND YIELD OF SESAME

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Dedicated to

my

Beloved Parents, elder Brothers and Sister

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ACRONYMS AND ABBREVIATIONS

%	Percentage
°C	Degree Centigrade
AEZ	Agro- Ecological Zone
ANOVA	Analysis of variance
BARI	Bangladesh Agricultural Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BINA	Bangladesh Institute of Nuclear Agriculture
BRRI	Bangladesh Rice Research Institute
Cm	Centimeter
CV %	Percent Coefficient of Variance
cv.	Cultivar (s)
DAT	Days After Transplanting
DMRT	Duncan's Multiple Range Test
e.g.	Example given
et al.	et alia (and others)
FAO	Food and Agriculture Organization
Fig.	Figure
G	Gram (s)
HI	Harvest Index
Hr	Hour(s)
i.e.	That is
IFDC	International Fertilizer Development Centre
IRRI	International Rice Research Institute
K_2O	Potassium Oxide
Kg	Kilogram (s)
Lb	Pound
LSD	Least Significant Difference
m^2	Square meter
DAS	Days After Sowing
Mm	Days After Emergence
MP	Muriate of Potash
N	Nitrogen
No.	Number
NS	Non Significant
P_2O_5	Phosphorus Penta Oxide
PU	Prilled Urea
S	Sulphur
SAU	Sher-e-Bangla Agricultural University
t ha^{-1}	Ton per hectare
var.	Variety
Viz.	Namely
wt.	Weight

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Abstract

The experiment was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University to evaluate the effect of four weeding frequencies(W_1=control, W_2=10, W_3=20 and W_4=30 days after emergence) and population densities (P_1=66666, P_2=33333, P_3=22222 and P_4=16666 plants/ha) on the growth and yield attributes of sesame. Weeding frequencies resulted in the increase on growth and yield attributes of sesame. The highest plant height (127.10 cm), number of branches/plant (6.33 cm) and dry weight/plant (23.63g) were obtained with 3 times weeding (10, 20 and 30 days after emergence respectively). Number of effective capsule/plant (109.60), 1000-seeds weight (3.19g), grain yield (0.98 t/ha) and harvest index (25.16%) were also found with same weeding treatment in this study. The highest plant height (136.90 cm) was recorded from the combined effect of 33333 plants/ha and three times weeding at 10, 20 and 30 days after emergence (DAE) and weeding at 10, 20 and 30 days after emergence (DAE). Weed infestation also affected the lowest plant height (109.50 cm) was found from 22222 plants/ha with no weeding. But the combined effect of 16666 plants/ha with three times weeding at 10, 20 and 30 days after emergence(DAE) revealed the highest number of leaves/plant (31.80), number of branches/plant (8.30) and dry weight/plant (26.93 g). On the other hand, the highest number of effective capsule/plant (146.8), number of seeds/capsule (79.20) and 1000-seed weight (3.86g) were found with the interaction effect of 16666 plants/ha with three times on growth, yield and yield contributing characters of the crop. The highest weed significantly biomass (152.1 g/6m^2) was observed from 16666 plants/ha with three times weeding at 10, 20 and 30 days after emergence(DAE) whereas the lowest figure was (27.55 g/6m^2) recorded from the plots treated with 666666 plants/ha with one weeding at 10 days after emergence(DAE). However, the results revealed that the plots, with highest plant population weeded once, caused lower weed densities. As such, the combined treatments of 66666 plants/ha with one weeding at 10 days after emergence showed the lowest infestation, as evaluated by the lowest weed dry weight (27.55 g/6m^2), in compare to that of the highest (65.17 g/6m^2) with 16666 plants/ha and three times weeding at 10, 20 and 30 days after emergence(DAE).

Chapter I

Introduction

Chapter 1
Introduction

Sesame (*Sesamum indicum* L.), a member of the family p*edaliaceae,* is known under different names in different countries viz: simsim, benniseed, til, gingelly and a jonjoli (Khidir, 1997). It is the most ancient oil seed crop known to use by men since 235 BC (Weiss 1987). The climatic and edaphic conditions of Bangladesh are quite suitable for cultivation of sesame. Traditionally the crop is cultivated either as a pure stand or as a mixed crop with aus rice, jute, groundnut, millets and sugarcane. Among various oil crops grown in Bangladesh, sesame ranks next to rapeseed and mustard in respect of both cultivated area and production (BBS, 2008). It is grown almost all regions in Bangladesh occupying 4.22% of the total cropped area and contributes about 11% of the total oil seed production (BARI, 1998).The crop is grown in both summer and winter seasons in Bangladesh. In summer, it covers about two thirds of the total oil cropped area of Bangladesh (Kaul and Das, 1986; BARI, 1994).

Sesame seed is a rich source of oil, protein, phosphorus and calcium (Rheenen, 1993). It is rich not only in oil (42-45%) but also in protein (20%) and carbohydrate (14-20%) (BARI, 1994). Sesame is also used for other purposes, such as, in manufacturing of margarine, paste (tahini), cake, and flour, soap, paint, perfumery products and of pharmaceutical as ingredients for drugs and as dispersing agent for different kinds of insecticide. Sesame seed contains antioxidants, which inhibit the development of rancidity in the oil (Hill, 1972). The sesame oilcake is used for cattle feed as well as manure since it contains protein of high biological value and appreciable quantities of P and K. It contains N, P_2O and K_2O and ranging from 6.2-6.2, 2.0-2.1, 1.1-1.3%, respectively (Chatterjee and Mondal, 1983). Yield and quality seeds of sesame are very low in Bangladesh. Sesame yield is very low due to poor management practices (Rahman *et al*., 1994). This might be attributed to several causes including low yielding varieties, biological constrains including diseases with severe weed infestation and heavy reliance on broadcasting method sowing resulting uneven stands in the field. Nantongo (2002) indicated that suboptimal population is a major constraint in sesame production and its yield also increased with increase in plant population. According to Ssekabembe *et al*., (2001) broadcasting the seed often results in undue crowding of plants in some places and low plant population in others. The variation in plant density results in variation in yield per hectare leading to reduced yield per unit area (Anyanga and Obong, 2001).

Plant density is one of the most important yield contributing characters which can be manipulated to maximize yield (Babu and Mitra, 1989). It also plays an important role in the dominance and suppression during the process of competition of two or more species having similar life forms (Hashem, 1991). Ahmed S. (1982) obtained greater yield of sesame at higher density grown. However, all crops have a stage during their life cycle when are particularly sensitive to weed competition. In general, it ranges up to first 25 to 50% of the life time of crops . So, the critical time of weed competition is the range within which a crop must be weeded to save the crop from damages of weeds (Islam *et al*., 1989). As such, the knowledge on critical period of weed competition and time of weed control for maximization of yield is also equally important in the case of sesame cultivation.

Meylemans and colleague (1994) reported that the most sensitive period for weed control was between 3 and 6 weeks after planting of black gram (*Vigna mungo*). Weeding before or after this period did not increase yields significantly. Un-weeded plots had a yield loss of up to 90% compared to weed-free fields. Competition by weeds influenced established plant density and number of pods per plant rather than 100-seed weight of the cop. Previous studies have shown that increase crop density reduce weed infestation in field and vegetable crops (Adigun *et al*., 1994). Therefore, in order to increase sesame yields, it is essential to improve the management practices and one way of it would be needed to verify the yield potential through optimum plant population density with removal of weed infestation from the field under cultivation of the crop.

Objectives of the research

- To determine the optimum frequency of weeding operation needed for sesame cultivation.
- To determine the optimum population density for high yield of sesame.
- To study the combined effect of weeding frequency and population density for better yield improvement of sesame in the farmers' field level.

Chapter II
Review of Literature

Chapter 2

Review of literature

An attempt has been made in this chapter to present a brief review of research in relation the Effect of Weeding Frequency and Plant Density on the Growth and Yield of Sesame *(Sesamum indicum* L.). Some of the pertinent findings of the research with Weeding Frequency and Plant Density on the Growth and Yield of Sesame *(Sesamum indicum* L.) are reviewed in this chapter.

Udom *et al.* (2009) Field experiments were conducted simultaneously at Guinea savannah ecological zone of Nigeria during the 2008 wet season to study the response of sesame to weeding frequency and plant-row spacings. The treatments were laid out in a randomized complete block design with three replications. The result showed that the number of capsules per plant, 100-seed weight, capsules and grain yield per hectare of sesame were significantly ($P<0.05$) increased by one weeding frequency only at location I. The parameters were not significantly affected by weeding frequency in location II. The capsules length, number of capsules per plant, capsules and grain yield were significantly ($P<0.05$) affected by plant-row spacings. The capsules and grain yield of sesame increased significantly ($P<0.05$) with decreasing plant-row spacing and conversely capsules length and number decreased with decreasing plant-row spacing. The number of pods significantly ($P<0.05$) increased by two weeding frequencies at location I and pod yield per hectare was also increased significantly by twice weeding at location II. All the other parameters such as pod lands, seeds per pod, 100-seed weight and grain yield per hectare were not significantly affected by the treatments. The interaction between the plant-row spacings and weeding frequency were significant in affecting number of seed per capsules and 1000-seed weight of sesame at location I, and number of pods and seed per pod at location II. Spacing of 30 cm and twice weeding produced the highest number of seed per capsules and

20 cm row spacing with twice weeding produced the highest 1000- seed weight. However, 30 cm row spacing with one weeding had highest number of pods/ plant and also 30 cm row spacing with twice weeding produced the highest seeds per pod.

Asghar *et al*. (2009) conducted a field studies in Faisalabad, Pakistan, to determine the effect of different sowing dates and row spacing on the growth and yield of sesame cv. 92006. Four sowing dates (8, 15, 22 and 29 July) and 3 row spacing (30, 45, 60 cm) were used. Effect of sowing dates was highly significant and maximum branches/plant and seed yield was produced when the crop was sown on 8 and 15 July due to higher number of capsules per plant and more seeds per capsule. Seed yield was increased with an increase in row spacing from 30 to 45 cm. However, further increase in spacing decreased the seed yield.

Avila and Graterol (2005) studied the effects of sowing date, row spacing and fertilizer rate on the growth and yield of sesame in Turen, Portuguesa State, Venezuela, during 1996-1997 and 1997-1998. A split-split-plot design with 4 replications was used. Four fertilizer treatments were allocated to the main plot (control, 250 kg diammonium phosphate ha-1, and cowpea incorporated as green cover crops). Sowing dates (20 December and 27 December 1996, and 3 January 1997) were evaluated as subplot treatments. Row spacing was evaluated in sub-subplots (0.60, 0.30 and 0.15 m between rows). Plant height, number of pods per plant, and grain yield were evaluated. The effects of fertilizer on growth and yield were not consistent during the 2 seasons. Row spacing had no consistent effect on plant height, but the number of pods per plant increased with the increase in row spacing. The grain yields tended to decrease as the planting date was delayed in both seasons. Greater grain yields were obtained under a row spacing of 0.15 m (higher by 3.8- and 1.8-fold than the yields obtained under 0.60 and 0.30 m row spacing, respectively). The results suggest the use of a spacing 0.15 m by farmers in sesame production areas in the zone.

Krishna *et al*. (2008) conducted a field trial during the summer at Tirupati, Andhra Pradesh, India, to assess the superiority of skip row planting of base crop of sesame over uniform row spacing at the same population level and to evaluate the feasibility of introducing green gram as intercrop under irrigated conditions. Data were recorded for plant height, leaf area index, capsules or pods per plant, test weight and seed yield per plant. Significantly higher sesame seed yield was recorded in sesame (30x6.6 cm) sole double row single skip treatment. Green gram yield was reduced when it was intercropped with sesame and 100% green gram population recorded higher yield than 50% green gram population. The highest net returns were obtained in sesame single row single skip + 100% green gram in skip row.

Gercek *et al.* (2007) carried out an experiment to determine the effect of irrigation method (sprinkle and drip) and row spacing (500-300, 700-300, 800-400 and 700-700 mm) on yield and several yield components of Local dark sesame in Sanliurfa (Turkey) in 2004 and 2005. The yield, plant height and number of capsules per plant were significantly affected by irrigation methods and row spacing. Means of sesame yields in two years were 1440 and 1732 kg ha-1 in sprinkle and drip irrigation, respectively. The highest yield was observed at 500-300 mm (1913 kg ha-1) treatment of plant density and the lowest yield was at 700 mm (1220 kg ha-1) row space.

Basavarajappa and Prabhakar (2006) conducted a field experiment during 2003/04 and 2004/05, in Dharwad, Karnataka, India, to evaluate performance of foxtail millet in different intercropping systems under shallow alfisols. Foxtail millet was planted in 30-cm rows with an intra-row spacing of 3.5 cm as sole crop. Pigeon pea, sesame, cotton, castor and mesta (*Hibiscus* *cannabinus)* were intercropped with foxtail millet at a 4:2 row proportion. Significant differences in grain yield were observed between the intercropped and sole foxtail millet. For intercropped foxtail millet, the highest values for yield per plant, 1000-seed weight, grain number per panicle, grain yield and straw yield were recorded with sesame and pigeon pea as intercrops. The performance of pigeon pea, sesame, cotton, castor and mesta was, generally, better under intercropping than under sole cropping.

