INFLUENCE OF WEEDING ON GROWTH AND YIELD OF RAPESEED VARIETIES

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CERTIFICATE

This is to certify that the thesis entitled "INFLUENCE OF WEEDING ON GROWTH AND YIELD OF RAPESEED VARIETIES" submitted to the Department of Agronomy, Sher-e-Bangla Aricultural University, Dhaka, in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in AGRONOMY, embodies the result of a piece of bona fide research work carried out by Lalita Rani Roy, Registration No. 27470/00669 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: 28/6/07

Place: Dhaka, Bangladesh

(Prof. Dr. Parimal Kanti Biswas)
Supervisor

Dedicated To
My
Beloved Parents

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The Author

INFLUENCE OF WEEDING ON GROWTH AND YIELD OF RAPESEED VARIETIES

ABSTRACT

The field experiment was conducted at the Agronomy Field of Sher-e- Bangla Agricultural University (SAU), Dhaka in the Rabi season (November-February) of 2006-2007 to study the influence of variety and number of weeding on the growth and yield of rapeseed. The treatment comprised of three varieties and four levels of weeding. Different varieties were Improved Tori-7, BARI sarisha-12 and SAU sarisha-1. The weeding treatments were no weeding, one weeding at 20 DAS, two weedings at 20 and 30 DAS and three weedings at 20, 30 and 40 DAS. The experiment was laid out in a Randomized Complete Block Design (RCBD) (factorial) with three replications. The seed yield of mustard varied with varietal difference along with different weeding intervals. The growth behaviour of the three studied varieties were different and hence weeding recommendation also varied. The variety SAU sarisha-1 showed the highest yield (1.57 t ha^{-1}) response with one weeding that followed by the same variety with two weedings (1.55 t ha^{-1}) but BARI sarisha-12 responded better with two weedings. No weeding was needed for Improved Tori-7 probably due to its earlier better growth coverage.

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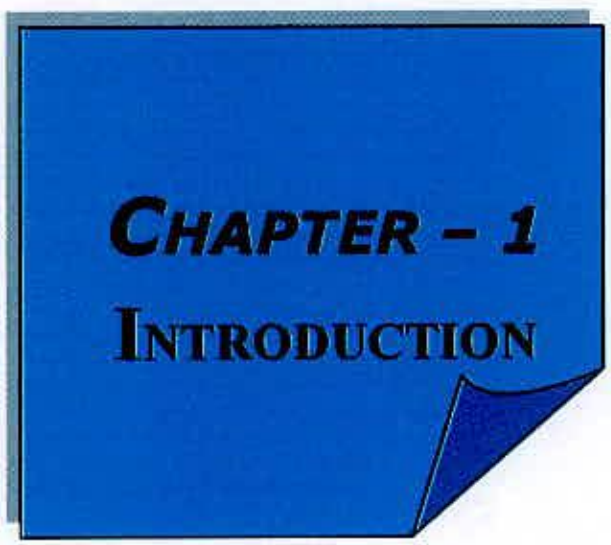
LIST OF ACRONYMS

AEZ	Agro Ecological Zone
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
C.V.	Coefficient of Variation
cv.	Cultivar
DAS	Days after sowing
E	East
et al.	*et alibi* (and others)
etc.	*et cetra* (and so on)
FAO	Food and Agriculture Organization
Fig.	Figure
HI	Harvest index
HYV	High yielding variety
i.e.	id est (that is)
LSD	Least significant difference
N	North, Nitrogen
SAU	Sher-e-Bangla Agricultural University
%	Percentage
^{0}C	Degree Celsius
cm	Centimeter
g	Gram
ha	Hectare
kg	Kilogram
m	Meter
t	Ton


CHAPTER – 1
INTRODUCTION

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INTRODUCTION

Rapeseed/mustard is one of the most important and widely grown oilseed crops of Bangladesh. Rapeseed/mustard belongs to genus *Brassica* under the family Cruciferae and is one of the important oil seed crop and currently ranked as the world's third important oil crop in terms of production and area. Worldwide the total annual production of *Brassica* is 44.41million tons of seed from an area of 27.24 million hectares (FAO, 2004).

Rapeseed/mustard has got several cultivated species, viz. *Brassica campestris* L., *Brassica juncea* L. Czern and *Brassica napus* L. In Bangladesh, oil crops occupy only 0.561million hectare out of total cropped area of 13.53 million hectare which is about 4.2% of the total cropped area and contribute to about 1.6% of total grain production of the country (BARI, 2002). Rapeseed/mustard occupies only 0.336 million hectare, which is 60% of total oil cropped area (Wahhab *et al*., 2002). The major reasons for low yield of rapeseed/mustard in our country are due to lack of high yielding variety, inappropriate sowing time and proper management etc.

Domestic production of edible oil almost entirely comes from rapeseed and mustard. The annual oil seed production is 376000 metric tons of which rapeseed covers 62% of the total edible oil (MOA, 2006). Edible oils play a vital role in human nutrition. As a high energy component of food, edible oil is important for meeting the caloric requirement. Each gram oil /fat supplies 9 kilocalorie energy while each gram of carbohydrate/ protein furnishes 4 kilocalorie (Stryer, 1980). It

is not only a high energy food but also a carrier of fat soluble vitamin D, E and K in the body. On the nutritional point of view at least 15-20% calorie come from the fats and oils. It is also important for improving the taste of a number of food items. It also serves as an important raw material for industrial use such as soaps, varnishes, hair oils, lubricants, textile auxiliaries, pharmaceuticals etc. Rapeseed oilcake is used as feed for cattle, fish and also as good manure for crops.

According to the National Nutrition Council (NNC) of Bangladesh, the recommended dietary allowance (RDA) is estimated to be 11 g oil per capita per day for a diet with 2700 kcal. On the basis of RDA, Bangladesh requires 0.29 million tons of oil to meet the demand of her people (FAO, 1998). One-third of the total requirement of oil is meeting by local production of rapeseed and mustard. The average seed yield of rapeseed and mustard is 0.71 t ha^{-1} in this country (BBS, 2004), which is far below the level as compared to that of the advanced countries like Belgium (4.7 t ha^{-1}), Denmark (3.6 t ha^{-1}), France (3.54 t ha^{-1}), Netherlands (3.47 t ha^{-1}), U.K. (2.89 t ha^{-1}), Germany (2.80 t ha^{-1}), Japan (2.16 t ha^{-1}) and Poland (1.86 t ha^{-1}), according to the statistics of FAO (2001).

Bangladesh Agricultural Research Institute (BARI), Bangladesh Agriculture University (BAU), Bangladesh Institute of Nuclear Agriculture (BINA) and Sher-e-Bangla Agricultural University (SAU) have released a number of new high yielding varieties of rapeseed/mustard for farmers' cultivation. The yield of HYV cultivars ranges from 1.4 to 2.1 t ha^{-1} (BARI, 2002). However, the yields in

farmers' fields are very low due to poor management along with using local varieties. A wide range of variations observed among the released varieties in respect of their growth, yield and quality.

Yield of rapeseed is hampered by different pests, among them weed as an important factor in reducing yield. Weeds affect the plant growth, yield and quality of rapeseed. *Brassica* oil crops are sensitive to weeds competition, particularly in the early stages of growth. It was observed that if weed was not properly controlled the yield reduced by 46% as well as quality deteriorated (Dixit and Gautam, 1996). Two hand weeding at 25 and 40 days after seeding (DAS) resulted in higher yield compared to that of weed infested plots i.e. control (Kaul and Das, 1986). *Brassica* oil crops are sensitive to weed, particularly in the early stages of growth. Therefore, weed control is very important for this crop in Bangladesh condition.

As rapeseed yield and quality is greatly affected by varieties and number of weeding hence, the present study was undertaken with the following objectives:

1. to compare the yield performance of three varieties,
2. to determine the optimum number of weeding for maximum yield of rapeseed , and
3. to study the yield of rapeseed varieties with different weed treatments.

CHAPTER – 2

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Rapeseed is an important oil crop of Bangladesh which contribute to a large extent in the national economy. But the research works done on this crop with respect to agronomic practices are inadequate. Its growth and yield are determined by various factors of which weed is one of the most important. A very little work has been done involving the weed competition with the mustard/rapeseed varieties. Some of the work pertinent to the present study has been reviewed below:

Effect of weeding

Competition of mustard with weed

Donovan and Sharma (1994) conducted an experiment on oilseed crops and reported that factors associated with crop losses due to weeds. They found that the yield loss generally increased with increasing wild oat population. Crop quality was reduced due to weeds.

In another experiment Ambast and Chakhaiyar (1984) studied the effect of weeding and weed free conditions on the growth and yield of mustard (*Brassica juncea*). They found that the maximum reduction in seed yield due to weed occurred between 20 and 40 days of growth in mustard.

Wahmhoff (1990) conducted an experiment on weed control in winter rape and concluded that rape yields were affected more by climatic factors, local site conditions, crop cover and the composition of the weed population than the total weed cover.

The competition effect of some weed species on the yield of winter oilseed rape was studied by Adoezewski (1991). In 7 years trials he observed that in oilseed rape at winnagora, Anthamis arvensis as a competitive weed. He also found large infestations causing up to 50% yield reduction.

Kandap *et al.* (1982) investigated on the competitive ability of certain crops against purple nutsedge (*Cyperus rotundus*) and observed that the grain yield of different crops under weed free and purple nutsedge weedy check treatments differed significantly. The competition from purple nutsedge weedy check treatments differed significantly. The competition from purple nutsedge caused yield reduction in maize (6.12%) followed by blackgram (23.45%), groundnut (31.72%) and soybean (57.85%).

Chemale and Fleck (1984) conducted an experiment on soybean cultivars in competition with *Euphorbia heterophylla*. They observed that soybean seed yield was reduced by weed competition. They also observed that the number of pods and seeds decreased with increasing weed density. The number of branches was reduced after 75 days of crop-weed competition.

Ali (1994) studied crop weed competition in various crop including mustard. He conducted an experiment on sandy loam soil to study the nature and magnitude of crop weed competition in intercropped chickpeas cv. Radhey/mustard cv. varuna (4.1 row ratio). The loss of seed yield caused by crop competition with weeds until the time of crop maturity was 34% in mustard.

Ros *et al.* (1986) conducted an experiment on soybean cultivars and found that the nature of competition between soybean and weeds. They concluded that cultivars of later maturity tended to compete more effectively with weeds.

In Cuba, an experiment was conducted by Fundora *et al.* (1994) on the effect of weed incidence on soybean productivity. They found that yield reduction occurred between 60 and 80% when plots were left with grass cover and these were independent of the length of the unweeded period. The presence of weeds on the last 30 d of the plant cycle favoured a general increase on fruit infection indexes. They also reported the necessity of weed control at 30 days after germination for seed production.

Bishnol *et al.* (1994) conducted an experiment of 3 crop varieties on weed competition on cotton. They found that as the number of days of weed maintenance increased seed cotton yields. Weed maintenance increased for 20 days after sowing followed by keeping the plots weed free resulted in the greatest seed cotton yields (2324-2798 kg ha^{-1}) compared to weed control values of 1566-1614 kg. HS45 was the greatest yielding cotton variety (2165-2428 kg) compared to the other varieties (H-777 and H-974) of yielding 1916-2193 and 2056-2384 kg, respectively.

In another experiment Raghvani *et al.* (1985) studied on crop weed competition in mungbean during kharif, from 1979-80 to 1982-83 on medium black soils of junagadh in India. Weed control during this period resulted in higher grain yield

and net monetary return. They observed that there was reduction in the dry weight of weeds with an increase in frequency of weeding. They recorded highest dry weight in control (no weeding) and lowest in weeding done thrice at 15, 30 and 45 DAS. They concluded that delay in weeding resulted in reduction of crop yield.

Weeds of mustard crop

Karim *et al.* (1994) reported most prominent weeds of mustard crop as *Cyperus rotundus, Cynodon dactylon, Paspalum scrobiculatum, Alternanthera sessilis, Panicum repens, Hygrophila polysperma, Plygonum plebjum, Eclipta alba, Digitaria sanguinalis, Leucus aspera, and Alternanthera philoxeroides.*

Ghosh *et al.* (1994) condicted an experiment on weed in mustard in sandy loam soil at Kharagpur, India during 1987-89. The most problematic weeds were *Digitaria sanguinalis. Echinochloa crus-galli, Cyperus rotundus, Cynodon dactylon, Croton sperciflora and Eclipta alba.*

Rujput *et al.* (1994) studied the weed control on mustard. They identified most problematic weeds were *Boerhavia diffusa, Cyperus rotundus, Chenopodium album, Trianthema monogana, Asphodelus tenuifolius, Melilotus indica and Convlvulus arvensis.*

Singh *et al.* (1994) observed that the most problematic weed species of mustard (*Brassica juncea* L. Czern and coss) were *Chenopodium album, Melilotus indica, Avena fatua and Phaseolis minor.*

Weed dry matter

Raghvani *et al.* (1985) studied in crop-weed competition on mungbean during kharif, from 1979-80 to 1982-83 on medium black soils of Junagadh in India. They observed that there was reduction on the dry weight of weeds with an increase in frequency of weeding. They recorded highest dry weight in control (no weeding) and lowest in weeding done thrice at 15, 30, and 45 DAS.

In Faozabad, India, Singh and Singh (1995) conducted trials during the winters of 1985-86 and 1986-87 on the effect of weed control on nutrition uptake by mustard and associated weeds. There were 4 weed control treatments (i.e. hand weeding once 25 days after sowing (DAS), hoeing 25 DAS + hand weeding 35 DAS, application of preem isoproturon at 0.75 kg ha^{-1} and thiolencarb at 10 kg ha^{-1} on nutrient uptake by *Brassica juncea* cv. Karti and associated weeds. All weed control treatments decreased weed DM over control.

Plant height

In an experiment, Gaffer (1984) observed that height of mustard was favorably increased with the spell of weed free periods by hand weeding.

Number of branches per plant

Chemale and Fleck (1984) conducted an experiment on soybean cultivars on competition with *Euphorbia microphylla*. They observed that the number of

branches was reduced after 75 days of crop-weed competition and two hand weeding gave the best result.

In an experiment, Gaffer (1984) observed that primary branches plant^{-1} of mustard were favourably increased with the spell of weed free periods.

Number of siliquae per plant

Chemale and Fleck (1984) conducted an experiment on soybean cultivars on competition with *Euphorbia microphylla.* They observed that the number of pods decreased with increasing weed density.

Yadav *et al.* (1984) observed that siliquae yields of rapeseed were significantly increased by removing weeds at 2, 4, 6 or 8 week after sowing (WAS). Further delayed on weed removal had little effect on production of siliquae.

Number of seeds per siliquae

Chemale and Fleck (1984) conducted an experiment on soybean cultivars on competition with *Euphorbia microphylla*. They observed that the number of seeds pod^{-1} decreased with increasing weed density.

Sarkar and Mondal (1985) observed that weeding at different dates affected some yield contributing characters and yield of different mungbean varieties. One weeding gave maximum number of seeds pod^{-1} on Mubarik and two weeding did identical result

Seed yield

Roebuck and Trennery (1978) conducted an experiment on weed control of winter oilseed rape and observed that effective weed control on the autumn increased the total crop dry weight at the start of flowering by 80-90%.

Kandap *et al.* (1982) investigated the competitive ability of certain crops against purple nutsedge (*Cyperus rotundus*) and observed that the grain yield of different crops under weed free and check treatments differed significantly. The competition from purple nutsedge caused yield reduction in maize (6.12%) followed by blackgram (23.45%), groundnut (31.72%) and soybean (57.85%).

Singh *et al.* (1982) reported that weeding at an interval of 15 days followed by weed infested condition caused a significant yield reduction. Competion after 60 DAT (days after transplanting) had no adverse effect on yield.

In an experiment on weed Hakansson (1984) observed that the yield loss of cereals directly related to weed weight.

Gaffer (1984) observed that the weed free condition produced the maximum seed yield and yield components of rapeseed. He also found that yield reduction was 23.0% in control as compared to weed free plots.

Ambast and Chakhaiyar (1984) observed the effect of weeding and weed free duration on the growth and yield of mustard (*Brassica juncea*). They found that

the maximum reduction on seed yield due to weed infestation between 20 and 40 days of growth on mustard.

Sarkar and Mondal (1985) observed that weeding of different dates affected some yield contributing characters and yield in different varieties of mungbean. Grain yield was reduced by 49 to 55% when weeds were allowed to grow undisturbed.

BARI (1985) studied yield loss due to uncontrolled weed growth on upland crops. The lowest yield reduction for mustard cv. SS-75 was only 12.29%.

Ciriciofola and Bianchi (1985) carried out experiment on cultivation technique of oilseed rape and observed that weed control is required to reduce weed competition at crop emergence and to avoid problems associated with harvest.

Bowerman (1990) studied for controlling weeds in winter oilseed rape and observed that significant yield increase were achieved mainly where level of weed control was high.

In Islamabad, Khan *et al.* (1995) observed that the ratooned rape cv. Wester produced higher seed yield from weed free plots.

Ghosh *et al.* (1994) conducted an experiment on sandy loam at kharagpur on weed control on mustard and reported that all weed control methods increased Indian mustard seed yield over untreated one.

Walker *et al.* (1990) evaluated yield response to weed control in oilseed rape on scotland. They conducted in a total of 16 oilseed rape trials during 1983-89

resulted in an yield increase of 7%. They also concluded that there was no relationship between weed density and yield response.

In Jordan, Qasem and Tell (1995) conducted an experiment on clay loam soils having 7 cultivars of duram wheat in weeded and unweeded condition. Grain and straw yields were greatest in the weeded plot. The maximum 1000 seed weight came from weeding and dependent upon the cultivar.

Effect of variety on different crop characters

Varietal performance of a crop depends on its genetic makeup. There are four species of *Oleiferous Brassica* viz. *B. campestris, B. juncea, B. napus* and *B. carinata*, which differs from one another with respect to crop characters.

Days to maturity

Zakaria and Jahan (1997) reported that the exotic varieties required lowest time to mature compared to the local varieties. AGA-95-21 took maximum time (188 days) to mature which was followed by the varieties Hyola-10 (114 days) and BLU-900 (111 days). The shortest duration variety was Tori-7 (77 days).

Hossain *et al.* (1996) found that the maximum duration maturity on variety was semu DNK-89/218 (118 days) and the lowest duration maturity on variety was Tori-7 (79 days).

Mondal and Islam. (1992) stated that Tori-7 took 72 days to mature, the varieties SS-75 and J-5004 matured 98 days of emergence.

Branches plant^{-1}

BARI (2000) found that under poor management number of branches plant^{-1} was higher in the variety SS-75; lower in the variety BARI sarisha-8. Under medium management, best performance was in Dhali and worst performance was in BARI sarisha-8. Under higher management, highest in Dhali and lowest on Nap-248.

Zakaria and Jahan (1997) found that the local varieties Tori-7 and Sampad produced the highest number of primary branches plant^{-1} (4.07) which was at par with BLN-900. The minimum number of primary branches plant^{-1} (2.90) was found in Jatarai which was identical to those found in Hhole-401 and BARI sarisha-8 varieties. Hossain *et al.* (1996) stated that the varieties were statistically different with respect to number of primary branches per plant.

Plant height

Ahmed *et al.* (1999) stated that the tallest plant (102.56 cm) was recorded on the variety Daulat. No significant difference was observed on plant height between Dhali and Nap-8509.

Ali and Rahaman (1998) observed significant variation in plant height of different varieties of rapes and mustard.

Zakaria and Jahan (1997) observed that Dhali was the tallest plant height (142.5 cm) which was similar with Sonali (139.5) and Japrai (138.6cm). The shortest plant height was observed in Tori-7 (90.97 cm) which was significantly shorter than other varieties.

Hossain *et al.* (1996) observed that the highest plant height in Narenda (175cm) which was identical with AGA-95-21 (166cm) and Hyola-51 (165 cm). The shortest variety was Tori-7.

Mondal and Islam (1992) reported that variety had significant effect on plant height. They found the highest plant height (134.4 cm) on the variety J-5004, which was identical with SS-75 and was significantly taller than JS-72 and Tori-7.

Number of siliquae plant^{-1}

Zakaria and Jahan. (1997) reported that in case of number of siliquae plant^{-1}, the highest number was recorded in BLN-900 (130-9) which was identical with that observed in Dhali (126.3). Tori-7 had the lowest (46.3) number of siliquae plant^{-1}.

Hossain *et al.* (1996) showed that there was marked statistical variation in number of siliquae plant^{-1}

Mondal and Islam (1992) found that that the maximum number of siliquae plant^{-1} (136) was found in the variety J-5004; which was identical with the variety Tori-7, the lowest number of siliquae plant^{-1} (45.9) was found in the variety SS-75.

Number of seeds siliqua^{-1}

Zakaria and Jahan (1997) found the highest number of seeds siliqua^{-1} (26.13) in Dhali, which was at par with Sonali Sarisha (23.5) and Jatorai (22.8). The lowest number (18.0) of seeds siliqua^{-1} was found in Tori-7, which was at par with that on Sampad (20.0), BARI Sarisha-7 (20.5) and BARI Sarisha-8 (21.6).

Siliqua length

BARI (1999) observed significant variations in siliquae length of different varieties of rapeseed. The highest siliquae length was found in Daulat and lowest in Dhali.