Cakmakc and Aydnoglu (2002) conduct a field studies during 2000-2002 in Anatolia, Turkey, to determine the influence of different row spacing (15, 30, 45 and 60 cm) and N fertilizer application rates (0, 50, 100 and 150 kg/ha) to the yield of chickling vetch (*Lathyrus sativus*). The treatment with 30 cm row spacing and 150 kg N ha-1 produced the highest forage and dry matter yield. The lowest forage yield was observed at 45 cm row spacing with no N fertilizer applied, while the lowest dry matter yield was observed at 30 cm row spacing and no N fertilizer application. The number of days for flowering was 109 days. Results indicate that if chickling vetch is sown during fall, it could provide adequate time to carry out sowing preparations for cotton, maize and sesame, which are the main crops of the region. It is concluded that chickling vetch is an alternative legume crop for rotation in terms of yield.

Sarkar and Banik (2002) conducted a field experiment during spring of 1999 and 2000 to study the effects of planting geometry (30x30, 45x15, and 45x30 cm), row orientation (east-west and north-south), and sulfur rate (0, 25, and 50 kg/ha) on the growth and productivity of sesame cv. B 67. Sowing was conducted on 12 March 1999 and 14 March 2000 after winter rice. Sesame matured in 90 days and was harvested in the first fortnight of June. A planting geometry of 45x15 cm enhanced leaf area index and net assimilation rate. Despite reductions in yield attributes (capsules per plant, seeds per capsule, and 1000-seed weight), plants grown at 45x15 cm had the highest seed yield (873 kg/ha), mainly due to high plant density. Planting in north-south direction and applying 50 kg S/ha were more effective in improving leaf area index, crop growth rate, relative growth rate, net assimilation rate, yield attributes, and crop yield than planting in east-west direction and applying 25 kg S/ha.

Thenua (1999) conducted a field experiment during the rainy seasons of 1991 and 1992 at Bichpuri, Uttar Pradesh, India, clusterbeans cv. Durgapura Safed or sesame cv. Type 4 were grown at spacings of 30 or 45 cm x 15 cm in the open or under L. leucocephala cv. K 8 canopies. The trees were subjected to 4 management practices: no lopping; central leader system; open centre system; or topping at 1.50 m height or pollarding. Seed yields, seed oil and protein contents, and N uptake of sesame and clusterbeans were highest with topping, followed by the central leader system. Spacing had no significant effects. L. leucocephala seed, forage and fuelwood yields were greatest with no lopping, followed by the open centre system.

Ramulu and Gautam (1999) conducted a field trial in 1994-95 in New Delhi, India, pearl millet [*Pennisetum glaucum*] was sole cropped at 45 or 60 cm row spacing or in paired rows at 40/80 cm spacing, or was intercropped with cowpeas [*Vigna unguiculata*], pigeonpeas [*Cajanus cajan*], sesame or groundnuts at 1:1 or 2:1 row ratios. Pearl millet equivalent yield was greatest with pigeonpeas at 1:1 followed by 2:1 row ratio. Rainfall use efficiency and N, P and K uptake were also greatest in these systems.

Kalaiselvan and Subrahmaniyan (2001) stated plant population was most critical for obtaining higher yield in sesame. Above or below the threshold level of plant population it would lead to intra-species competition among plants for scarce resources which cause subnormal sesame seed yield. Hence, identification of optimum population for each variety being tested becomes vital. Various reports indicate that the growth and yield attributes and yield of sesame were determined by plant densities. Adoption of suitable and optimum spacing would fulfil the objective of maximizing the yield of sesame.

Vieira (2004) conducted a field trial in 2003 in Cariris Velhos, Paraiba, Brazil, sesame cv. Serido 1, CNPA G2 and CNPA G3 were grown in different spacing patterns. There was no significant interaction between cultivar and spacing. CNPA G3 gave significantly higher seed yields (0.71 t/ha) than the other cultivars (0.40-0.42 t/ha). Spacing did not affect yield.

Patil (2000), in a field experiment in 1996-98 in Maharashtra, sesame cv. Padma was grown at spacings of 30 x 10 or 15 cm or 45 x 10 or 15 cm and given 0-50 kg N/ha. Mean seed yield (0.58 t/ha) and net returns were highest at the 30 x 15 cm spacing + 50 kg N.

Ayyaswamy and Chinnusamy (2005) conducted a field trial in Tamil Nadu, the sole crops cassava cv. Co 2 (80 x 60 or 60 x 80 cm spacing), groundnuts cv. Co 1 (30 x10 cm) and sesame cv. Co 1 (30 x 30 cm) were grown or cassava was intercropped with groundnuts (60 x 80 cm) or sesame (60 x 80 cm). Crops were irrigated with 5 cm depth of water at irrigation water:cumulative pan evaporation (IW:CPE) ratios of 0.3, 0.45 or 0.6. In a second experiment cassava was grown alone or intercropped with groundnuts and crops were given 12.5 t farmyard manure (FYM)/ha or 5 or 10 t coir waste/ha, with the same irrigation treatments as the 1st experiment. Cassava tuber and groundnut pod yields increased with increase in irrigation frequency, whereas sesame seed yield was highest with an IW:CPE ratio of 0.45. Cassava yield was unaffected by intercropping with groundnuts, but was decreased by intercropping with sesame. In the 1st experiment net returns were highest when cassava was intercropped with groundnuts with an IW:CPE ratio of 0.6. In the 2nd experiment, intercropping cassava with groundnuts, application of 10 t coir waste/ha and irrigating at an IW: CPE ratio of 0.6 gave the highest net returns.

Raghuwanshi (2009) conducted a field trial at Tikamgarh, Madhya Pradesh in the 2008 kharif (monsoon) season, sesame cv. TKG-9, TKG-21, JLSC-8 and JT-7 produced mean seed yields of 2.53, 2.80, 2.92 and 1.86 t/ha, respectively. Yield averaged 2.05 and 3.00 t with spacings of 30 x 15 and 10 x 10 cm, and 3.99, 1.85 and 1.75 t when sown at the onset of monsoon (1 July) or 10 or 20 d after this date..

Auwalu (2009) conducted a field experiment to determine the effects of N rate (0, 30, 60 or 90 kg N/ha), timing of N application (single or split applications), intra-row spacing (5, 10, 15 or 20 cm) and harvesting frequency (every 2 or 3 weeks) on the growth and yield of vegetable sesame. The experiments were conducted at Bauchi in the savanna ecological zone of Nigeria. Plant height, leaf area index and marketable yield were significantly increased by N application. Split application of N produced significantly higher total marketable yield than a single application. Decrease in intra-row spacing resulted in a significant decrease in yield per plant, however yield per hectare increased significantly. Although total marketable yield was not significantly affected by harvesting frequency, harvesting sesame at fortnightly intervals produced higher yields. A split application of 60 kg N/ha and a spacing of 20 x 10 cm was recommended for optimum production of vegetable sesame.

A field experiment was conducted during 1997/98 and 1998/99, in Dharwad, Karnataka, India, to evaluate performance of foxtail millet in different intercropping systems under shallow alfisols. Foxtail millet was planted in 30-cm rows with an intra-row spacing of 3.5 cm as sole crop. Pigeon pea, sesame, cotton, castor and mesta [*Hibiscus cannabinus*] were intercropped with foxtail millet at a 4:2 row proportion. Significant differences in grain yield were observed between the intercropped and sole foxtail millet. For intercropped foxtail millet, the highest values for yield per plant, 1000-seed weight, grain number per panicle, grain yield and straw yield were recorded with sesame and pigeon pea as intercrops. The performance of pigeon pea, sesame, cotton, castor and mesta was, generally, better under intercropping than under sole cropping.

The effects of sowing date, row spacing and fertilizer rate on the growth and yield of sesame were studied in Turen, Portuguesa State, Venezuela, during 1996-1997 and 1997-1998. A split-split-plot design with 4 replications was used. Four fertilizer treatments were allocated to the main plot (control, 250 kg diammonium phosphate ha-1, and cowpea incorporated as green cover crops). Sowing dates (20 December and 27 December 1996, and 3 January 1997) were evaluated as subplot treatments. Row spacing was evaluated in sub-subplots (0.60, 0.30 and 0.15 m between rows). Plant height, number of pods per plant, and grain yield were evaluated. The effects of fertilizer on growth and yield were not consistent during the 2 seasons. Row spacing had no consistent effect on plant height, but the number of pods per plant increased with the increase in row spacing. The grain yields tended to decrease as the planting date was delayed in both seasons. Greater grain yields were obtained under a row spacing of 0.15 m (higher by 3.8- and 1.8-fold than the yields obtained under 0.60 and 0.30 m row spacing, respectively). The results suggest the use of a spacing 0.15 m by farmers in sesame production areas in the zone.

Boydak and Kavak (2007) carried out an experiment from June to October 2005, in Harran, Sanliurfa, Turkey, to evaluate the effects of drip and sprinkler irrigation on weed density and yield of sesame. *Cynodon dactylon*, *Prosopis farcta*, *Xanthium strumarium*, *Cirsium arvense*, *Amaranthus albus*, *Euphorbia supina*, *Amaranthus retroflexus* and *Glycyrrhiza glabra* were identified as the most important weed species infesting sesame. Sesame was harvested on 20 October 2005 and the influence of weeds on the yield of sesame was evaluated. The weeds caused 34.56% yield loss under sprinkler irrigation and 22.38% under drip irrigation.

Singh (2001) carried out an experiment at Agra during rainy (kharif) seasons of 1995 and 1996 to assess the effect of nitrogen levels and different weed control techniques to *Sesamum indicum* on weed density, seed yield, nutrients depletion by weeds and net returns. Sixty kg N ha-1 registered highest yield (979 kg ha-1) and net returns (Rs. 10327 ha-1) in addition to higher N uptake by crop and N depletion by weeds. However, higher levels of N could not influence P and K removal by weeds significantly. Among different herbicidal treatments, application of Fluchloralin at pre-planting @ 1.0 kg ha-1 followed by one manual weeding at 3 WAS gave maximum seed yield (756 kg ha-1) and net return (Rs. 9600 ha-1). Weed killing efficiency (39.8%), seed yield response (kg of seed/kg N) and N uptake by crop were highest and NPK depletion by weeds was least with this treatment. Chemical weeds control was easier, time saving and less expensive as compared to manual weeding.

Yadav (2002) carried out an experiment during the kharif season of 1999 at Hisar, Haryana, India, to study the bio-efficacy of dinitroaniline herbicides for weed control in sesame (*S. indicum*), cv. HT1. The study revealed that among the three dinitroaniline herbicides (Pendimethalin, Fluchloralin, Trifluralin) applied, application of pendimethalin at 1.0 or 1.25 kg/ha pre-emergence (PE) was more effective against various grassy and broad leaved weeds such as *Echinochloa crus-galli*, *Dactyloctenium aegyptium*, *Cyperus rotundus* and *Trianthema portulacastrum*. Supplementary treatment of one hoeing at 4 weeks after sowing with any of the herbicides (at 1 kh/ha) provided more efficient weed control, improved yield attributes and increased sesame yield (843-901 kg seed/ha), compared to the application of dinitroaniline herbicides alone (640-793 kg seed/ha).

Baskaran and Solaimalai (2002) carried out an experiment to determine the effect of weed management practices on yield attributes and yield of rice fallow sesame. Un-weeded check resulted in least yield attributes number of primary and secondary branches/plant, dry weight/plant, number of capsules/plant, number of seeds/capsule and 1000-seed weight and yield of sesame. Higher results gained with more weeding practices. Maximum yield components and yields of sesame were obtained under pre-emergence application of Alachlor granules at 1.5 kg/ha as sand mix + hoeing on 30 DAS which was on par with hand hoeing on 15 and 30 DAS. The yield increase was 2.41 and 1.52% higher under Alachlor granules at 1.5 kg/ha + hand hoeing over hand hoeing twice.

Om-Prakash, and Singh (2001) conducted a field experiment to determine the effects of N fertilizer application and weed (*Cyperus rotundus*, *Cynodon dactylon*, *Phyllanthus niruri* and *Digera muricata*) control measures on sesame were investigated in Uttar Pradesh, India, during 1995 and 1996. Treatments consisted of N levels, i.e. 0, 30, 60 and 90 kg/ha, and weed control treatments, i.e. weedy control, hand weeding 3 weeks after sowing, pre-emergence application of Oxyfluorfen at 0.15 kg/ha, pre-emergence application of Oxyfluorfen (0.15 kg/ha) + hand weeding, pre-planting application of Fluchloralin at 1.0 kg/ha, pre-planting application of Fluchloralin (1.0 kg/ha) + hand weeding, pre-emergence application of Alachlor at 1.0 kg/ha and pre-emergence application of Alachlor (1.0 kg/ha) + hand weeding. N fertilizer rate did not significantly affect the weed population. For the crop in both years, the application of 90 kg N/ha resulted in the highest number of capsules per plant, seeds per capsule, 1000-seed weight, seed yield, dry weight/plant, straw yield and harvest index. Aside from exhibiting the highest weed-killing efficiency, pre-planting application of Fluchloralin + hand weeding recorded the highest values for seed yield and most yield-contributing characters.