Hossain *et al.* (1996) stated that the varieties of rapeseed differed significantly in respect of siliqua length. The longer siliqua was found in hybrid BGN-900 (7.75cm) that was similar to Hyole-101, Sampad, Dhali and Hyola-51. The shortest siliqua length was found in hybrid Semu-249/84 (4.62cm) which was identical to those of Semu-DNK-89/218, AGH 95-7 and Tori-7. The longest siliqua (8.07cm) was found in BLN-900, which was superior to all other varieties. The shortest siliqua length (4.83 cm) was obtained in Hyola-401 (Zakaria and Jahan (1997)

Weight of thousand seeds

Mondal and Wahhab (2001) found that weight of 1000 seeds varies from variety to variety and from species to species. They found the thousand seed weight 2.50-2.65 g in case of improved Tori-7 (*B. campestries*) and 1.50-2.80 g in Rai-5 (*B. napus*).

Karim *et al.* (2000) reported that the varieties showed significant difference in weight of thousand seeds. They found higher weight of 1000 seed in J-4008 (3.50 g) J-3023 (3.43 g), J-3018 (3.42g).

Hossain *et al.* (1998) observed significant variation in 1000 seed weight as influenced by different varieties. They found Hyda-401 had the highest thousand seeds weight (3.43 g) and the lowest thousand seed weight was recorded in Tori-7 (2.1 g).

BARI (2001) reported that there was significant variation in thousand seed weight in different mustard varieties and the highest weight in Jamalpur-1 variety and lowest in BARI sarisha-10.

Grain yield

Rahman (2002) stated that yield variation existed among the varieties whereas the highest yield was observed in BARI Sarisha-7, BARI sarisha-11 (2.00-2.50 t ha^{-1}) and the lowest yield was in variety Tori-7 (0.95-1.10 t ha^{-1})

BARI (2001) observed that seed yield and other yield contributing characters significantly varied among the varieties.

Mondal *et al.* (1995) reported that after continuous efforts of plant breeders of Oilseed Research Centre, BARI have developed several short duration genotypes of *B. napus* with high yield potential. The genotype, Nap-3 was one of these genotypes (Biswas and Zaman, 1990).

Zaman *et al.* (1991) reported that seed yields of rape and mustard were different in different varieties. Chakrabarty *et al.* (1991) stated that seed yields varied from species to species.

Mendham *et al.* (1990) showed that seed yield was variable due to varietal difference in species of *B. napus*. Similar findings were noticed by Chay and Thurling (1989).

Malik (1989) observed that *B. carinata* produced 49% higher yield than *B. juncea* and *B. campestries.*

Uddin *et al.* (1987) reported that there was a significant yield difference among the varieties of rapes and mustard with the same species.

Monir and Mc Neilly (1987) reported that there was no significant yield difference between cultivars of *B. napus.*

BARI (1992) in a competitive performance of 3 species of *Brassica campestris, B. juncea* and *B. napus*. Tori-7, TS-72 and SS-75 from *B. campestis*, Rai-5 from *B. juncea* and Nap-1 from *B. napus* were compared for performance on yield. Tori-7, TS-72, SS-75, Rai-5 and Nap-1 gave average yield of 730, 500, 457, 592, and 492 kg ha^{-1}, respectively. Tori-7 was significantly superior to other varieties except Rai-5.

Halle *et al.* (1990) conducted an experiment with local and improved mustard. They observed that the improved mustard cv. SS-67 gave high yields compared with local cultivars.

Singh and Patra (1990) conducted an experiment on 7 varieties to observe their performance. The variety PT-30 gave the highest yield, an average of 660.70 kg ha^{-1} while the variety T-9 had yield of 576.18 kg ha^{-1}.

In Bangladesh, Qazi *et al.* (1993) observed the performance of modern varieties/ advanced lines/ mutants. Rai-5 and Sambal of *Brassica juncea* produced 2.56 and 1.98 t seed ha^{-1}.

Stover yield

BARI (2000) reported that in case of poor management Isd-local gave the highest stover yield (3779 kg ha^{-1}) and lowest yield (1295 kg ha^{-1}) was found in Nap-248. In case of medium management highest weight (6223.3 kg ha^{-1}) was in the same variety. The highest stover yield (6400 kg ha^{-1}) was obtained from the variety Rai-5 and lowest stover yield (4413.3 kg ha^{-1}) was obtained from Tori-7.

Biological yield

The biological yield of plant was measured in terms of total dry weight of the plant at final harvest that easily correlated to seed yield and depends on the growth of the plant during its various development stages. In *B. campestris*, the total

anthesis phase of growth has a greater significance for the determination of seed yield than the vegetative phase (Thurling, 1974a).

Mendham *et al.* (1990) showed that vernalization and photoperiod appear to affect the rate of development to flowering on a quantitative and additive fashion in all cultivars, which helped to biological yield.

Harvest index

Robertson *et al.* (2004) stated that Indian mustard had a lower harvest index.

Islam *et al.* (1994) showed that mustard varieties had significant variation on harvest index (%).

Mendham *et al.* (1981) stated that a low harvest index of rapeseed might be due to shattering of pod and seed during mature stage. In *Brassica* species harvest index was strongly influenced by environment (Thurling, 1974b).

CHAPTER – 3

MATERIALS AND METHODS

MATERIALS AND METHODS

3.1. Experimental site

The research was conducted at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka-1207. The experimental field is located at 23^0 77' N latitude and 90^0 33' E longitude at a height of 9 meter above the sea level (BCA, 2004). The land was medium high and well drained.

3.2. Climate

The annual precipitation and potential evapotranspiration of the site were 2152 mm and 1297 mm, respectively. The average maximum and minimum temperature was 30.34 ^{0}C and 21.21^{0}C, respectively with mean temperature of 25.17 ^{0}C. Temperature during the cropping period ranged between 31.5 ^{0}C and 12.5 ^{0}C. The humidity varied from 47% to 68%. The day length ranged between 10.5 and 11.0 hours and there was 165mm rainfall during the experimentation.

3.3. Soil

The soil of the experimental site belongs to the agro-ecological region of "Madhupur Tract" (AEZ No. 28). It was Deep Red Brown Terrace soil and belonged to "Noda" soil series. The top soil is silty clay loam in texture. Organic matter content was very low (0.82%) and soil p^H varied from 5.47-5.63.

3.4. Experimental materials

Seeds of two rapeseed varieties namely Improved Tori-7 and BARI sarisha-12 were collected from Oil Seed Research Centre, Bangladesh Agricultural Research Institute, Gazipur. SAU sarisha -1 was collected from Sher-e-Bangla Agricultural University, Dhaka. Before sowing, the seeds were tested for germination in the laboratory and the percentage of germination was found to be over 90% for all the varieties.

3.5. Experimental treatments

The experimental treatments are as follows:

A. **Factor** -1. Variety: 3

(i) Improved Tori-7 (V_1)

(ii) BARI sarisha-12 (V_2)

(iii) SAU sarisha -1 (V_3)

B. **Factor**-2. Weeding level: 4

(i) No weeding (W_0)

(ii) One weeding at 20 DAS (W_1)

(iii) Two weeding at 20 and 30 DAS (W_2)

(iv) Three weeding at 20, 30 and 40 DAS (W_3)

3.6. Experimental design and lay out:

The experiment was laid out in a Randomized Complete Block Design (RCBD) (factorial) with three replications. Factorial arrangements of treatments within the plot were made at random. The unit plot size was 3.6m x 3m. The distance between two adjacent unit plots was 0.5m and distance between two replications or between two blocks was 1m.

3.7. Crop Husbandry

3.7.1. Land Preparation

The experimental field was ploughed with power tiller and rotavator. Subsequent cross ploughing was done followed by laddering to make the land level. All weeds, stubbles and residues were removed from the field.

3.7.2. Fertilization

The experimental plots were fertilized with a recommended dose of 100-90-60-30-5-6 kg ha^{-1} of N, P_2O_5, K_2O, S, Zn and Bo, respectively from their sources of Urea, TSP, MP, Gypsum, Zinc Sulphate and Boron. The half of urea and the whole amount of other fertilizers were applied as basal during final land preparation and the rest urea as top dressing before flowering.

3.7.3. Germination test

Germination test was done before sowing the seeds in the field. Filter paper were placed on petridishes and the papers were soaked with water. Seeds were distributed at random in petridish. Data on emergence were collected and converted to percentage basis by using the following formula:

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

3.7.3. Sowing of seeds

Seeds were sown on 10th November, 2006 maintaining 30cm row spacing in each plot. Sowing was done continuously in rows.

3.7.4. Weeding and thinning

The experimental plots were found to be infested with different kinds of weeds, viz. Bathua (*Chenopodium album* L.), Durba (*Cynodon dactylon*), Nut sedge (*Cyperus rotundus* L.), Biskatali (*Polygonum hydropiper* L.), Goose grass (*Eleusine indica*) etc. Weeding was done manually with 'nirani' as per treatment. Thinning was done in all the unit plots with care to maintain a constant plant population on each row. Finally plants were kept at 5 cm distance in rows.

3.7.5. Irrigation

Pre-sowing irrigation was given in the field to ensure optimum germination. First irrigation was given at 25 days after sowing (DAS) and the second irrigation was given at 55 DAS following flood method.

3.7.6. Application of pesticides

Crops were attacked by aphids (*Lipaphis erysimi*. K). It was controlled by spraying Malathion 60 EC at the rate of 2 ml/litre of water. The spraying was done in the afternoon while the pollinating bees were away from the field.

3.8. Harvesting and processing

The experimental crop was harvested at maturity when 80% of the siliquae turned straw yellowish in colour. Harvesting was done in the morning to avoid shattering. Excluding the boarder lines plants were harvested from the centre of each plot at ground level with the help of a sickle for grain and stover yield. Prior to harvesting, ten plants were sampled randomly from each plot, bundled separately, tagged and brought to a clean cemented threshing floor from which different yield parameters were recorded. The crop was sun dried properly by spreading them over floor and seeds were separated from the siliquae by beating the bundles with the help of bamboo sticks.

The seeds thus collected were dried in the sun for reducing the moisture in the seed to about 9% level. The stovers were also dried in the sun. Seed and stover yield were recorded. The biological yield was calculated as the sum of the seed yield and stover yield.

3.8. Sampling and data collection

Ten sample plants were selected at random from each plot. Plant height, number of branches per plant, number of siliquae per plant, siliqua length, number of seeds siliqua^{-1}, weight of thousand seeds and shelling percentage were recorded separately. From each plot the weight of the grain and straw were taken. Biological yield and the harvest index were calculated from these data.

The parameters studied in the experiment were as follows:

i. Plant height at 25 and 50 DAS and at harvest (cm).

ii. Plant dry weight at 25 and 50 DAS and at harvest.

iii. Number of branches plant $^{-1}$

iv. Number of siliquae plant $^{-1}$

v. Length of siliqua

vi. No. of seeds siliqua $^{-1}$

vii. Weight of 1000 seeds (g)

viii. Shelling percentage

ix. Grain yield (t ha^{-1})

x. Stover yield (t ha^{-1})

xi. Harvest index (%)

i. Plant height (cm)

The height of randomly selected ten plants was measured from ground level (stem base) to the tip of the plant. Mean plant height was calculated and expressed in cm.

ii. Number of branches per plant

The number of branches of ten randomly sampled plants were counted and recorded. Average value of ten plants was recorded as number of branches per plant.

iii. Number of siliquae per plant

Siliquae of ten plants was counted and divided by ten which indicated the number of siliqua per plant.

iv. Length of siliqua

Length of ten siliquae collected randomly from sampled plants and the mean length was recorded.

v. Number of seeds per siliqua

The number of seeds was counted by splitting ten siliquae which were sampled from sampled plants and then mean value was determined.

vi. Weight of 1000 seeds

Thousand seeds were randomly counted from the total seeds of each sample. Then the weight was taken by a digital balance. The 1000 seed weight was recorded in gram.

vii. Shelling percentage

The weight of 10 siliquae and the grains of 10 siliquae were taken from each treatment and the mean results were recorded. Shelling percentage was calculated by the following formulae:

$$\text{Shelling percentage (\%)} = \frac{\text{Weight of shell (g)}}{\text{Weight of siliquae (g)}} \times 100$$

viii. Grain yield (kg ha^{-1})

The mean grain weight was taken by threshing the plants of each sample area and then converted to kg ha^{-1} in dry weight basis.

ix. Stover yield (kg ha^{-1})

The stover weights were calculated after threshing and separation of grain from plant of sample area and then expressed in kg ha^{-1} on dry weight basis.

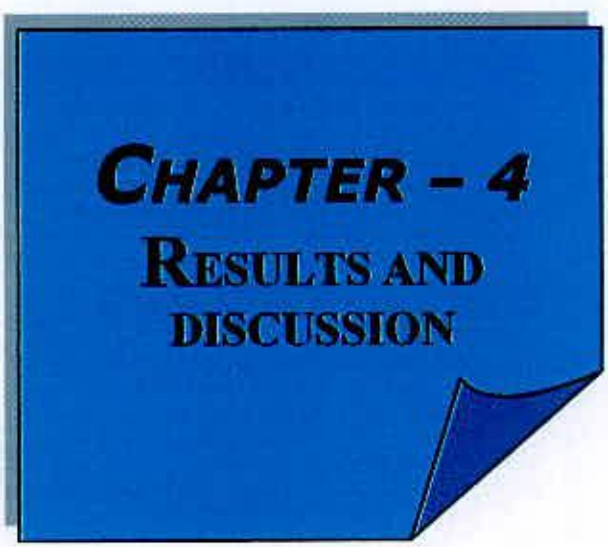
xi. Harvest index (%)

The harvest index was calculated by the ratio of grain yield to biological yield and expressed in percentage.

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

xii. Statistical analysis

The data were analysed following Analysis of Variance (ANOVA) technique using IRRISTAT software adjusted (version 4.0) and mean differences were adjudged by using LSD test at 5% level of significance.


CHAPTER - 4
RESULTS AND
DISCUSSION

RESULTS AND DISCUSSION

4.1 Plant height

Effect of variety

The plant height was significantly influenced by variety at 25 and 50 days after sowing (DAS) and at harvest (Appendix 2 and Table 1). The result revealed that at 25 DAS, the tallest plant height (16.43cm) was obtained from Improved Tori-7 that followed by BARI Sarisha-12 (14.50cm) and the shortest plant height (12.77cm) was obtained from SAU Sarisha-1. At 50 DAS the tallest plant height (96.25cm) was obtained from BARI Sarisha-12. The second highest plant height (85.57cm) was obtained from Improved Tori-7 and the shortest plant height (68.46cm) was obtained from SAU Sarisha-1. But at harvest the scenario was changed and the tallest plant height was obtained from SAU Sarisha-1 (120.94cm) followed by BARI Sarisha-12 (117.86cm) and the shortest plant height (97.53cm) was obtained from Improved Tori-7. Such variation at plant height among the varieties during their growth might be due to their varietal characteristics. Similar variation at plant height among rapeseed/mustard varieties was also reported by many scientists (Ahmed *et al.*, 1999; Ali *and Rahaman*, 1998; Zakaria and Jahan 1997; Hossain *et al.*, 1996 and Mondal and Islam., 1992).

Table 1 Plant height (cm) of rapeseed as affected by varieties and number of weedings

Treatment	*Days after sowing*		
	25	*50*	*At harvest*
Variety			
Improved Tori-7	16.43	85.57	97.53
BARI sarisha-12	14.50	96.25	117.86
SAU sarisha-1	12.77	68.46	120.94
LSD(0.05)	0.372	1.226	13.42
Weeding			
No weeding	16.52	83.41	115.47
One weeding	14.17	85.66	105.58
Two weeding	13.61	81.91	112.68
Three weeding	13.96	82.74	114.70
LSD(0.05)	0.430	1.415	NS
CV (%)	3.02	1.47	14.14

NS = Not significant

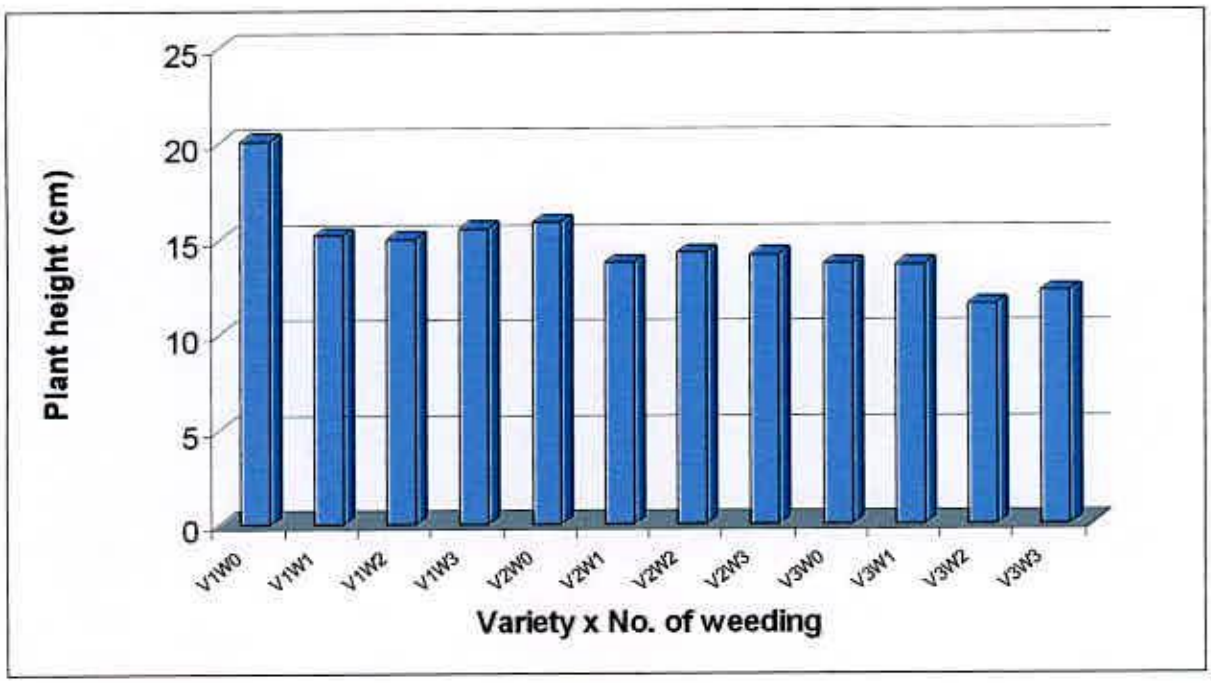
Effect of weeding

The plant height was significantly influenced by the number of weeding at 25 and 50 DAS and at harvest (Appendix 2 and Table 1). At 25 DAS, the tallest plant height (16.52cm) that obtained from no weeding that followed by (14.17cm) and (13.96cm) was obtained from one weeding and three weedings respectively . The shortest plant height (13.61cm) was obtained from two weedings that was similar with three weedings. At 50 DAS, the tallest plant height (85.66cm) was obtained from one weeding. The second highest plant height (83.41cm) was obtained from no weeding that followed by three weedings. The shortest plant height (81.91cm) was obtained from two weedings. No significant variation in

plant height observed between two and three weedings treatments. At harvest the number of weeding had no significant effect on plant height though the maximum plant height (115.47cm) was found in no weeding plots. Gaffer (1984) observed that yield contributing characters like plant height was favourably increased with the spell of weed free period.

Interaction effect of variety and number of weeding

There was a significant variations in plant height observed due to interaction among varieties and number of weedings at 25 and 50 DAS and at harvest (Appendix 2).



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

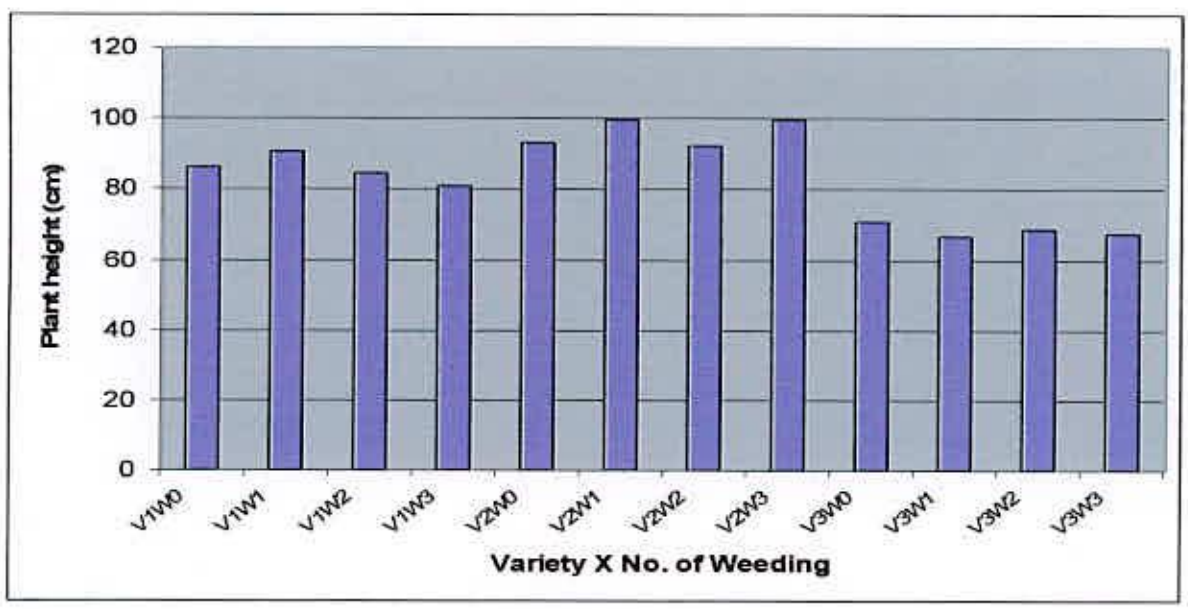
W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure1. Interaction effect of variety and number of weeding on plant height of rapeseed at 25 DAS ($LSD_{0.05}$ = 0.74)

At 25 DAS, the longest plant height was obtained from Improved Tori-7 with no weeding (20.08cm) that followed by (15.83cm), (15.52cm) and (15.15cm) from BARI sarisha-12 with no weeding (15.83cm), Improved Tori-7 with three weeding (15.52cm) and improved Tori-7 with single weeding (15.15cm) respectively. The shortest plant height (11.58cm) was obtained from SAU sarisha-1 having two weeding (Fig.1).