Venkatakrishnan, A.S. (1998) conducted a field experiment on red lateritic soil at Vridhachalam, Tamil Nadu, India during the monsoon seasons (kharif) of 1992 and 1993 to evaluate the effect of different dryland technologies alone and in combination on the yield attributes and the yield of sesame (*Sesamum indicum* cv. TMV 4) under un-irrigated conditions. The combination of all the dryland technologies such as seed treatment with 2% KH2PO4 and Azospirillum, cultivation of broad beds (120-130 cm), application of composted coir pith, application of enriched farmyard manure (FYM) with 75% of the recommended rate of NPK fertilizers, and pre-sowing incorporation of Fluchloralin at 1 kg/ha + 1 hand-weeding increased the plant height, root length, number of branches/plant, number of capsules/plant and the seed yield of sesame compared with farmers' practices, and the dryland technologies used individually. The increased yield by the combination of different dryland technologies was 82.7% higher than the control (875 kg/ha compared with 479 kg). All the individual dryland technologies also increased the yield (by 49.9-66.6%) compared with farmers practices.

Malik and Muhammad (2004) conduct a field studies in Somalia during April-June and October-December 2003, the efficacy of the herbicides Stomp 330E [Pendimethalin] at 3.7 litre ha^{-1}, Fusilade 25EC [Fluazifop-P] at 3.7 litre ha^{-1} and Gramoxone 20EC [Paraquat] at 1.5 litre ha^{-1} was compared with that of hand weeding for the control of weeds infesting sesame, and the effect of these treatments on yield was determined. Stomp 330E was applied pre-emergence and the remaining herbicides were sprayed after planting. The results showed that all herbicides and hand weeding gave an effective level of control. Greatest weed control was obtained using Stomp (86.04%), followed by hand weeding (84.97%) and Gramoxone (81.34%). Stomp 330E treated plots gave a significantly higher seed yield (5.08 t ha-1) compared to the untreated control (3.06 t ha-1), and did not produce any phytotoxic effects.

Zewdie, K. (2005) conducted a field experiment in 2004 at Werer (Ethiopia) on a Fluvisol to evaluate sesame yield losses due to the interactions of soil fertility, irrigation interval and weed competition by applying optimum practices and to assess the yield potential of the crop. The treatments used were 30, 60 and 90 kg N/ha, irrigation intervals of 10, 15, and 20 days, and no weeding, one hand weeding at 20-25 days after emergence (DAE) and two hand weeding (20-25 and 40-45 DAE). A highly significant yield difference due to weeding treatments and irrigation interval was found. One hand weeding increased grain yield by 83%. No significant yield difference was observed from the use of fertilizers.

Venkatakrishnan (2006) conducted a field trial in the kharif (monsoon) seasons at Vridhachalam, with sesame cv. TMV4, the individual and combined effects were studied of improved practices including seed hardening with 2% KH2PO4, seed treatment with Azospirillum, formation of broad-bed and furrows, application of 12.5 t coir pith/ha, farmyard manure enriched with 75% of the recommended fertilizer, pre-sowing incorporation of Fluchloralin (1 kg/ha) + 1 hand weeding 30 days after sowing, and results were compared with farmers' practice. The combination of improved practices increased plant height, root length, number of branches/plant, number of capsules/plant and seed yield compared with farmers' practice or individual improvements. Improved practices increased seed yield by 82.7% compared with the control. All the individual improvements increased the yield compared with the farmers' practice.

Sootrakar (2005) carried out an experiment during the rainy seasons on a sandy clay-loam soil. Treatments comprised 3 sesame varieties (local, JT7 and JLSC8) as the main-plot treatments and 7 weed control methods. *Cyperus rotundus* and *Cynodon dactylon* were the dominant perennial weed species present, and *Echinochloa* spp., *Commelina benghalensis*, *Digera arvensis*, *Phyllanthus niruri* and *Physalis minima* were the main annual weeds. Fluchloralin (ppi [pre-plant incorporated] or pre-emergence) at 2 l/ha killed all the annual weeds; however, *Cyperus rotundus* and *Cynodon dactylon* partially re-emerged. Hand weeding (HW) 3 times (25, 40 and 55 days after sowing) resulted in the lowest weed counts at crop maturity and the highest weed control efficiency (WCE; 98.85%), followed by Fluchloralin (ppi) + 1 HW (WCE 98.56%). Averaged for the sesame varieties, highest seed yield (0.77 t/ha) was recorded under the 3 HW treatment as was the highest net return (Rs 6131/ha for JLSC8). The second highest average seed yield (0.69 t/ha) was produced under the Fluchloralin (ppi) + 1 HW treatment.

El-Ouesni *et al.* (2007) conducted a field trial at Nobarya, Egypt, during 2006-07, the effects were evaluated of 2 plant population densities (1 or 2 plants/hill), 2 weed control treatments (hoeing twice at 35 + 55 d after sowing and pre-em. Prometryn at 1 kg/feddan) and 3 N fertilization levels (15, 30 and 45 kg N/feddan) for weed control in, and growth and yields of, sesame cv. Giza 32. Prometryn + 1 plant/hill + N fertilization at 45 kg resulted in the lowest weed DW and FW of 15.3 and 44.44 g/msuperscript 2, resp., and the greatest crop plant height, number of branches/plant and seed yields of 134 cm, 16.52 and 11.58 g/plant, respectively. [1 feddan=0.42 ha.].

Chapter III

Materials and Methods

Chapter 3

Materials and Methods

In this chapter, the details on different materials used and methodology followed during the experimental period are described.

The experiment was conducted at the Agronomy field, Sher-e-Bangla Agricultural University, Dhaka during March to July 2009. This chapter deals with a brief description on experimental site, climate, soil, land preparation, layout, experimental design, intercultural operations, data recordings and their analyses.

3.1 Site description

The experiment was conducted at the research field of Agronomy Department, Sher-e-Bangla Agricultural University, Dhaka under the Agro-ecological zone of Madhupur Tract, AEZ-28. The land area was situated at 2341N latitude and 9022E longitude at an altitude of 8.6 meter above sea level as shown in Appendix I.

3.2 Climate

The experimental area was under the sub-tropical that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif-1 season (March-July) associated with moderately low temperature during the rabi season (October-March).

3.3 Soil

The soil of the experimental field belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles.

The experimental area was flat having available irrigation and drainage system. The land was above flood level and sufficient sunshine was available during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done from Soil Resources and Development Institute (SRDI), Dhaka and shown in Appendix II.

3.4 Planting materials

BARI Til 3, a high yielding variety of sesame, developed by Bangladesh Agricultural Research Institute (BARI), Gazipur. Seeds of this variety was used as a planting material.

3.4.1 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 **(**Bangladesh Agricultural Research Institute, BARI,Gajipur).

3.5 Land preparation

The land was first opened on the 9th March, with the tractor drawn disc plough. Ploughed soil was then brought into desirable tilth by 4 operations of ploughing and lavelling with acountry plough and a ladder respectively. The stubble and weeds were removed. The land was finally prepared on the 16th March, 2009. Experimental land was divided into unit plots following the design of experiment. The plots were spaded one day before planting and the basal dose of fertilizers was incorporated thoroughly before planting.

3.6 Fertilizer application

The fertilizers were applied by the following dozes:

Urea	:	115 Kg ha^{-1}
TSP	:	140 Kg ha^{-1}
MoP	:	45 Kg ha^{-1}
Gypsum	:	105 Kg ha^{-1}
Zinc sulphate	:	5 Kg ha^{-1}
Boric Acid	:	10 Kg ha^{-1}

Whole amount of TSP, MP, Gypsum, Boric acid, Zinc sulphate and half amount of Urea were applied as basal dose during final land preparation. The rest portion of Urea was applied before flowering stage (at 25-30 Days After Emergence).

3.7 Treatments of the experiment

The experiment was conducted considering two factors of which were weeding frequencies and the densities of plant population.

3.7.1 Factor (A): Population density

The following plant densities were maintained by manipulating the plant to plant distances designated as follows:

Symbol Used		Plants ha^{-1}	Plant to plant distance (cm)
P_1	:	66666	5
P_2	:	33333	10
P_3	:	22222	15
P_4	:	16666	20

3.7.2 Factor (B): Weeding frequencies

The weeding operations were practiced by the following frequencies designated as:

W_0	:	No weeding (control)
W_1	:	One time weeding on 10 Days After Emergence
W_2	:	Two times weeding on 10 and 20 Days After Emergence
W_3	:	Three times weeding on10, 20 and 30 Days After Emergence

3.7.3 Interaction of Factor A and Factor B

By the combination of the factors, a total of 16 treatment arrangements shown below, which were tested through our experimentation.

P_1W_0	P_2W_0	P_3W_0	P_4W_0
P_1W_1	P_2W_1	P_3W_1	P_4W_1
P_1W_2	P_2W_2	P_3W_2	P_4W_2
P_1W_3	P_2W_3	P_3W_3	P_4W_3

3.8 Experimental design and layout

The experiment was laid out in a Randomized Complete Block Design (factorial). Each treatment was replicated thrice. The size of a unit plot was 3 m × 2 m. The distance between two adjacent replications (block) was 1m and the row-to-row distance was 1 m. The inter block and inter row spaces were used as footpath and irrigation/drainage channels.

3.9 Germination test

Germination test was performed before sowing the seeds in the field. For laboratory test, petridishes were used. Filter paper was placed on petridishes and the papers were soaked with water. Seeds were distributed at random in petridishes. Data on emergence were calculated expressed as percentage by using the following formula:

$$\text{Germination (\%)} = \frac{\text{Number of germinated seeds}}{\text{Number of seeds set for germination}} \times 100$$

3.10 Sowing of seeds

Seeds were sown on the 19th March, 2009 on continuous lines. Plant to plant distances of the crop were maintained according to the treatment under the study, on the other hand row to row distance of 30 cm was followed for each treatment. Seeds were sown in 2cm deep (approximately) furrows. Immediately after sowing the furrows were covered with soil to protect moisture for good germination of seeds.

3.11 Intercultural operations

3.11.1 Weeding

Weeding was done at 10, 20, and 30 Days After Emergence according to the treatment. Demarcation boundaries and drainage channels were also kept weed free.

3.11.2 Thinning

An initial thinning was practiced at 10 Days After Sowing to shade out the overcrowded plant population from the plots. A final thinning was done at 20 Days After Sowing with a view to maintain the populations as per the design of our experiment.

3.11.3 Irrigation

A pre-sowing irrigation was done for all the plots to maintain equal germination. After sowing two irrigations were done during the life cycle. First irrigation and second irrigation were done at 12 and 22 Days After Sowing respectively.

3.11.4 Application of pesticides

The crops were attacked by mites at the time of vegetative stage. It was controlled by spraying Diazinon 60 EC @ 1litre ha^{-1}. Malathion 57 EC @ 2 ml/litre of water was sprayed to control hawkmoth and jute hairy caterpillar at the time of pod formation. The sprayings were done in the afternoon to keep the pollinating bees away from the field.

3.12 Harvesting and threshing

The crop was harvested at 21st June, 2009. When the leaves, stems, and pods of sesame became yillowish in colour, the plants were harvested. One squire meter area from each of the plots was harvested for recording the yield data. 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 pods by beating with bamboo sticks and later were cleaned, dried and weighed. The weights of the dry straw were also taken.

3.13 Sampling

The sampling was done first at 20 Days After Emergence and it was continued at an interval of ten days, viz. 30, 40, 50 and 60 Days After Emergence. At each harvest, five plants were selected randomly from each plot. The selected plants of each plot were uprooted carefully by a khurpi and washed in a running tape water to remove the soil. The number of leaves, branches, flowers and pods were recorded separately. The components were oven dried at 60^{o}C for 72 hours to record constant dry weights. Total dry matter was determined by recording the dry weight of each portion of the plants. From each plot the weight of the straw were taken. Biological yield and the harvest index were also calculated from this data.

3.14 Data collection

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

3.14.1 Growth data

- Plant height (cm)
- Number of leaves/plant
- Number of branches/plant
- Dry matter weight/ plant (g)

3.14.2 Yield data

- Number of effective capsule/plant
- Number of non-effective capsule/plant
- Number of seeds/capsule
- Weight of 1000 seeds
- Seed yield
- Stover yield
- Harvest index

3.14.3 Dry weight of weed (g per $6m^2$)

After weeding, treatment wise weeds were packed and oven dried to determine the dry weight.

3.15 Procedure of data collection

3.15.1 Plant height (cm)

The heights of five plants were measured with a meter scale from the ground level to the top of the plants.

3.15.2 Number of branches plant^{-1}

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

3.15.3 Dry matter weight plant^{-1} (g)

For measuring the dry matter weight plant^{-1}, the parts of the plants were separated and then dried in oven at 60 – 70^{0}C for 72 hours and weight was taken carefully. The weight of separated parts was taken separately. The sum of the plant parts constituted the total dry matter of a single plant.

3.15.4 Number of capsule plant^{-1}

Number of total capsule of pre-selected plants from each unit plot was noted and the mean number was recorded.

3.15.5 Number of seeds capsule^{-1}

The number of seeds was counted from randomly taking ten capsules from each sample of each plot and recorded as per treatment.

3.15.6 Weight of 1000 seeds

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

3.15.7 Seed yield

Weight of seeds of the harvested area (1 m$^{2)}$ at the centre of each plot was taken and then converted it into t ha^{-1}.