At 50 DAS, the longest plant height (99.68cm) was obtained from BARI sarisha-12 with three weeding that followed by (93.33cm) and (92.44cm) were obtained from BARI sarisha-12 with no weedings and BARI sarisha-12 with two weeding. The shortest plant height (66.80cm) was obtained from SAU sarisha-1 having one weeding (Fig.2).



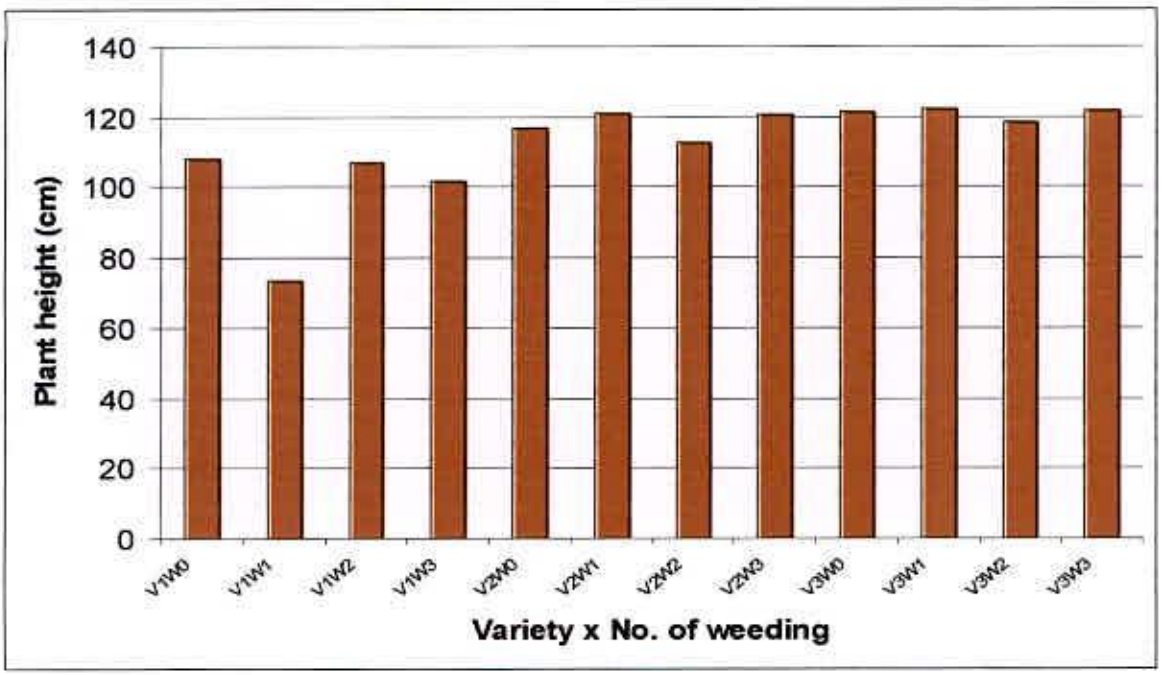
V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 2. Interaction effect of variety and number of weeding on plant height of rapeseed at 50 DAS ($LSD_{0.05}$ = 2.45)

At harvest all the interaction treatments showed similar plant height except Improved Tori-7 having one weeding (Fig.3) that gave the lowest plant height of 73.57 cm.



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 3. Interaction effect of variety and number of weeding on plant height of rapeseed at harvest. ($LSD_{0.05}$ = 26.84)

4.2 Plant dry weight

Effect of variety

The plant dry weight was significantly influenced by the variety at 25 and 50 DAS and at harvest (Appendix 3). At 25 DAS, the highest plant dry weight (2.55g) was obtained from Improved Tori-7. The second highest plant dry weight

(2.13g) was obtained from BARI sarisha-12 that followed by SAU sarisha-1 (1.97g). There was no significant variation in plant dry weight observed between BARI sarisha-12 and SAU sarisha-1. At 50 DAS the highest plant dry weight (16.10g) was obtained from BARI Sarisha-12 that was similar with Improved Tori-7 (15.47g). The significantly lowest plant dry weight (12.20g) was obtained from SAU Sarisha-1. At harvest the highest plant dry weight (196.00gm) was obtained from SAU Sarisha-1 that followed by BARI Sarisha-12 (137.00g). The lowest plant dry weight (100.00g) was obtained from Improved Tori-7.

Effect of weeding

The plant dry weight was significantly influenced by the weeding treatments at 25 and 50 DAS and at harvest (Appendix 3 and Table 2). At 25 DAS, the highest plant dry weight (2.41g) was obtained from no weeding plants that similar with single weeding (2.20g) and three weedings (2.19g). The lowest plant dry weight (2.08g) was obtained from two weedings that similar with one and three weedings. At 50 DAS, the highest plant dry weight (16.52g) was obtained from one weeding that followed by no weeding (14.36g) three weedings (14.20g) and two weedings (13.29g). But at harvest the highest plant dry weight (151.67g) was obtained from single weeding that similar with two (148.89g) and no (147.223g) weeding treatments. The significantly lowest plant dry weight (131.11g) was obtained from three weedings. The lower dry matter production at

higher weeding treatments might be due to higher plant injury during later stages of weeding that affects on dry mater production of the crop.

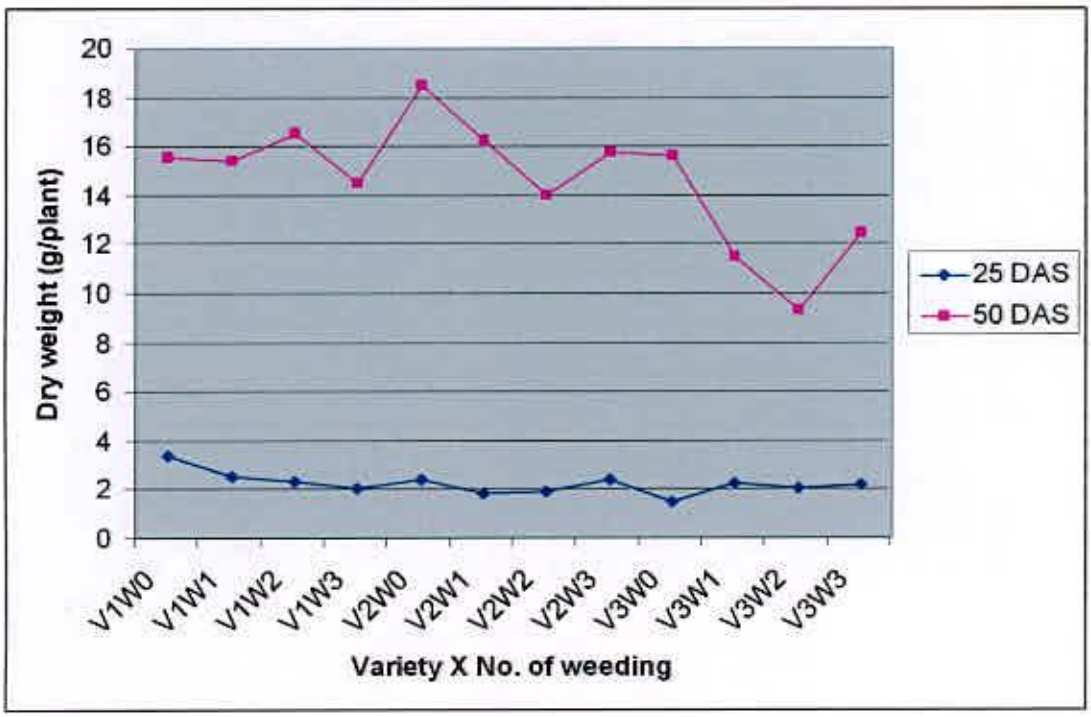
Table 2 Plant dry weight (g) of rapeseed as affected by varieties and number of weedings

Treatments	*Days after sowing*		
	25	*50*	*At harvest*
Variety			
Improved Tori-7	2.55	15.47	100.00
BARI sarisha-12	2.13	16.10	137.00
SAU sarisha-1	1.97	12.20	196.00
LSD(0.05)	0.200	1.056	4.855
Weeding			
No weeding	2.41	14.36	147.22
One weeding	2.20	16.52	151.67
Two weeding	2.08	13.29	148.89
Three weeding	2.19	14.20	131.11
LSD(0.05)	0.231	1.219	5.609
CV(%)	33.42	8.55	3.96

Interaction effect of variety and number of weeding

There was a significant variation in plant dry weight observed due to interaction between variety and number of weedings at 25 and 50 DAS and at harvest (Appendix 3). At 25 DAS, the highest plant dry weight (3.37 g) was obtained from Improved Tori-7 having no weeding that followed by (2.51g) that obtained from Improved Tori-7 having one weeding. The lowest plant dry weight (1.44g) was obtained from SAU sarisha-1 with no weeding (Fig. 4).

At 50 DAS, the highest plant dry weight (18.47g) was obtained from BARI sarisha-12 with no weeding that followed by (16.53g) and (16.20g) from Improved Tori-7 with two weeding and BARI sarisha-12 with single weeding respectively. The lowest plant dry weight (9.32g) was obtained from SAU sarisha-1 having two weedings (Fig. 4).



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

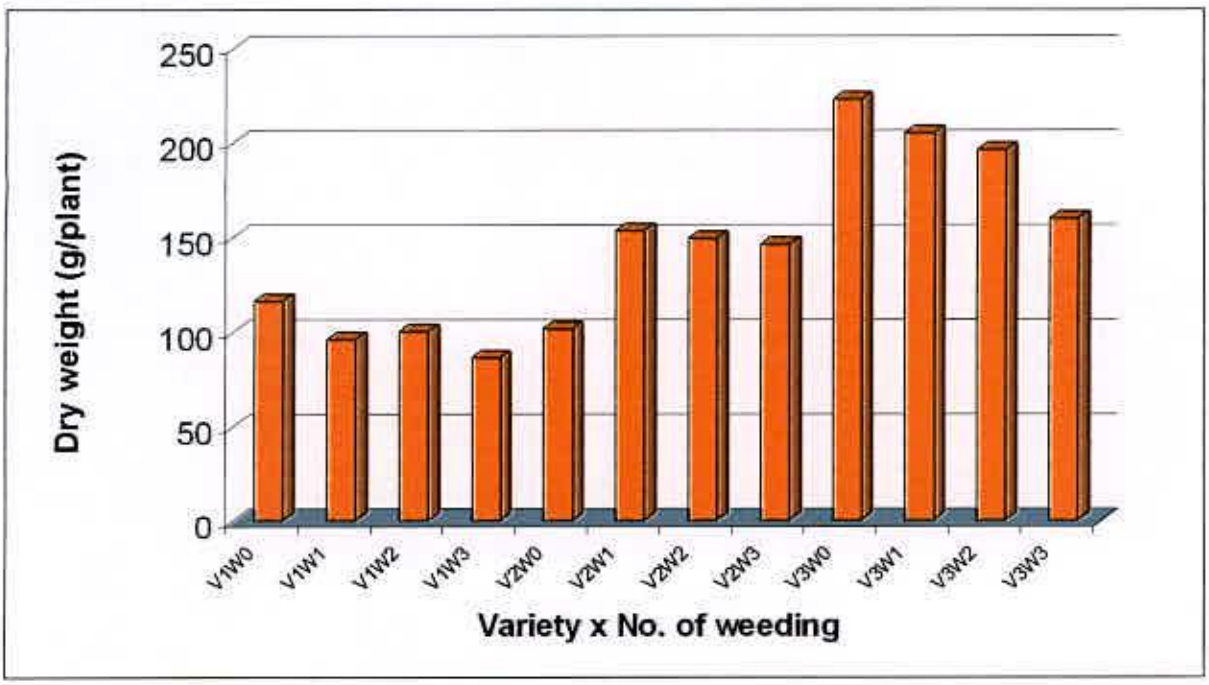
W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 4. Interaction effect of variety and number of weeding on plant dry weight of rapeseed at 25 ($LSD_{0.05}$ = 0.400) and 50 ($LSD_{0.05}$ = 2.112) DAS.

At harvest, the highest plant dry weight (223.33g) was obtained from SAU sarisha-1 having no weeding that followed by (205.00g) and (196.67g) from SAU sarisha-1 having one weeding and SAU sarisha-1 with two weedings respectively.

The lowest plant dry weight (96.67g) was obtained from Improved Tori-7 with three weedings (Fig. 5).



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 5. Interaction effect of variety and number of weeding on plant dry weight of rapeseed at harvest. ($LSD_{0.05}$ = 9.711)

4.3 Number of branches per plant

Number of branches per plant is the result of genetic make up of the crop and environmental conditions which plays a remarkable role towards the final seed yield of the crop (Sana *et al.*, 2003). In this study it indicated that the number of branches per plant varied significantly with different variety and number of weeding.

Effect of variety

The number of branches per plant was significantly influenced by the variety (Appendix 4 and Table 3). The highest number of branches per plant (10.79) produced by the variety SAU Sarisha-1 that followed by BARI Sarisha-12 (7.27) and Improved Tori-7 (6.95). Zakaria and Jahan (1997) reported that the local varieties Tori-7 and Sampad produced the highest number of primary branches plant $^{-1}$ (4.07) which was at a BLN-900. The minimum number of primary branches plant $^{-1}$ of 2.90 was found in Jatarai which was identical to those found in Hhole-401 and BARI Sarisha-8 varieties. Hossain *et al.* (1996) they stated that the varieties were statistically different with respect to number of primary branches.

Effect of weeding

The number of branches per plant was significantly influenced by the weeding (Appendix 4 and Table 3). The highest number of branches per plant (8.79) produced by the one weeding that similar with two weedings (8.53) where no weeding treatment gave the lowest (7.74) number of branches plant^{-1}. Chemale and Fleck (1984) also found similar results of weeding effects on number of branches. Gaffer (1984) observed that primary branches plant^{1} were favorably increased with the spell of weed free periods. The lower number of branches in no weeding treatment might be due to higher competition of plants with weeds for light, air, nutrients. The higher number of weeding also reduced the number of branches per plant that might be due to higher plant injury during later weedings.

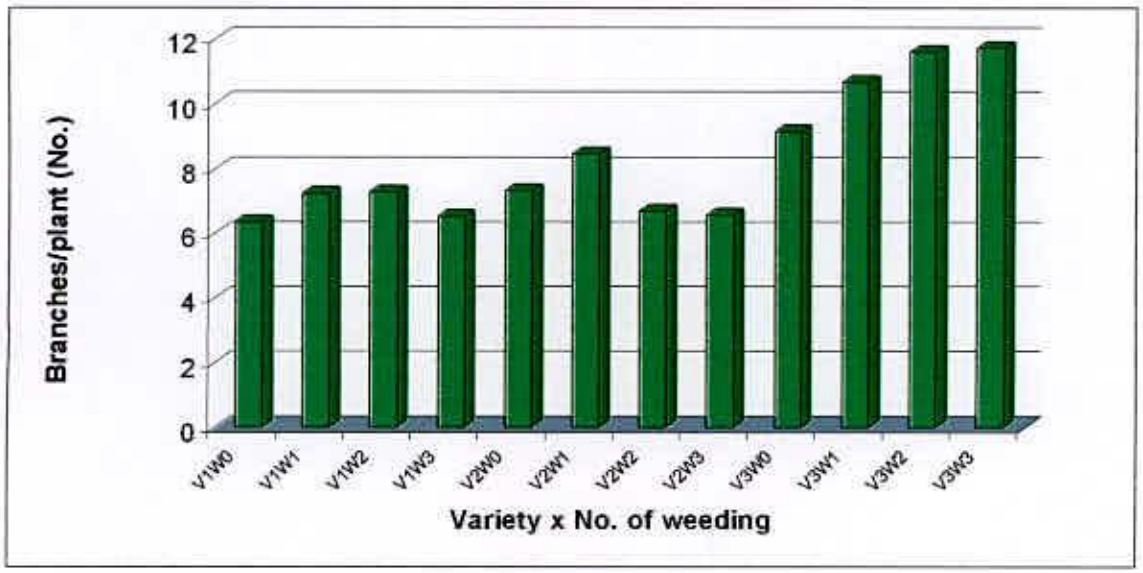
Table 3 Yield attributes of rapeseed as affected by varieties and number of weedings

Treatment	Branches plant^{-1} (No.)	Siliquae plant^{-1} (No.)	Length of siliquae (cm)	Seeds siliquae^{-1} (No)	1000-seed weight (g)
Variety					
Improved Tori-7	6.95	163.43	5.83	18.60	2.79
BARI sarisha-12	7.27	211.95	5.92	18.38	2.92
SAU sarisha-1	10.79	240.13	5.98	17.14	2.79
LSD(0.05)	0.394	17.695	NS	0.939	NS
Weeding					
No weeding	7.74	222.70	6.28	18.09	2.42
One weeding	8.79	215.63	5.74	17.93	3.25
Two weedings	8.53	149.20	6.01	19.37	3.32
Three weedings	8.28	188.14	5.61	16.77	2.35
LSD(0.05)	0.455	20.432	0.364	1.083	0.247
CV (%)	5.59	10.19	6.31	6.15	10.62

NS = Not significant

Interaction effect of variety and number of weeding

Number of branches plant $^{-1}$ was significantly effected by the interaction between variety and number of weeding (Fig.6). The interaction between the variety SAU sarisha-1 and two weeding produced the highest number of branches plant^{1} (11.73) that followed by (11.60) from SAU sarisha-1 having three weeding. The lowest number of branches plant^{-1} was observed in the interaction of Improved Tori-7 and three weedings (6.53).



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 =Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 6. Interaction effect of variety and number of weeding on branches plant^{-1} of rapeseed. ($LSD_{0.05}$ = 0.788)

4.4 Number of siliquae per plant

Number of siliquae per plant is the result of genetic make up of the crop and environmental conditions (Sana *et al.*, 2003). It is an important yield contributing character which has a great effect on final yield.

Effect of variety

The number of siliquae per plant was significantly influenced by the variety (Appendix-4 and Table-3). It observed from the Table-3 that SAU sarisha-1

produced the highest no. of siliquae plant^{-1} (240.13). BARI Sarisha-12 produced the second highest no. of siliquae plant^{-1} (211.95). Improved Tori-7 produced the lowest no. of siliquae plant^{-1} (163.43). Zakaria and Jahan. (1997) reported that Tori-7 had the lowest number of siliquae plant^{-1}. Islam *et al.* (1994) reported that significant variation in siliquae plant^{-1} in different varieties of mustard.

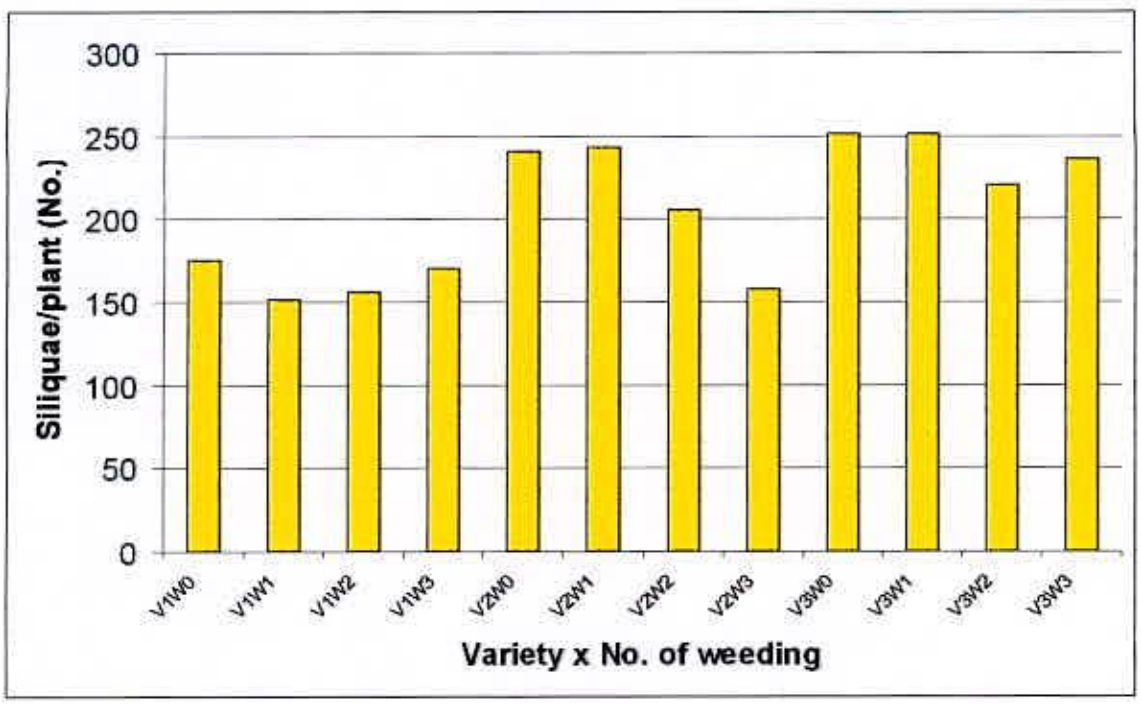
Effect of weeding

The number of siliquae per plant was significantly influenced by the weeding (Appendix 4 and Table 3). The highest number of siliquae per plant (222.70) produced by the no weeding treatment which was at per with one weeding treatment (215.63). Two weedings treatment gave the lowest number of siliquae plant^{-1} (149.20). Three weeding gave the intermediate siliquae number per plant (188.14). This result was corroborated with the results found by Chemale and Fleck (1984), Yadav *et al.* (1984) and Sarkar and Mondal (1985).