3.15.8 Stover yield plot^{-1} (t ha^{-1})

The weight of the stover were calculated after threshing and separation of grain from the sample and then expressed in (t ha^{-1}) on dry weight basis.

3.15.9 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 (Donald and Hamblim, 1976).

Grain yield

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

3.16 Analysis of data

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

Chapter IV
Results and Discussion

Chapter 4
Results and Discussion

The results obtained from the present study focused on different parameters related to agronomic practices with their resultant effects on yield and yield contributing characters have been presented and discussed in this chapter.

4.1 Growth parameters

4.1.1 Plant height (cm)

4.1.1.1 Effect of population density

Plant height was significantly influenced by population density at different growth stages of sesame (Table 1). The highest plant heights at 30, 60 Days After Sowing and at harvest recorded were 39.75, 91.50 and 129.60 cm respectively with P_2 (plants ha^{-1}= 33333), which were statistically identical with P_1 (plants ha^{-1} = 66666) at 30 and 60 Days After Sowing. On the other hand the lowest plant heights with P_3 (plants ha^{-1}= 22222) at 30 and 60 Days After Sowing and at harvest were found 30.96, 85.40 and 121.50 cm respectively, which were statistically identical with P_1 (plants ha^{-1} = 66666) at harvest. The result obtained from all other treatments showed intermediate result compared to highest and lowest plant height under the present study. Similar findings were reported by Krishna *et al*. (2008) and Avila and Graterol (2005).

Table 1: Effect on plant height influenced by different population density at different growth stages of sesame

Treatment	Plant height (cm)		
	30 DAS	60 DAS	At harvest
P_1	38.90 a	90.52 a	121.70 c
P_2	39.75 a	91.50 a	129.60 a
P_3	30.96 b	85.40 c	121.50 c
P_4	31.73 b	88.51 b	125.20 b
$LSD_{0.05}$	1.087	1.534	1.193
CV (%)	5.66	7.99	6.58

Here,

Symbol Used		Plants ha^{-1}	Plant to plant distance (cm)
P_1	:	66666	5
P_2	:	33333	10
P_3	:	22222	15
P_4	:	16666	20

4.1.1.2 Effect of weeding

Weeding frequency had significant effect on plant height at different growth stages of sesame (Table 2). It was found that the highest plant heights at 30, 60 Days After Sowing and at harvest (36.83, 90.39 and 127.10 cm respectively) with W_3 (Three times weeding). However, the effect of weeding on plant height was identical with W_2 (Two times weeding) at harvest. At 30, 60 Days After Sowing and at harvest the lowest plant heights (33.19, 86.44 and 119.90 cm respectively) were recorded with W_0 (no weeding), which were statistically different from all other treatments. The results obtained were also supported by El-Ouesni *et al.* (2007).

Table 2: Effect on plant height influenced by different weeding frequency at different growth stages of sesame

Treatment	Plant height (cm)		
	30 DAS	60 DAS	At harvest
W_0	33.19 c	86.44 c	119.90 c
W_1	35.72 b	89.99 ab	124.00 b
W_2	35.60 b	89.10 b	127.00 a
W_3	36.83 a	90.39 a	127.10 a
$LSD_{0.05}$	1.087	0.9809	1.193
CV(%)	5.66	7.99	6.58

Here,

W_0	:	No weeding (control)
W_1	:	One time weeding on 10 Days After Emergence
W_2	:	Two times weeding on 10 and 20 Days After Emergence
W_3	:	Three times weeding on10, 20 and 30 Days After Emergence

4.1.1.3 Interaction effect of population density and weeding frequency

Significant variation was observed on plant height influenced by interaction effect of population density and weeding frequency (Fig.1). It was revealed that the highest plant heights at 30, 60 Days After Sowing and at harvest were 45.40, 96.50 and 136.90 cm respectively with P_2W_3 (Population Density = 33333 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence) which appeared statistically similar with P_1W_3 (Population Density = 66666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence) at 30 and 60 Days After Sowing. The lowest plant heights at 30, 60 Days After Sowing and at harvest were found 28.80, 80.80 and 109.50 cm respectively with $P_3W_{0,}$ which were closely followed by P_3W_3, P_4W_0 and P_4W_3 at 30 Days After Sowing. The results obtained from all other combination of treatments showed significantly different results in respect of highest and lowest plant height under the present study. The results could be comparable to those of El-Ouesni *et al*. (2007) and Om-Prakash, and Singh (2001).

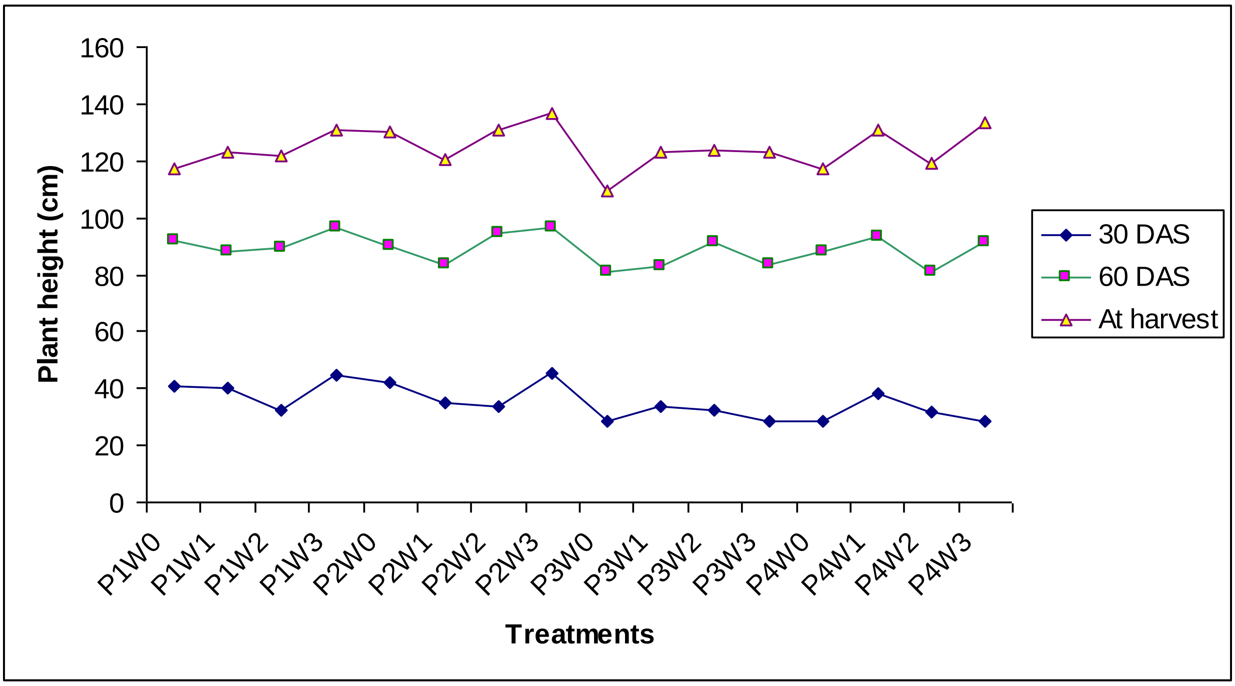

Figure 1. Effect on plant height influenced by interaction effect of population density and weeding frequency at different growth stages of sesame

4.1.2 Number of leaves/plant

4.1.2.1 Effect of population density

Number of leaves/plant was significantly influenced by population density at different growth stages of sesame (Table 3). At 30 Days After Sowing there was no significant effect on number of leaves/plant was observed but at 60 Days After Sowing and at harvest significant influence was observed. The highest number of leaves/plant at 60 Days After Sowing and at harvest was 30.48 and 28.22 respectively with P_4 (plants ha^{-1} =16666). The lowest number of leaves/plant at 60 Days After Sowing and at harvest was 25.82 and 22.46 respectively obtained with P_1 (plants ha^{-1} = 66666), which was statistically non-differentiate with P_2 (plants ha^{-1} = 33333). The result obtained from all other treatments showed intermediate result compared to highest and lowest number of leaves/plant under the present study. The result under the present study showed that higher population density represent increased number of leaves than lower plant spacing.

Table 3: Effect on number of leaves/plant influenced by different population density at different growth stages of sesame

Treatment	Number of leaves/plant		
	30 DAS	60 DAS	At harvest
P_1	10.18	25.82 c	22.46 c
P_2	10.85	26.01 c	23.54 c
P_3	11.07	28.18 b	26.55 b
P_4	11.44	30.48 a	28.22 a
$LSD_{0.05}$	NS	1.147	1.148
CV(%)	4.87	8.99	7.74

Here,

Symbol Used		Plants ha^{-1}	Plant to plant distance (cm)
P_1	:	66666	5
P_2	:	33333	10
P_3	:	22222	15
P_4	:	16666	20

4.1.2.2 Effect of weeding

Weeding frequency had no significant effect on number of leaves/plant at different growth stages of sesame (Table 4). But it was recorded that the highest number of leaves/plant at 30, 60 Days After Sowing and at harvest was 10.31, 30.87 and 27.67 respectively with W_3 (Three times weeding). At 30, 60 Days After Sowing and at harvest, the lowest number of leaves/plant was 10.31, 29.87 and 27.67 respectively with W_0 (No weeding).

Table 4: Effect on number of leaves/plant influenced by different weeding frequency at different growth stages of sesame

Treatment	Number of leaves/plant		
	30 DAS	60 DAS	At harvest
W_0	10.07	25.72	24.03
W_1	11.95	26.33	24.27
W_2	11.22	27.57	24.79
W_3	10.31	29.87	27.67
$LSD_{0.05}$	NS	NS	NS
CV(%)	4.87	8.99	7.74

Here,

W_0	:	No weeding (control)
W_1	:	One time weeding on 10 Days After Emergence
W_2	:	Two times weeding on 10 and 20 Days After Emergence
W_3	:	Three times weeding on10, 20 and 30 Days After Emergence

4.1.2.3 Interaction effect of population density and weeding frequency

Significant variation was observed on number of leaves/plant influenced by interaction effect of population density and weeding frequency at different growth stages of sesame except 30 Days After Sowing (Fig.2). It was found that the highest number of leaves/plant at 60 Days After Sowing and at harvest was 34.10 and 31.80 respectively with P_4W_3 (Population Density = 16666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence) which was statistically identical with P_3W_3 (Population Density = 22222 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence) at 60 Days After Sowing and at harvest. On the other hand the lowest number of leaves/plant at 60 Days After Sowing and at harvest was 23.50 and 20.93 with P_1W_0 (Population Density = 66666 Plants ha^{-1} and No weeding) which was closely followed by P_1W_0 (Population Density = 66666 Plants ha^{-1} and No weeding) at 60 Days After Sowing and at harvest. The result under the present study indicates that increased population density with increased weeding frequency showed increased number of leaves/plant.

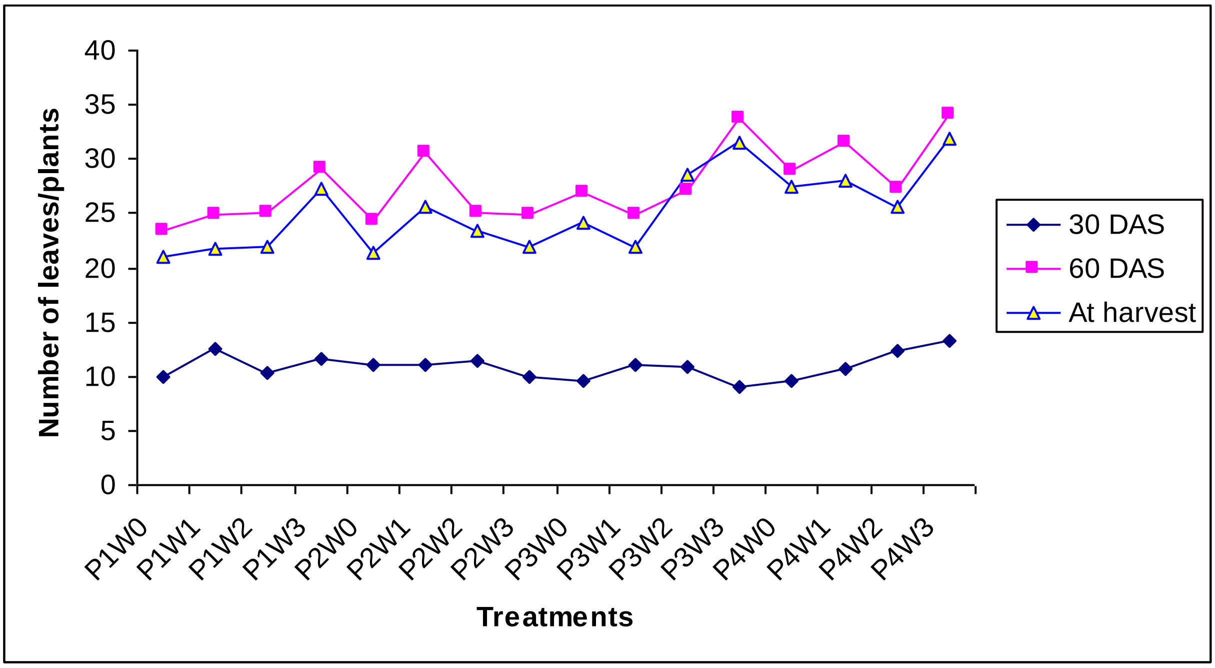

Figure 2. Effect on number of leaves/plant influenced by interaction effect of population density and weeding frequency at different growth stages of sesame

4.1.3 Number of branches/plant

4.1.3.1 Effect of population density

Number of branches/plant was significantly influenced by population density at different growth stages of sesame (Table 5). The highest number of branches/plant at 30, 60 Days After Sowing and at harvest were recorded as 5.22, 5.42 and 7.13 respectively with P_4 (plants ha^{-1} =16666), which were statistically similar with P_2 (plants ha^{-1} =33333), and P_3 (plants ha^{-1} =22222), at 30 and 60 Days After Sowing. The lowest number of branches/plant at 30, 60 Days After Sowing and at harvest were 3.83, 3.94 and 4.03 respectively obtained with P_1 (plants ha^{-1} =66666). The results obtained from our study could be comparable with Asghar *et al*. (2009).

Table 5: Effect on number of branches/plant influenced by different plant density at different growth stages of sesame

Treatment	Number of branches/plant		
	30 DAS	60 DAS	At harvest
P_1	3.83 b	3.94 b	4.03 d
P_2	4.79 a	5.05 a	4.72 c
P_3	4.89 a	5.10 a	5.79 b
P_4	5.22 a	5.42 a	7.13 a
$LSD_{0.05}$	0.5649	0.5455	0.5273
CV(%)	5.56	8.81	7.34

Here,

Symbol Used		Plants ha^{-1}	Plant to plant distance (cm)
P_1	:	66666	5
P_2	:	33333	10
P_3	:	22222	15
P_4	:	16666	20

4.1.3.2 Effect of weeding

Weeding frequency played a significant effect on number of branches/plant at different growth stages of sesame (Table 6). At 30, 60 Days After Sowing and at harvest the highest number of branches/plant were 5.16, 5.15 and 6.33 respectively with W_3 (Three times weeding) which was closely followed by W_2 (Two times weeding) at 30 and 60 Days After Sowing. On the other hand the lowest number of branches/plant at 30, 60 Days After Sowing and at harvest were 4.13, 4.23 and 4.81 respectively recorded with W_0 (No weeding) treatment as also supported by Baskaran and Solaimalai (2002).

Table 6: Effect on number of branches/plant influenced by different weeding frequency at different growth stages of sesame

Treatment	Number of branches/plant		
	30 DAS	60 DAS	At harvest
W_0	4.13 b	4.23 b	4.81 c
W_1	4.38 b	4.47 b	5.00 bc
W_2	5.05 a	5.30 a	5.53 b
W_3	5.16 a	5.51 a	6.33 a
$LSD_{0.05}$	0.565	0.545	0.527
CV(%)	5.56	8.81	7.34

Here,

W_0	:	No weeding (control)
W_1	:	One time weeding on 10 Days After Emergence
W_2	:	Two times weeding on 10 and 20 Days After Emergence
W_3	:	Three times weeding on10, 20 and 30 Days After Emergence

4.1.3.3 Interaction effect of population density and weeding frequency

Significant variation was observed on number of branches/plant as affected by the interaction effect of population density and weeding frequency (Fig.3). At 30, 60 Days After Sowing and at harvest, the highest number of branches/plant were found 6.70, 6.73 and 8.30 respectively with P_4W_3 (Population Density = 16666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence) which showed identical values with P_3W_3 (Population Density = 22222 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence) at 60 Days After Sowing only. But the lowest number of branches/plant at 30, 60 Days After Sowing and at harvest were recorded as 2.90, 2.97 and 3.00 with P_1W_0 (Population Density = 66666 Plants ha^{-1} and No weeding) which were statistically different with P_1W_0, P_2W_0 and P_4W_0.

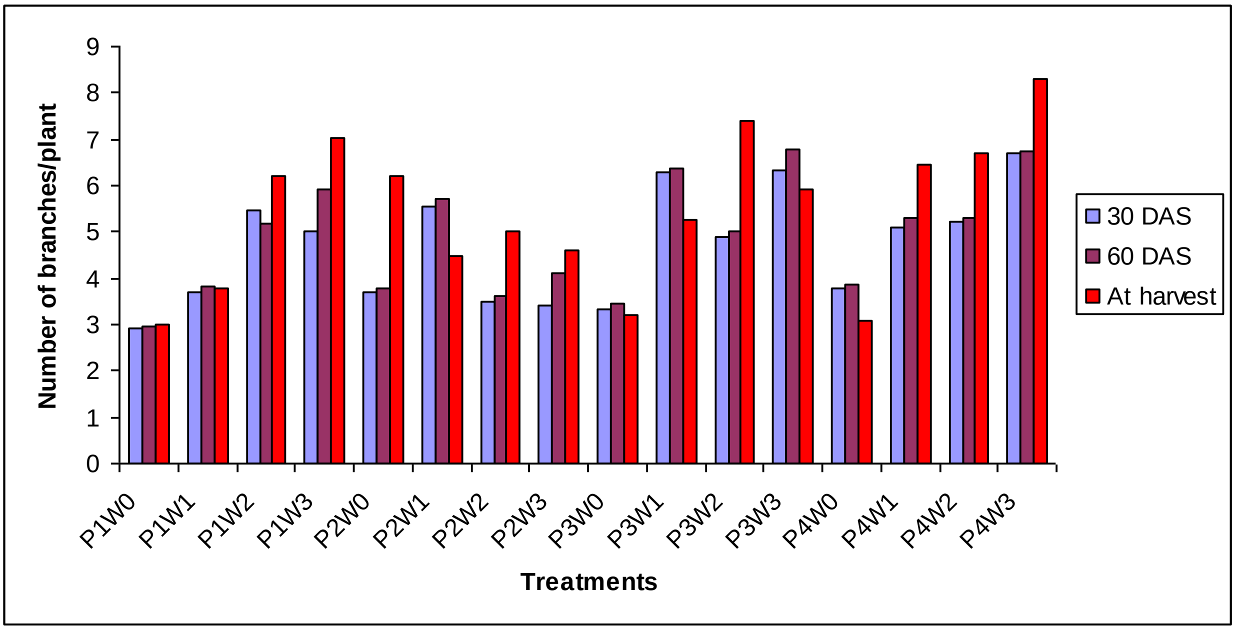

Figure 3. Effect on number of branches/plant influenced by interaction effect of population density and weeding frequency at different growth stages of sesame

4.1.4 Dry weight/plant (g)

4.1.4.1 Effect of population density

Dry weight/plant was significantly influenced by population density at different growth stages of sesame except 30 Days After Sowing (Table 7). It was observed that the highest dry weight/plant at 60 Days After Sowing and at harvest was 17.17 and 22.30 g respectively with P_4 (Plants ha^{-1} = 16666). On the other hand the lowest dry weight/plant at 60 Days After Sowing and at harvest was 13.76 and 18.00 g respectively with P_1 (Plants ha^{-1} = 66666). The results obtained with other treatments showed intermediate results compared to highest and lowest dry weight/plant. The result resembles with that of Cakmakc and Aydnoglu (2002).

Table 7: Effect on dry weight/plant influenced by different population density at different growth stages of sesame

Treatment	Dry weight/plant		
	30 DAS	60 DAS	At harvest
P_1	2.178 d	13.76 d	18.00 d
P_2	2.863 a	14.63 c	19.07 c
P_3	2.464 b	15.43 b	20.29 b
P_4	2.227 c	17.17 a	22.30 a
$LSD_{0.05}$	0.0373	0.02637	0.1119
CV(%)	6.42	5.29	6.66

Here,

Symbol Used		Plants ha^{-1}	Plant to plant distance (cm)
P_1	:	66666	5
P_2	:	33333	10
P_3	:	22222	15
P_4	:	16666	20

4.1.4.2 Effect of weeding

Weeding frequency had significant effect on dry weight/plant at different growth stages of sesame except 30 Days After Sowing (Table 8). It was noted that the highest dry weight/plant at 60 Days After Sowing and at harvest were 18.30 and 23.63 g respectively with W_3 (Three times weeding). In contrast, the lowest values (13.29 g and 17.52 g) were found with W_0 (No weeding) treatment at 60 Days After Sowing and at harvest respectively. The results obtained with other treatments showed intermediate results compared to highest and lowest dry weight/plant. Similar findings were reported by Baskaran and Solaimalai (2002).

Table 8: Effect on dry weight/plant influenced by different weeding frequency at different growth stages of sesame

Treatment	Dry weight/plant		
	30 DAS	60 DAS	At harvest
W_0	2.235 d	13.29 d	17.52 d
W_1	2.278 c	14.22 c	18.61 c
W_2	2.517 b	15.17 b	19.90 b
W_3	2.703 a	18.30 a	23.63 a
$LSD_{0.05}$	0.03729	0.02637	0.1119
CV(%)	6.42	5.29	6.66

Here,

W_0	:	No weeding (control)
W_1	:	One time weeding on 10 Days After Emergence
W_2	:	Two times weeding on 10 and 20 Days After Emergence
W_3	:	Three times weeding on10, 20 and 30 Days After Emergence

4.1.4.3 Interaction effect of population density and weeding frequency

Significant variation was observed on dry weight/plant influenced by interaction effect of population density and weeding frequency (Fig. 4). It was revealed that the highest dry weights/plant at 30, 60 Days After Sowing and at harvest were 3.16, 21.31 and 26.93 g respectively with P_4W_3 (Population Density = 16666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence). On the other hand the lowest dry weights/plant at 30, 60 Days After Sowing and at harvest were 1.53, 11.11 and 14.45 g with P_1W_0 (Population Density = 66666 Plants ha^{-1} and No weeding). The results obtained with other treatments showed significantly different results compared to highest and lowest dry weight/plant. The results obtained could be referred to as of Om-Prakash, and Singh (2001).

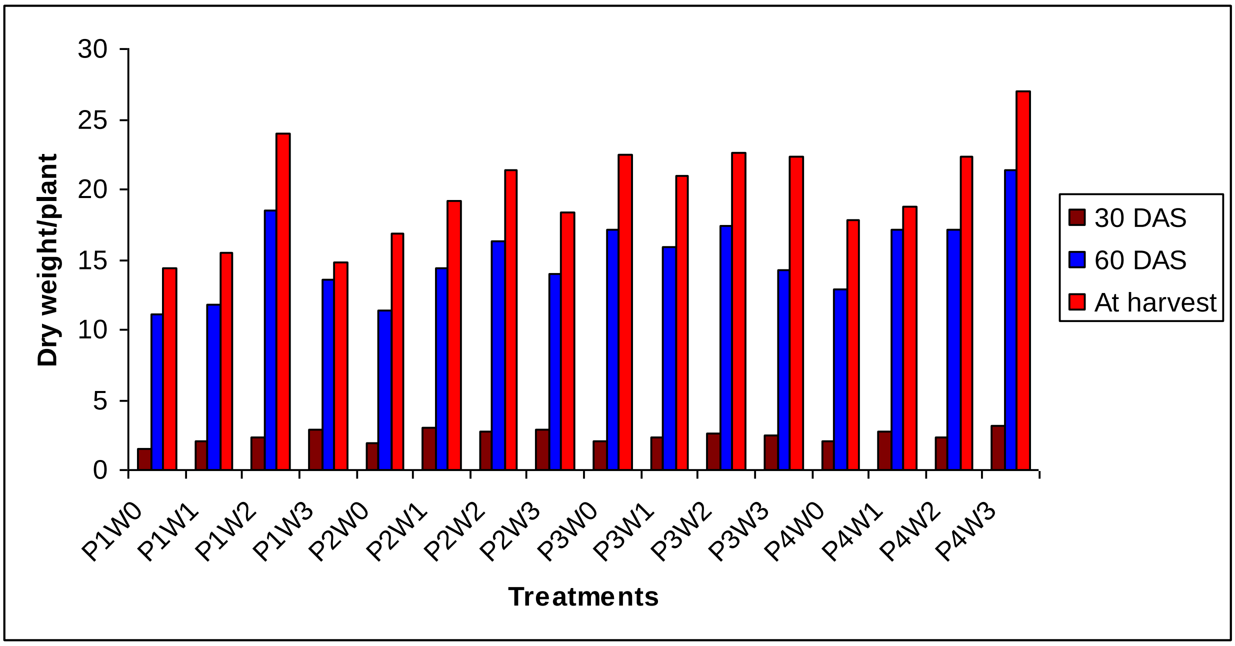

Figure 4. Effect on dry weight/plant as influenced by interaction effects of population density and weeding frequency at different growth stages of sesame

4.2 Yield parameters

4.2.1 Effect of population density

4.2.1.1 Number of effective capsules/plant

Number of effective capsules/plant was significantly influenced by population density of sesame (Table 9). It was found that the highest number of effective capsule/plant was 111.60 with plots treated with the lowest level of plant population, P_4 ((Plants ha^{-1} = 16666)). On the other hand the lowest number of effective capsules/plant (82.17) was recorded with the highest level of population, P_1 (Plants ha^{-1} = 66666) of the crop. The result could be attributed to the population density of plants, which might have the effect on the growth of the crop resulting on the variation of effective tillers per plant as also supported by Gercek *et al.* (2007).