Interaction effect of variety and number of weeding

The interaction of variety and number of weeding had significant effect on the number of siliquae plant^{-1} (Fig.7). It was observed that the interaction between the variety SAU sarisha-1 and no weeding produced the highest number of siliquae plant^{-1} (251.83) that similar with the same variety with single weeding and BARI Sarisha-12 having one weeding (243.40). The lowest number of siliquae

plant^{-1} was observed from the interaction of Improved Tori-7 having one weeding (151.70).



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 7. Interaction effect of variety and number of weeding on siliquae plant^{-1} of rapeseed. ($LSD_{0.05}$ = 35.390)

4.5 Length of siliqua

Effect of variety

Variety did not affect significantly on the length of siliqua (Appendix-4 and Table 3). Numerically the maximum length of siliqua (5.98 cm) was observed

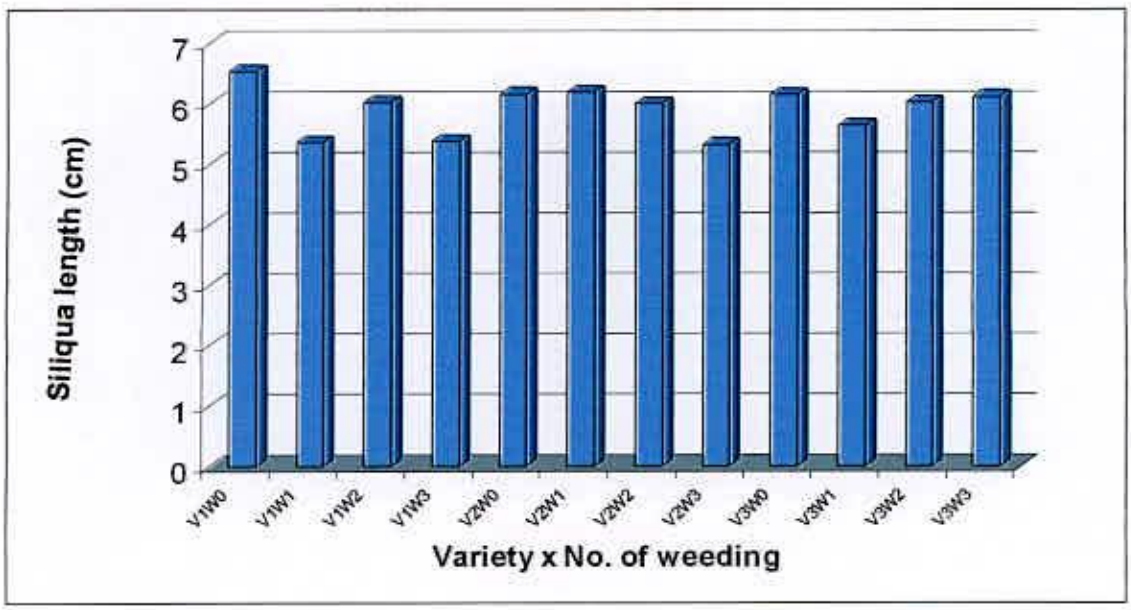
from SAU sarisha-1. Improved Tori-7 gave the lowest length of siliqua (5.83 cm). Zakaria and Jahan (1997) reported that Tori-7 had the lowest length of siliqua .This result was conflict with that of Islam *et al.* (1994), Hossain *et al.* (1996) and BARI (1999) who reported the significant variation in length of siliqua in different varieties of rapeseed.

Effect of weeding

Weeding had a significant role in the elongation of siliqua (Appendix 4 and Table 3). The longest length of siliqua (6.28 cm) produced by the no weeding treatment where two weeding treatment produced the similar length of siliqua (6.01cm). Three weedings treatment gave the lowest length of siliqua (5.61cm). Chemale and Fleck (1984) disagreed this result.

Interaction effect of variety and number of weeding

The interaction between variety and number of weeding revealed significant variations for siliquae length (Fig.8) where Improved Tori-7 produced the longest siliqua (6.54cm) with no weeding treatment which was statistically similar with BARI sarisha-12 having no weeding, BARI Sarisha-12 with one weeding and SAU sarisha-1 with no weeding. But the lowest siliqua length was observed in the interaction of BARI sarisha-12 with three weedings (5.33cm).



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 8. Interaction effect of variety and number of weeding on siliqua length of rapeseed. ($LSD_{0.05}$ = 0.631)

4.6 Number of seeds per siliqua

Number of seeds per siliqua is also an important factor which contributes towards seed yield. Variety as well as number of weeding had a significant effect on the number of seeds siliqua^{-1} in this study.

Effect of variety

The number of seeds per siliqua was significantly influenced by the variety (Appendix 4 and Table 3). The highest number of seeds per siliqua (18.60) was produced by the variety Improved Tori-7 that similar with the variety BARI

sarisha-12 (18.38). The lowest number of seeds per siliqua (17.14) was given by the variety SAU sarisha-1. Variation in seeds siliqua^{-1} among the varieties was in conformity with Islam *et al.* (1994) who found a significant variation in number of seeds siliqua^{-1} among different varieties of mustard and rapeseed. Zakaria and Jahan (1997) found highest number of seeds siliqua^{-1} (26.11) in Dhali, which was at par with Sonali Sarisha (23.5) and Jatorai (22.8). The lowest number (18.0) of seeds siliqua^{-1} was found in Tori-7, which was at par with that of Sampad (20.0), BARI Sarisha-7 (20.5) and BARI Sarisha-8 (21.6).

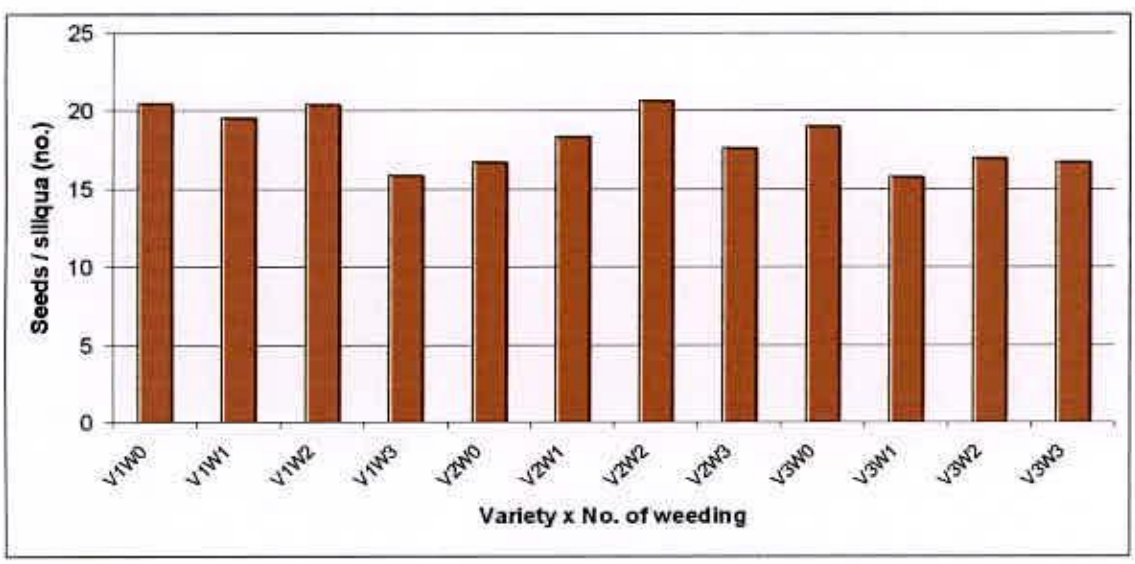
Effect of weeding

Weeding had a great effect on the production of seeds per siliqua (Appendix 4 and Table 3). From this study it was observed that two hand weeding produced the highest number of seeds per siliqua (19.37). The second highest number of seeds per siliqua (18.09) was obtained from no weeding treatment and the lowest number of seeds per siliqua (16.77) was obtained from three weedings treatment. This result is also supported by Sarkar and Mondal (1985). Chemale and Fleck (1984) observed that the number of seeds pod^{-1} of soybean decreased with increasing weed density.

Interaction effect of variety and number of weeding

The interaction between variety and number of weeding had significant effect on the number of seeds per siliqua (Fig. 9). The highest number of seeds per siliqua (20.70) was observed from BARI sarisha-12 with two weedings. The

second highest number of seeds per siliqua (20.50) was obtained from Improved Tori-7 having no weeding that similar with the same variety with two weedings. The lowest number of seeds per siliqua (15.19) was observed from the interaction of Improved Tori-7 having three weedings that similar with SAU sarisha-1 with one weeding.



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 9. Interaction effect of variety and number of weeding on seeds per siliquae of rapeseed. ($LSD_{0.05}$ = 1.877)

4.7 Weight of 1000 seeds

The weight of seed is related with the magnitude of seed development as an important yield determinant and plays a decisive role on expression of yield potential of a variety (Sana *et al.*, 2003).

Effect of variety

Variety did not affect significantly on the weight of thousand seeds (Appendix 4 and Table 3). The maximum weight of thousand seeds (2.92g) was observed from BARI sarisha-12 and minimum (2.79g) was observed in Improved Tori-7 and SAU Sarisha-1 (2.79g). Mondal and Wahhab (2001), Karim *et al.* (2000) and Hossain *et al.* (1998) reported that weight of 1000 seeds varies from variety to variety and from species to species.

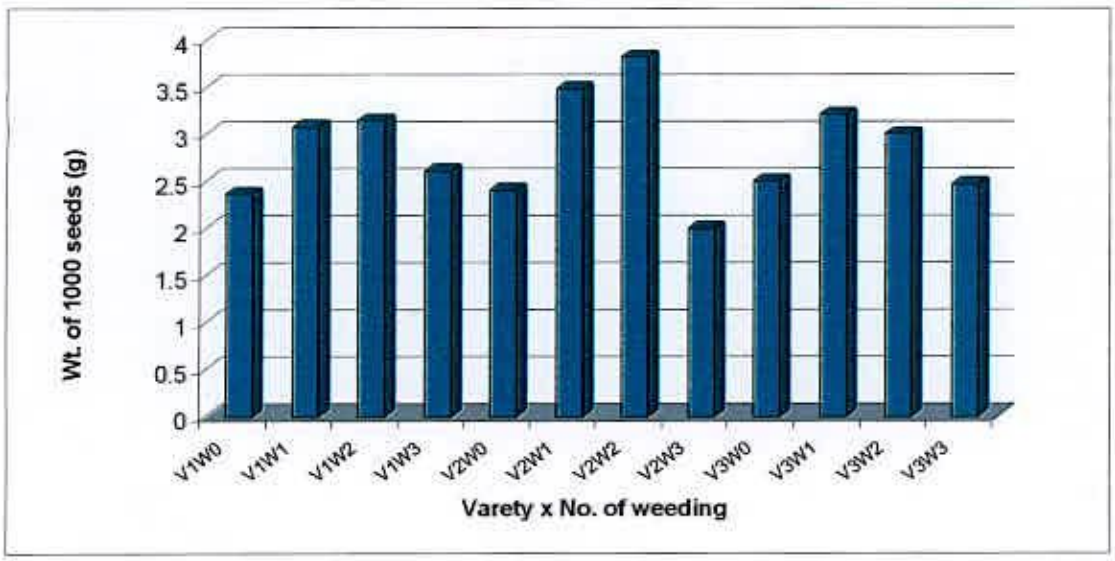
Effect of weeding

Thousand seed weight was significantly influenced by weeding (Appendix 4 and Table 3). It was found that two weedings plot produced the highest number of 1000 seed weight (3.32g) that followed by (3.25g) was obtained from one weeding plot. The lowest weight of 1000 seeds (2.35g) was obtain from three weeding plot. Qasem and Tell (1995) reported that greatest 1000 seed weight came from weed plots.