4.2.1.2 Number of non-effective capsule/plant

Number of non-effective capsules/plant was not significantly influenced by population density of sesame. But it was recorded that the highest number of non-effective capsule/plant was 8.42 with P_1 ((Plants ha^{-1} = 66666)) whereas the lowest (6.72) was recorded with P_4 ((Plants ha^{-1} = 16666)) treated plots (Table 9).

4.2.1.3 Number of seeds/capsule

Number of seeds/capsule was not significantly influenced by population density of sesame. But, the highest and the lowest number of seeds/capsule were recorded 76.59 and 74.62 with P_4 ((Plants ha^{-1} = 16666)) and P_1 (Plants ha^{-1} = 66666) treatments respectively (Table 9).

Table 9: Effect on yield parameters influenced by different population density at different growth stages of sesame

Treatment	Number of effective capsules/plant	Number of non-effective capsules/plant	Number of seeds/capsule
P_1	82.17 d	8.42	74.62
P_2	97.15 b	7.64	75.30
P_3	88.58 c	7.80	75.38
P_4	111.60 a	6.72	76.59
$LSD_{0.05}$	2.081	NS	NS
CV (%)	4.97	2.65	4.54

Here,

Symbol Used		Plants ha^{-1}	Plant to plant distance (cm)
P_1	:	66666	5
P_2	:	33333	10
P_3	:	22222	15
P_4	:	16666	20

4.2.2 Effect of weeding

4.2.2.1 Number of effective capsules/plant

Number of effective capsules/plant was significantly influenced by weeding frequency of sesame (Table 10). The highest number of effective capsule/plant (109.60) was found in W_3 (Three times weeding). On the other hand, the lowest number of effective capsule/plant was recorded 81.73 with W_0 (No weeding) treatment. The results obtained with other treatments showed intermediate results compared to highest and lowest number of effective capsule/plant. Similar result was with Baskaran and Solaimalai (2002).

4.2.2.2 Number of non-effective capsule/plant

Number of non-effective capsule/plant was not significantly influenced by weeding frequency of sesame. However, the highest (9.15) and the lowest (6.83) number of non-effective capsule/plant were found in W_0 (No weeding) and W_3 (Three times weeding) treated plots respectively (Table 10).

4.2.2.3 Number of seeds/capsule

Number of seeds/capsule was not significantly influenced by weeding frequency of sesame. But it was observed that the highest number of seeds/capsule was 76.24 with W_3 (Three times weeding), whereas that of the lowest (75.09) was recorded with W_0 (No weeding). treatment (Table 10).

Table 10: Effect on yield parameters influenced by different weeding frequency at different growth stages of sesame

Treatment	Number of effective capsules/plant	Number of non-effective capsules/plant	Number of seeds/capsule
W_0	81.73 c	9.15	75.09
W_1	94.03 b	7.03	75.17
W_2	94.20 b	7.57	75.39
W_3	109.60 a	6.83	76.24
$LSD_{0.05}$	2.081	NS	NS
CV(%)	4.97	2.65	7.54

Here,

W_0	:	No weeding (control)
W_1	:	One time weeding on 10 Days After Emergence
W_2	:	Two times weeding on 10 and 20 Days After Emergence
W_3	:	Three times weeding on10, 20 and 30 Days After Emergence

4.2.3 Interaction effect of population density and weeding frequency

4.2.3.1 Number of effective capsule/plant

Significant variation was observed on number of effective capsules/plant influenced by interaction effect of population density and weeding frequency (Table 11). The highest number of effective capsules/plant was recorded 146.80 with P_4W_3 (Population Density = 16666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence). In the case of P_1W_0 (Population Density = 66666 Plants ha^{-1} and No weeding), the lowest number of effective capsules/plant (66.93) was recorded. The results obtained with other treatments showed significantly different results compared to the highest and the lowest number of effective capsule/plant. The yield pattern of effective capsule/plant, as influenced by the treatments of our study, is also supported by Udom *et al*. (2009).

4.2.3.2 Number of non-effective capsule/plant

There was no significant variation was observed on number of non-effective capsule/plant as influenced by the interaction effect of population density and weeding frequency (Table 11). But, in the case of P_1W_0 (Population Density = 66666 Plants ha^{-1} and No weeding), the highest number of non-effective capsule/plant was found 9.80, whereas the lowest number of non-effective capsule/plant (5.00) was recorded with P_4W_3 (Population Density = 16666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence).

4.2.3.3 Number of seeds/capsule

Significant variation was observed on number of seeds/capsule as affected by by the interaction effect of population density and weeding frequency (Table 11). The highest number of seeds/capsule (79.20) was found with P_4W_3 (Population Density = 16666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence). On the other hand the lowest number of seeds/capsule (72.91) was resulted with P_1W_0 (Population Density = 66666 Plants ha^{-1} and No weeding). My findings on the said parameter of sesame could be compared with that reported by Udom *et al*. (2009).

Table 11: Effect yield parameters influenced by interaction effect of population density and weeding frequency at different growth stages of sesame

Treatment	Number of effective capsule/plant	Number of non-effective capsule/plant	Number of seeds/capsule
P_1W_0	66.93 k	9.80	72.91 h
P_1W_1	93.00 f	5.70	76.44 c
P_1W_2	93.40 ef	7.50	75.53 d
P_1W_3	88.73 g	7.70	76.13 cd
P_2W_0	70.53 k	6.67	73.40 gh
P_2W_1	85.80 gh	7.67	77.33 b
P_2W_2	95.60 ef	8.80	75.91 cd
P_2W_3	97.73 e	6.27	75.93 cd
P_3W_0	81.20 i	6.40	73.53 gh
P_3W_1	109.5 c	8.90	77.20 b
P_3W_2	102.4 d	9.40	74.71 e
P_3W_3	103.8 d	6.50	74.80 e
P_4W_0	76.00 j	7.40	73.69 fg
P_4W_1	83.87 hi	7.70	76.53 c
P_4W_2	122.7 b	10.90	74.31 ef
P_4W_3	146.8 a	5.00	79.20 a
$LSD_{0.05}$	4.162	NS	0.6328
CV(%)	4.97	2.65	7.54

4.3 Yield and yield contributing characters

4.3.1 Effect of population density

4.3.1.1 Weight of 1000 seeds (g)

Weight of 1000 seeds was significantly influenced by plant density of sesame (Table 12). The highest 1000 seed weight (3.25 g) was found in P_4 (Plants ha^{-1} = 16666), which was statistically identical to the effect of P_3 (Plants ha^{-1} = 22222)

Treatment. The lowest 1000 seed weight was recorded as 2.95 g with P_1 (Plants ha^{-1} = 66666) treated plots. The results obtained with other treatments showed intermediate results compared to highest and lowest 1000 seed weight. The results obtained from the study could be compared as of the report of Sarkar and Banik (2002).

4.3.1.2 Seed yield (t/ha)

Seed yield of was significantly influenced by population densities of sesame (Table 12). In the case of P_1 (Plants ha^{-1} = 66666), the highest seed yield was 0.94 t/ha, which was closely followed by P_2 (Plants ha^{-1} = 33333) and P_3 (Plants ha^{-1} = 22222). On the other hand the lowest seed yield was 0.71 t/ha with P_4 (Plants ha^{-1} = 16666). The seed yield pattern recorded here were found similarity as of the effects of plant population density in sesame reported by Ayyaswamy and Chinnusamy (2005), Kalaiselvan and Subrahmaniyan (2001), Sarkar and Banik (2002) and Avila and Graterol (2005).

4.3.1.3 Stover yield (t/ha)

Stover yield was significantly influenced by population density of sesame (Table 12). The highest stover yield (3.55 t/ha) was found with P_2 (Plants ha^{-1} = 33333), which was closely followed by P_1 (Plants ha^{-1} = 66666), and P_4 (Plants ha^{-1} = 16666). On the other hand, the lowest stover yield was 2.79 t/ha with P_3 (Plants ha^{-1} = 22222).

4.3.1.4 Harvest index (%)

Harvest index was significantly influenced by population density of sesame (Table 12). The densely populated stands P_1, (Plants ha^{-1} = 66666) resulted with the highest harvest index (22.70%), which was closely followed by P_2 (Plants ha^{-1} =33333) and P_3 (Plants ha^{-1} = 22222). The lowest harvest index (21.26%) was found from the plots treated with thinly populated P_4, (Plants ha^{-1} = 16666) plots.

Table 12: Effect on yield and yield contributing characters as influenced by different weeding frequency at different growth stages of sesame

Treatment	Weight of 1000 seeds (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
P_1	2.95 b	0.940 a	3.417 ab	22.70 a
P_2	2.96 b	0.920 ab	3.550 a	21.61 ab
P_3	3.20 a	0.755 ab	2.792 b	22.17 ab
P_4	3.25 a	0.713 b	2.992 ab	21.26 b
$LSD_{0.05}$	0.053	0.197	0.694	1.093
CV(%)	6.89	5.29	4.88	8.91

Here,

Symbol Used		Plants ha^{-1}	Plant to plant distance (cm)
P_1	:	66666	5
P_2	:	33333	10
P_3	:	22222	15
P_4	:	16666	20

4.3.2 Effect of weeding

4.3.2.1 Weight of 1000 seeds (g)

Weight of 1000 seeds was significantly influenced by weeding frequency of sesame (Table 13). It was observed that, the highest 1000 seed weight was 3.19 g with W_3 (Three times weeding) and that of the lowest was found 2.99 g with W_0 (No weeding) situation. The results obtained with other treatments showed intermediate results compared to the highest and lowest 1000 seed weight.

4.3.2.2 Seed yield (t/ha)

Seed yield was significantly influenced by weeding frequency of sesame (Table 13). The highest seed yield (0.98 t/ha) was recorded with W_3 (Three times weeding). The lowest seed yield (0.74t/ha) was found with W_0 (No weeding). The results obtained with other treatments showed intermediate results compared to highest and lowest seed yield. Similar result was obtained with Singh (2001).

4.3.2.3 Stover yield (t/ha)

Stover yield was significantly influenced by weeding frequency of sesame (Table 13). It was revealed that the highest stover yield was 3.43 t/ha with W_1 (One time weeding) . On the other hand the lowest stover yield was 2.99 t/ha with W_2 (Two times weeding) which was statistically similar with W_3 (Three times weeding).

4.3.2.4 Harvest index (%)

Harvest index was significantly influenced by weeding frequency of sesame (Table 13). In the case of W_3 (Three times weeding), the highest harvest index was 25.16%. The lowest harvest index was found 19.60% with W_0 (No weeding), which was statistically identical with W_1 (One time weeding).

Table 13: Effect on yield and yield contributing characters influenced by different weeding frequency at different growth stages of sesame

Treatment	Weight of 1000 seeds (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
W_0	2.99 c	0.74 c	3.25 b	19.60 c
W_1	3.08 b	0.81 b	3.43 a	20.41 c
W_2	3.10 b	0.79 bc	2.99 c	22.56 b
W_3	3.19 a	0.98 a	3.08 c	25.16 a
$LSD_{0.05}$	0.034	0.065	0.099	1.089
CV(%)	6.89	5.29	4.88	8.91

Here,

W_0	:	No weeding (control)
W_1	:	One time weeding on 10 Days After Emergence
W_2	:	Two times weeding on 10 and 20 Days After Emergence
W_3	:	Three times weeding on10, 20 and 30 Days After Emergence

4.3.3 Interaction effect of population density and weeding frequency

4.3.3.1 Weight of 1000 seeds (g)

Significant variation was observed on 1000 seed weight influenced by interaction effect of population density and weeding frequency (Table 14). It was showed that, the highest 1000 seed weight was 3.86 g with P_4W_3. The lowest 1000 seed weight 2.55 g was obtained in P_1W_0 (Two times weeding). The results obtained with other treatments showed significantly different results compared to highest and lowest 1000 seed weight. Similar findings were initiated by Udom *et al*. (2009) and Om-Prakash, and Singh (2001).

4.3.3.2 Seed yield (t/ha)

Significant variation was observed on seed yield influenced by interaction effect of population density and weeding frequency (Table 14). It was revealed that, the highest seed yield was 1.12 t/ha with P_1W_3 (Population Density = 66666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence). On the other hand the lowest seed yield was 0.55 t/ha with P_4W_0 (Population Density = 16666 Plants ha^{-1} and No weeding). The results obtained with other treatments showed significantly different results compared to highest and lowest seed yield. The result under the present study was similar with Om-Prakash, and Singh (2001) and Udom *et al*. (2009).

4.3.3.3 Stover yield (t/ha)

Significant variation was observed on stover yield as influenced by the interaction effect of population density and weeding frequency (Table 14). It was found that the highest stover yield (4.37 t/ha) was recorded with P_1W_0 (Population Density = 66666 Plants ha^{-1} and No weeding), which was closely followed by P_3W_1 (Population Density = 22222 Plants ha^{-1} and One time weeding at 10 Days After Emergence). The lowest stover yield (2.47 t/ha) was found with P_3W_0 (Population Density = 22222 Plants ha^{-1} and No weeding), which was statistically similar with P_2W_0 (Population Density = 33333 Plants ha^{-1} and No weeding). The results obtained with other treatments showed significantly different results compared to highest and lowest stover yield. The result under the present study was identical with Om-Prakash and Singh (2001).

4.3.3.4 Harvest index (%)

Significant variation was observed on the harvest index (%) as of combined effect of population density and weeding frequency in sesame (Table 14). In the case of P_1W_3 (Population Density = 66666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence), the highest harvest index was 26.81%, which was statistically similar with P_1W_2, P_3W_0 and P_3W_3. On the other hand the lowest harvest index (17.13%) was found with P_4W_0 (Population Density = 16666 Plants ha^{-1} and No weeding), which showed identical value with P_3W_1 (Population Density = 22222 Plants ha^{-1} and One time weeding at 10 Days After Emergence). The results obtained with other treatments showed significantly different results compared to highest and lowest harvest index. The result under the present study was initiated by Om-Prakash, and Singh (2001).

Table 14: Interaction effect of population density and weeding frequency on yield and yield contributing characters of sesame

Treatment	Weight of 1000 seeds (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
P_1W_0	2.55 i	0.98 bc	4.37 a	20.70 bc
P_1W_1	3.22 de	0.74 ef	3.13 c-e	20.27 bc
P_1W_2	3.21 de	0.98 bc	3.03 c-e	25.35 a
P_1W_3	2.84 f	1.12 a	3.13 c-e	26.81 a
P_2W_0	3.59 b	0.58 gh	2.60 fg	19.31 cd
P_2W_1	3.11 e	0.82 de	3.10 c-e	22.34 b
P_2W_2	2.85 f	0.67 fg	3.00 c-e	21.54 bc
P_2W_3	3.39 c	1.02 ab	3.80 b	21.91 b
P_3W_0	2.65 hi	0.78 d-f	2.47 g	25.48 a
P_3W_1	3.14 e	0.89 cd	4.10 ab	17.91 d
P_3W_2	3.26 d	0.74 ef	3.13 c-e	21.22 bc
P_3W_3	3.48 c	0.99 bc	2.93 d-f	26.43 a
P_4W_0	2.69 gh	0.55 h	2.77 e-g	17.13 d
P_4W_1	2.76 fg	0.79 de	3.37 c	21.13 bc
P_4W_2	2.86 f	0.80 de	2.80 e-g	22.14 b
P_4W_3	3.86 a	0.86 d	3.27 cd	21.26 bc
$LSD_{0.05}$	0.106	0.106	0.346	2.181
CV(%)	6.89	5.29	4.88	8.91

4.4 Weeding effects on weed growth

Four weeding regimes were chosen to observe the effects on weed growth and yield of sesame. However, significant variation was observed on dry matter yield of weed depending upon the treatments of our study (Fig. 5). The highest dry weed biomass (152.15 g/6m^2) was recorded with three weeding and that of the lowest (27.55 g/6m^2) was with plots weeded once. It was also found that weeding frequency decreased weed population per plot, which helped maximizing crop yield. The lower weeding frequency resulted with reduced yield of sesame.

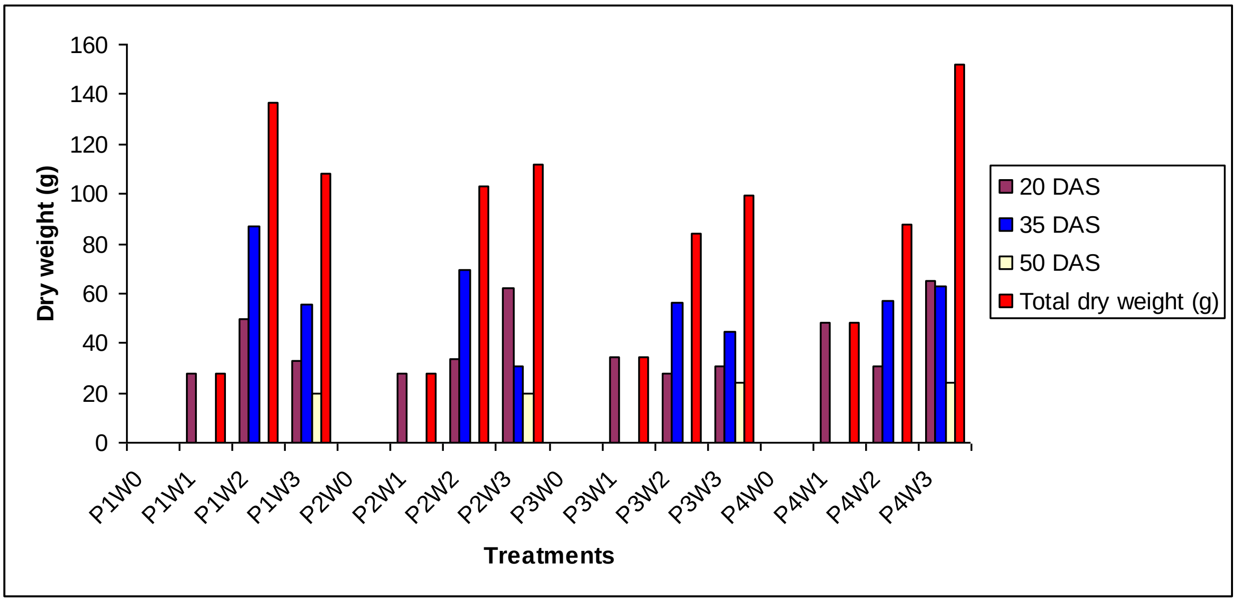

Figure 5. Dry weight of weed at different days after sowing as per treatment

Chapter V

Summary and Conclusion

Chapter 5

Summary and conclusion

The experiment was conducted at the Agronomy field at Sher-e-Bangla Agricultural University, Dhaka during the period from March 2009 to June 2009 to study the effect of weeding frequency and population density on the growth and yield of sesame *(Sesamum indicum* L.).The experiment was conducted in a Randomized Complete Block Design (RCBD) with 3 replications.

The factors considered for the experiment were (i) population density (four plant densities) and (ii) weeding frequency (four weeding frequencies). The population densities were created by maintaining 5, 10, 15 and 20cm plant to plant distances. Weeding frequencies were practiced by no weeding (control), one time weeding at 10 Days After Emergence, two times weeding at 10 and 20 Days After Emergence and three times weeding at 10, 20 and 30 Days After Emergence. Results showed that the population densities and weeding frequencies and their interactions have significant effect on different growth and yield parameters.

The growth parameters; plant height, number of leaves/plant, number of branches/plant and dry weight/plant were significantly influenced by different population densities under the present study. It was observed that the highest plant height was obtained with lower plant densities. The population density, 33333 Plants ha^{-1}, (plant to plant distance = 10 cm) showed the highest plant height (129.60 cm) at harvest where the lowest (121.50 cm) was with the population density (22222 Plants ha^{-1}) of plant to plant distance = 15 cm at harvest.

In the case of number of leaves/plant, number of branches/plant and dry weight/plant at harvest respectively the highest results (28.22, 7.13 and 22.30 g respectively) were obtained with the highest plant from population density of 16666 Plants ha^{-1} with plant to plant distance = 20 cm, where the lowest (22.46, 4.03 and 18.00 g respectively) were obtained with lowest plant from population density of 66666 Plants ha^{-1} with plant to plant distance = 5 cm.

Yield and yield contributing parameters; number of effective capsule/plant, 1000 seed weight, grain yield, stover yield and harvest index were also very much influenced by different plant densities under the present study. In the case of number of effective capsule/plant and 1000 seed weight respectively, the highest results (111.60 and 3.25 g respectively) were obtained with the highest plant from population density of 16666 Plants ha^{-1} with plant to plant distance = 20 cm, where the lowest (82.17 and 2.95 g respectively) were obtained with lowest plant from population density of 66666 Plants ha^{-1} with plant to plant distance = 5 cm under the present study. The highest seed yield and harvest index; 0.94 and 22.70% respectively were obtained with the highest population density (Plants ha^{-1}= 66666) but the lowest (0.713 t/ha and 21.26%) were obtained with the lowest population density (Plants ha^{-1}= 16666). In case of stover yield, the highest and lowest results (3.55 and 2.79 t/ha respectively) were obtained from population density of 33333 and 22222 Plants ha^{-1} with plant to plant distance 10 and 15 cm respectively.

The growth parameters; plant height, number of leaves/plant, number of branches/plant and dry weight/plant were significantly influenced by different weeding frequencies under the present study. The highest plant height, number of branches/plant and dry weight/plant (127.10 cm, 6.33 and 23.63 g respectively) were obtained with highest weeding frequency (three times weeding 10, 20 and 30 Days After Emergence) where the lowest (119.90 cm, 4.81 and 17.52 g respectively) were obtained with no weeding frequency.

Yield and yield contributing parameters; number of effective capsule/plant, 1000 seed weight, grain yield, stover yield and harvest index were also very much influenced by different weeding frequency under the present study. Number of effective capsule/plant, 1000 seed weight, grain yield and harvest index respectively, the highest results (109.60, 3.19 g, 0.98 t/ha and 25.16% respectively) were also obtained with the highest weeding frequency (three times weeding 10, 20 and 30 Days After Emergence) where the lowest (81.72, 2.99 g, 0.74 t/ha and 19.60% respectively) were obtained with no weeding frequency. But in the case of stover yield the highest and lowest results (3.42 and 2.99 t/ha) were obtained with one time weeding (10 Days After Emergence) and two times weeding (10 and 20 Days After Emergence) respectively.

The growth parameters; plant height, number of leaves/plant, number of branches/plant and dry weight/plant were significantly influenced by combined effect of different population densities and weeding frequencies under the present study. The highest plant height (136.90 cm) was obtained with the combined effect of P_2W_3 (Population Density = 33333 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence) and the lowest plant height (109.50 cm) was obtained with the combined effect of P_3W_0 (Population Density = 22222 Plants $ha^{-1}$and No weeding). But in the case of highest number of leaves/plant (31.80), number of branches/plant (8.30) and dry weight/plant (26.93 g) were obtained with the combined effect of P_4W_3 (Population Density = 16666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence) where the lowest were (20.93, 3.00 and 14.45 g respectively) with the combined effect of P_1W_0 (Population Density = 66666 Plants $ha^{-1}$and No Weeding).

Yield and yield contributing parameters; number of effective capsule/plant, number of seeds/capsule, 1000 seed weight, grain yield, stover yield and harvest index were also significantly influenced by combined effect of different population densities and weeding frequencies under the present study. The highest number of effective capsule/plant, number of seeds/capsule and 1000 seed weight (146.8, 79.20 and 3.86 g respectively) were obtained with the combined effect of P_4W_3 (Population Density = 16666 Plants $ha^{-1}$and Three times weeding at 10, 20 and 30 Days After Emergence) where the lowest were (66.93, 72.91 and 2.55 g respectively) with the combined effect of P_1W_0 (Population Density = 66666 Plants ha^{-1} and No Weeding). But in the case of highest grain yield and harvest index (1.12 t/ha and 26.81% respectively) were obtained with the combined effect of P_1W_3 (Population Density = 66666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence) where the lowest were (0.55 t/ha and 17.13% respectively) with the combined effect of P_4W_0 (Population Density = 16666 Plants $ha^{-1}$and No Weeding). Again with the deliberation of stover yield, the highest and lowest results (4.37 and 2.47 t/ha respectively) were obtained with the combined effect of P_1W_0 (Population Density = 66666 Plants ha^{-1} and No Weeding) and P_3W_0 (Population Density = 22222 Plants ha^{-1} and Three times weeding (10, 20 and 30 Days After Emergence).

The crop growth rate, yield and yield contributing characters of sesame had significant influence against dry weed biomass. Results showed that highest dry weed biomass (152.15 g) was obtained with P_4W_3 (Population Density = 16666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence) where the lowest was (27.55 g) with P_1W_1 (Population Density = 66666 Plants ha^{-1} and one weeding at10 Days After Emergence). The result obtained in the case of first weeding showed that higher population density causing lower weeding infestation and from this point of view P_1W_1 (Population Density = 66666 Plants ha^{-1} and one weeding at10 Days After Emergence) showed the lowest weed infestation (27.55 g) where the highest was (65.17 g) with P_4W_3 (Population Density = 16666 Plants ha^{-1} and Three times weeding at 10, 20 and 30 Days After Emergence).

Thus the results obtained exhibited that the results from all the treatments were not encouraging in respect of growth, yield and yield contributing characters of sesame. Considering the performance of all population densities and weeding frequency under the present study to achieve the higher performance on yield, Population Density of 66666 Plants ha^{-1} (plant to plant distance = 5 cm) and three times of weeding (10, 20 and 30 Days After Emergence) is a better approach for sesame production.

References

References

Adigun, M, Shamdane, G. and Ahmed, S. (1994). Effect of time of weeding and plants density on the growth and yield of blackgram. *Bangladesh J. Agric. Res*. p. 162.

Ahmed, S. (1982). Effect of time of weeding and plant density on the growth and yield of sesame. *Bangladesh J. Agric. Res.* **12**(1): 19-22.

Anyanga, W.O. and Obong, Y.Y. 2001. Sesame (*Sesamum indicum* L.) In: J.K. Mukiibi (ed.) Agriculture in Uganda. **11,** 97-102.

Asghar, A., Asif, T., Nadeem, M.A. and Bajwa, A.L. (2009). Effect of sowing dates and row spacings on growth and yield of sesame. Faisalabad, Pakistan: Directorate of Agricultural Information, Ayub Agricultural Research Institute. *J. Agric. Res.* Lahore. **43**(1): 19-26.

Auwalu, B.M. (1995). Influence of some agronomic practices on the growth and yield of vegetable sesame (*Sesamum radiatum*, Schum.). *Advances-in-Horticultural-Science.* **9**(1): 33-36.

Avila, J.M. and Graterol, Y.E. (2005). Planting date, row spacing and fertilizer effects on growth and yield of sesame (*Sesamum indicum* L.). Barquisimeto, Venezuela: Decanato de Agronomia, Universidad Centroccidental 'Lisandro Alvarado'. Bioagro. **17**(1): 35-40.

Ayyaswamy, M. and Chinnusamy, C. (2005). Effect of irrigation regimes, comrade cropping and soil amendments on the yield and economics of cassava, groundnut and sesame. *Madras Agric. J.* **83**(6): 338-341.

Babu, K. S. and Mitra, S. K. (1989). Effect of plant density on grain yield of blackgram during Rabi season. *Madras Agric. J*. **76**: 290-292.

Bangladesh Bureau of Statistics (BBS). (2008). Statistical Year Book of Bangladesh. Statistics Division. Ministry of Planning. Government of the Peoples Republic of Bangladesh. Dhaka.

BARI (1994). Bangladesh Agricultural Research Institute. Annual Report for 1994. Bangladesh Agril. Res. Inst., Joydebpur, Gazipur.

Basavarajappa, R. and Prabhakar, A.S. (2006). Effect of planting geometry and plant density on yield performance of foxtail millet based intercropping systems under red soils of transitional tract. Dharwad, India: University of Agricultural Sciences. Karnataka-Journal-of-Agricultural-Sciences. **15**(3): 450-456.

Basavarajappa, R. and Prabhakar, A.S. (2006). Effect of planting geometry and plant density on yield performance of foxtail millet based intercropping systems under red soils of transitional tract. Dharwad, India: University of Agricultural Sciences. *Karnataka J. Agric. Sci*. **15**(3): 450-456.

Baskaran, R. and Solaimalai, A. (2002). Hisar, India: Gaurav Society of Agricultural Research Information Centre. *Research-on-Crops*. **3**(1): 32-36.

Boydak, E. and Kavak, H. (2007). The effects of drip and sprinkler irrigation methods on weed density and yield in sesame plantation in Sanlurfa conditions (GAP). Erzurum, Turkey: Ataturk Universitesi Ziraat Fakultesi. Ziraat-Fakultesi-Dergisi,-Ataturk-Universitesi. **33**(2): 189-191.

Cakmakc, S. and Aydnoglu, B. (2002). The effects of different row spaces and fertilizer dosages on forage yield of chickling vetch (*Lathyrus sativus* L.) in the Mediterranean coastal region. Antalya, Turkey: Akdeniz Universitesi, Ziraat Fakultesi. Ziraat-Fakultesi-Dergisi,-Akdeniz-Universitesi. **5**(1): 95-99.

E.A. Weiss (1983). Oil Seed Crops. Longman Inc. New York.

El-Ouesni, F.E.M., Gaweesh, S.S.M. and Abd-El-Haleen, A.K. (2007). Effect of plant population density, weed control and nitrogen level on associated weeds, growth and yield of sesame plant(s). Bulletin-of-Faculty-of-Agriculture,-University-of-Cairo. **45**(2): 371-388.

Gercek, S., Boydak, E. and Simsek, M. (2007). Effect of irrigation methods and row spacing on yield and yield components of sesame [*Sesamum indicum* (L.)]. Faisalabad, Pakistan: ANSInet, Asian Network for Scientific Information. *Pakistan J. Bio. Sci*. **7**(12): 2149-2154.

Hashem, M. (1991). Effect of time of weeding and plant density on the growth and yield of mungbean. *Bangladesh J. Agric. Res.* **16**(2): 19-22.

Hill, A.L. (1972). Crop Production in Dry Regions. Vol. 2, Int. Textbook Co. Ltd. London. pp. 381-386.

Islaam, M. A., Mamun A. A., Bhuiyan, M. S. U. and Hossain, S. M. A. (1989). Weed biomass and grain yield in wheat as affected by seed rate and duration of weed competition. *Bangladesh J. Agric*. **14**: 213-224.

Kalaiselvan, P. and Subrahmaniyan, K. (2001). Plant density effect on the growth and yield of sesame - a review. Karnal, India: Agricultural Research Communication Centre. Agricultural-Reviews. **22**(1): 52-56.

Khidir (1997). Oil Seed Crops in the Sudan. Khartoum University press, Khrtoum, Sudan.

Krishna, M.H., Reddy, A.P.K., Obulamma, U. and Kumari, C.R. (2008). Crop geometry and intercropping on growth, yield attributes and yield of sesame and greengram. Hyderabad, India: Acharya N G Ranga Agricultural University. *J. Res. ANGRAU*. **32**(4): 1-4.

Malik, N.A. and Muhammad, R. (2004). Effect of herbicides and cultural operations on weed control and grain yield in sesame. *J. Agric. Res. Lahore*. **30**(1): 147-152.

Meylemans, B., Sangakkara, U. R. and Damme, P. (1994). Critical period of weed competition for black gram (*Vigna mungo*) in Sri Lanka. Faculty of Agriculture and Applied Biological Sciences, University of Gent, Belgium. **59**(3b): 1351-1360.

Nantongo, S. (2002). Effect of spatial arrangement and plant population on growth and yield of simsim (*Sesamum indicum*) in pure stands and in mixtures with finger millet (*Eleusine coracana*). M.Sc. Thesis, Makerere University.

Om-Prakash, and Singh, P.K. (2001). Effect of weed-control measures and nitrogen fertilization on yield and yield attributes of sesame (*Sesamum indicum*) under rainfed condition. New Delhi, India: Indian Council of Agricultural Research. Indian-Journal-of-Agricultural-Sciences. **71**(9): 610-612.

Patil, A.B. (2000). Influence of nitrogen levels and spacings on grain yield of sesamum. *J. Maharashtra Agric. Univ*. **21**(3): 368-369.

Raghuwanshi, R.S. (2009). Effect of sowing dates and plant densities on seed yield of sesame cultivars. *Crop-Res. Hisar*. **8**(2): 404-406.

Ramulu, V. and Gautam, R.C. (1999). Evaluation of pearlmillet intercropping for yield and resource utilization under rainfed conditions. Annals-of-Agricultural-Research. **20**(2): 240-242.

Rahman, M. M., Maula, M. G., Begum, S. and Hossain, M. A. (1994). Maximization of yield sesame through management practices. Central Annual Research, BARI, Joydebpur, Gazzipur. pp. 53-56.

Kaul, A. K. and Das, M. L. (1986). Oilseeds in Bangladesh. Pub: Bangladesh, Canada Agric See. Team. Ministry of Agril. Govt. of the People's Republic of Bangladesh, Dhaka. pp. 69.

Chatterjee, R. and Mondal, B. (1983). Principles of crop production. West Bengal State Book Board. p. 89.

BARI (Bangladesh Agricultural Research Institute) (1998). Til Fasalar Chass. Bangladesh Agricultural Research Institute, Joydebpur, Gazipur. pp. 30-31.

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*). New Delhi, India: Indian Council of Agricultural Research. *Indian J. Agric. Sci.* **72**(2): 70-73.

Ssekabembe, C. K., Osiru, D. S. O., Ogenga-Latigo, M. W., Nantongo, S. and Okidi, J. 2001. Some aspects of simsim production in northern and eastern Uganda. African Crop Science Conference Proceedings **5,** 689-697.

Singh, P.K. (2001). Studies on the effect of N-fertilization and weed control techniques on weed suppression, yield and nutrients uptake in sesame (*Sesamum indicum*). Hisar, India: Indian Society of Weed Science. *Indian J. Weed Sci.* **33**(3/4): 139-142.

Sootrakar, B.P. (2005). Effect of weed control methods on weed growth and yield of sesame (*Sesamum indicum*) varieties. *Crop Res. Hisar*. **9**(1): 16-21.

Thenua, O.V.S. (1999). Effect of subabul (*Leucaena leucocephala*) canopy on yield, quality and nitrogen uptake of clusterbean (*Cyamopsis tetragonoloba*) and sesame (*Sesamum indicum*) under agro-silviculture system. Indian-Journal-of-Agronomy. **44**(1): 68-72.

Udom, G.N., Fagam, A.S. and Ekwere, E. (2009). Effect of plant-row spacing and weeding frequency on the yield performance of sesame. *Emir. J. Agric. Sci*. **18** (2): 52-60.

Venkatakrishnan, (2006). Effect of dryland technologies on the yield of sesame under rainfed condition. *Madras Agric. J*. **83**(1): 51-53.

Venkatakrishnan, A.S. (1998). Effect of dryland technologies on yield of sesame (*Sesamum indicum*) under rainfed condition. *Indian J. Agron*. **43**(1): 154-157.

Vieira, D.J. (2004). Growth analysis of sesame in Cariris Velhos, Paraiba: effect of cultivars and spacing.Comunicado-Tecnico-Centro-Nacional-de-Pesquisa-de-Algodao. **56**: 7.

Yadav, M.R. (2002). Studies on the effect of dinitroaniline herbicides on the control of weeds, growth and yield of sesame (*Sesamum indicum* L.). Hisar, India: Agri Bio Research Publishers. Annals-of-Agri-Bio-Research. **7**(2): 157-160.

Zewdie, K. (2005). Importance of yield limiting factors on sesame under irrigation at Werer. IAR-Newsletter-of-Agricultural-Research. **11**(2): 6.

References

Appendices

Appendix I. Monthly average air temperature, relative humidity and total rainfall of the experimental site during the period from March 2009 to July 2009

Month	RH (%)	Max. Temp. (ºC)	Min. Temp. (ºC)	Rain fall (mm)
February	50.31	29.50	18.49	0
March	44.95	33.80	20.28	0
April	60.28	34.00	22.89	200
May	65.05	35.00	25.00	190
June	66.44	31.50	24.25	186

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix II. Physiochemical properties of the initial soil

Characteristics	**Value**	**Critical value**
Particle size analysis.		
% Sand	26	…..
% Silt	45	…..
% Clay	29	…...
Textural class	silty-clay	…...
pH	5.6	acidic
Organic carbon (%)	0.45	…...
Organic matter (%)	0.78	…...
Total N (%)	0.03	0.12
Available P (ppm)	20.00	27.12
Exchangeable K (me/100 g soil)	0.10	0.12
Available S (ppm)	45	…...

Appendix III: Effect on plant height influenced by different plant density at different growth stages of sesame

Source of variations	Degrees of freedom	Mean spuare		
		Plant height (cm)		
		30 DAS	60 DAS	At harvest
Replication	2	1.440	99.429	36.068
Factor A	3	257.41*	87.002*	172.999*
Factor B	3	28.217*	37.895*	136.983*
AB	9	77.389*	92.921*	153.284*
Error	30	1.699	3.384	2.049

Appendix IV: Effect on number of leaves/plant influenced by different plant density at different growth stages of sesame

Source of variations	Degrees of freedom	Mean spuare		
		Number of leaves/plant		
		30 DAS	60 DAS	At harvest
Replication	2	0.445	8.803	5.731
Factor A	3	NS	57.443*	84.757*
Factor B	3	NS	NS	NS
AB	9	NS	17.873*	25.992*
Error	30	0.479	1.892	1.896

Appendix V: Effect on number of branches/plant influenced by different plant density at different growth stages of sesame

Source of variations	Degrees of freedom	Mean spuare		
		Number of branches/plant		
		30 DAS	60 DAS	At harvest
Replication	2	0.785	0.394	0.206
Factor A	3	4.294*	4.983*	21.943*
Factor B	3	3.058*	4.641*	5.522*
AB	9	4.915*	4.336*	4.035*
Error	30	0.459	0.428	0.400

Appendix VI: Effect on dry weight/plant influenced by different plant density at different growth stages of sesame

Source of variations	Degrees of freedom	Mean spuare		
		Dry weight/plant		
		30 DAS	60 DAS	At harvest
Replication	2	0.011	0.011	0.015
Factor A	3	1.173**	25.240*	40.682*
Factor B	3	0.573**	56.900*	84.894*
AB	9	0.407**	12.966*	20.835*
Error	30	0.002	0.001	0.018

Appendix VII: Effect on yield parameters influenced by different plant density at different growth stages of sesame

Source of variations	Degrees of freedom	Mean spuare		
		Number of effective capsules/plant	Number of non-effective capsules/plant	Number of seeds/capsule
Replication	2	1937.122	0.293	38.665
Factor A	3	1943.952*	NS	NS
Factor B	3	1558.646*	NS	NS
AB	9	830.354*	NS	10.670*
Error	30	6.230	0.420	0.820

Appendix VIII: Effect on yield and yield contributing characters influenced by different weeding frequency at different growth stages of sesame

Source of variations	Degrees of freedom	Mean spuare			
		Weight of 1000 seeds (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
Replication	2	0.398	0.050	0.424	69.939
Factor A	3	0.285*	0.159*	1.516*	4.767*
Factor B	3	0.083*	0.122*	0.438*	74.172*
AB	9	0.571**	0.035*	0.672*	13.903*
Error	30	0.236	0.056	0.693	1.710