Interaction effect of variety and number of weeding

The interaction between variety and number of weeding significantly effected the weight of 1000 seeds (Fig. 10). The highest 1000 seed weight (3.81g)was observed from BARI Sarisha-12 having two weedings that followed by (3.47g), (3.20 g) and (3.14 g) from BARI sarisha-12 with one weeding, SAU sarisha-1 with one weeding and Improved Tori-7 with two weedings respectively.

The lowest weight of 1000 seeds (1.99g) was obtained from the interaction of BARI sarisha-12 with three weedings.



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 10. Interaction effect of variety and number of weeding on weight of 1000 seeds of rapeseed. ($LSD_{0.05}$ = 0.509)

4.8 Shelling percentage

Effect of variety

Variety showed statistically similar effect on shelling percentage of rapeseed variety (Appendix 5 and Table 4). The maximum shelling percentage (46.12%) was observed in BARI sarisha-12 and minimum (40.38%) was observed in Improved Tori-7.

Effect of weeding

Weeding did not effect significantly the shelling percentage of rapeseed (Appendix 5 and Table 4). Numerically three weedings treatment showed the maximum shelling percentage (47.04%) that followed by one weeding (44.97%) Two weeding treatment showed the minimum shelling percentage (39.84%).

Interaction effect of variety and number of weeding

Interaction effect of variety and number of weeding had no significant effect on shelling percentage. However, numerically the maximum shelling percentage (47.60) was observed in SAU sarisha-1 with one weeding treatment whereas the minimum (36.98%) was observed in Improved Tori-7 in two weedings treatment.

4.9 Seed yield

Effect of variety

Seed yield of rapeseed was not significantly influenced by the variety (Appendix 5 and Table 4). Numerically the maximum seed yield (1.37 t ha^{-1}) was obtained from SAU Sarisha-1 that followed by Improved Tori-7 and BARI

Sarisha-12 (1.26 t ha^{-1}). The result was in agreement with Monir and McNeilly (1987) who reported that there was no significant yield difference between cultivars of *B. napus*. The result disagreed with Rahman (2002), BARI

(2001), Mandal *et al.* (1995), Zaman *et al.* (1991) and Mendham *et al* who reported that seed yields of rape and mustard are different in different varieties.

Table 4 Yield, harvest index and shelling percentage of rapeseed as affected by varieties and number of weedings

Treatments	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Harvest index (%)	Shelling percentage
Variety				
Improved Tori-7	1.26	2.95	35.21	40.38
BARI sarisha-12	1.26	3.31	30.96	46.12
SAU sarisha-1	1.37	3.45	31.02	45.03
LSD(0.05)	NS	0.46	2.195	NS
Weeding				
No weeding	1.29	3.40	29.30	43.52
One weeding	1.34	3.32	34.08	44.97
Two weeding	1.42	3.11	33.87	39.84
Three weeding	1.15	3.11	32.33	47.04
LSD(0.05)	NS	NS	2.535	NS
CV (%)	4.92	16.83	0.006	15.70

NS = Not significant

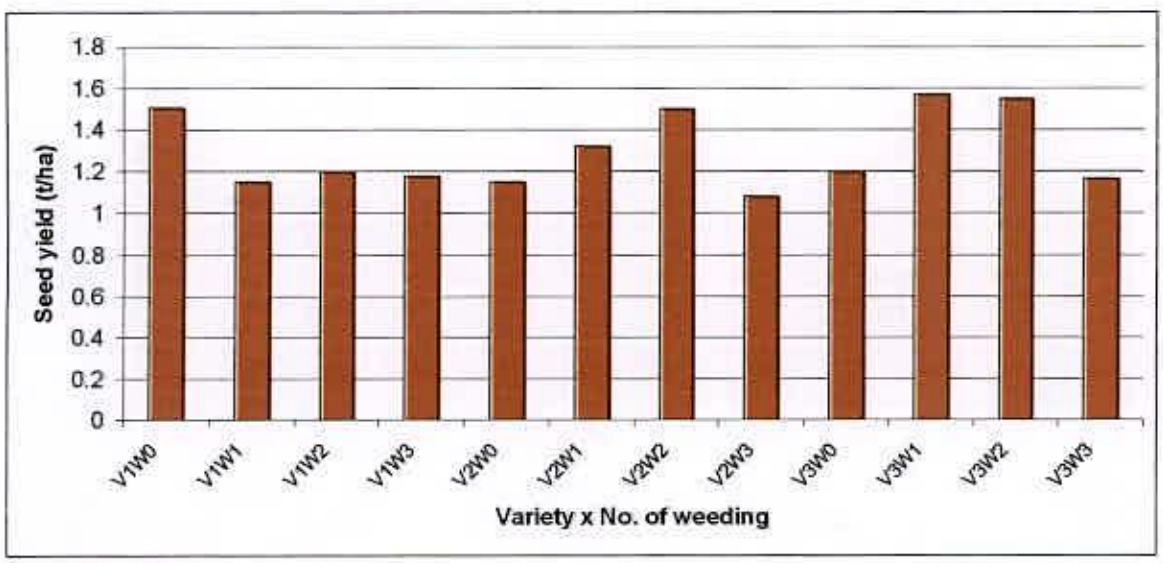
Effect of weeding

Weeding did not affect significantly on the seed yield (Appendix 5 and Table 4). Numerically the maximum seed yield (1.42 t ha^{-1}) was observed from two weedings treatment and minimum (1.15 t ha^{-1}) was observed in three

weedings treatment. The result disagreed with Singh *et al.* (1983), Chemale and Fleck (1984), Sarker and Mondal (1985).

Interaction effect of variety and number of weeding

The interaction between variety and number of weeding significantly affected the seed yield (Fig.11). The highest seed yield (1.57t ha^{-1}) was obtained from the combination of SAU sarisha-1 and one weeding that similar with the same variety with two weedings (1.55 t ha^{-1}), BARI sarisha-12 with two weedings (1.50 t ha^{-1}) and Improved Tori-7 with no weeding (1.51 t ha^{-1}). The lowest seed yield (1.15 t ha^{-1}) was obtained from the interaction of BARI Sarisha-12 with three weedings.



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 =Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 11. Interaction effect of variety and number of weeding on seed yield of rapeseed. ($LSD_{0.05}$ = 0.108)

4.10 Stover yield

Effect of variety

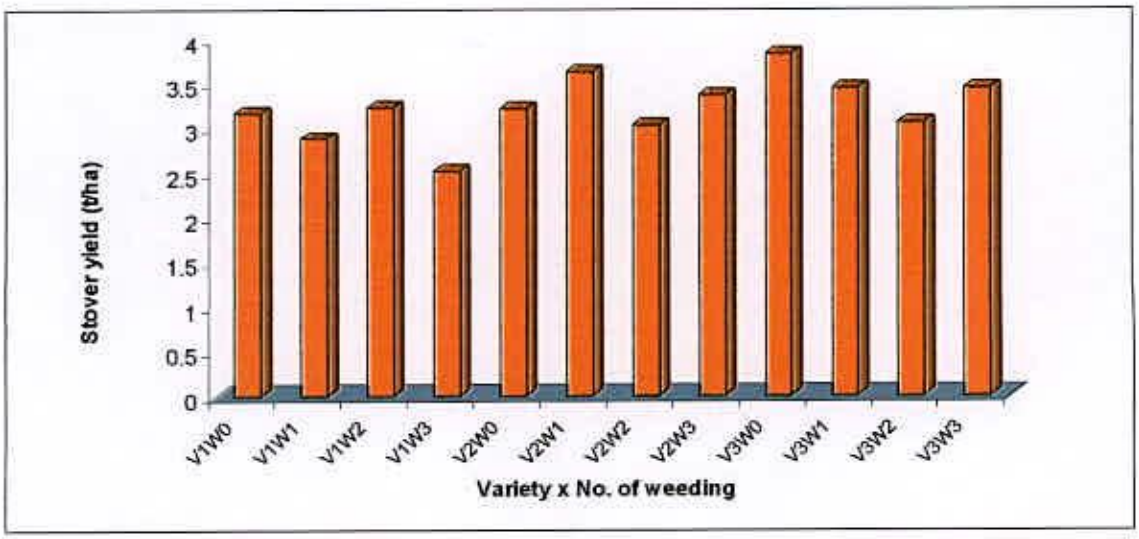
Stover yield was significantly influenced by the variety (Appendix 5 and Table 4). SAU sarisha-1 gave the highest straw yield (3.45 t ha^{-1}) which was statistically similar with BARI Sarisha-12 (3.31 t ha^{-1}). The lowest stover yield (2.95 t ha^{-1}) was observed in Improved Tori-7. BARI (2000) reported that the highest stover yield, 6400 kg ha^{-1} was obtained from the variety Rai-5 and lowest stover yield, 4413.3 kg ha^{-1} was obtained from Tori-7. BARI (2000) reported that stover yields of rape and mustard are different in different varieties

Effect of weeding

Weeding showed statistically similar effect on stover yield of rapeseed variety (Appendix 5 and Table 4). Numerically, the maximum stover yield (3.40 t ha^{-1}) was observed in no weeding treatment and minimum (3.11 t ha^{-1}) was observed in two and three weedings treatment.

Interaction effect of variety and number of weeding

The interaction between variety and number of weeding significantly affected the stover yield (Fig.12). Stover yield was found to be highest (3.83t ha^{-1}) with the combination of SAU sarisha-1 and no weeding that followed by BARI sarisha-12 (3.63 t ha^{-1}) with one weeding. Stover yield was lowest (2.52 t ha^{-1}) in the treatment combination of Improved Tori-7 with three weedings.



V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 12. Interaction effect of variety and number of weeding on stover yield of rapeseed. ($LSD_{0.05}$ = 0.921)

4.11 Harvest index

Effect of variety

Variety significantly effected the harvest index (Appendix 5 and Table 4). Improved Tori-7 produced the highest harvest index (35.21%). The second highest harvest index (31.02%) was observed in SAU Sarisha-1 which was statistically similar with BARI sarisha-12 (30.96%). Similar result was also observed by Islam *et al.* (1994).

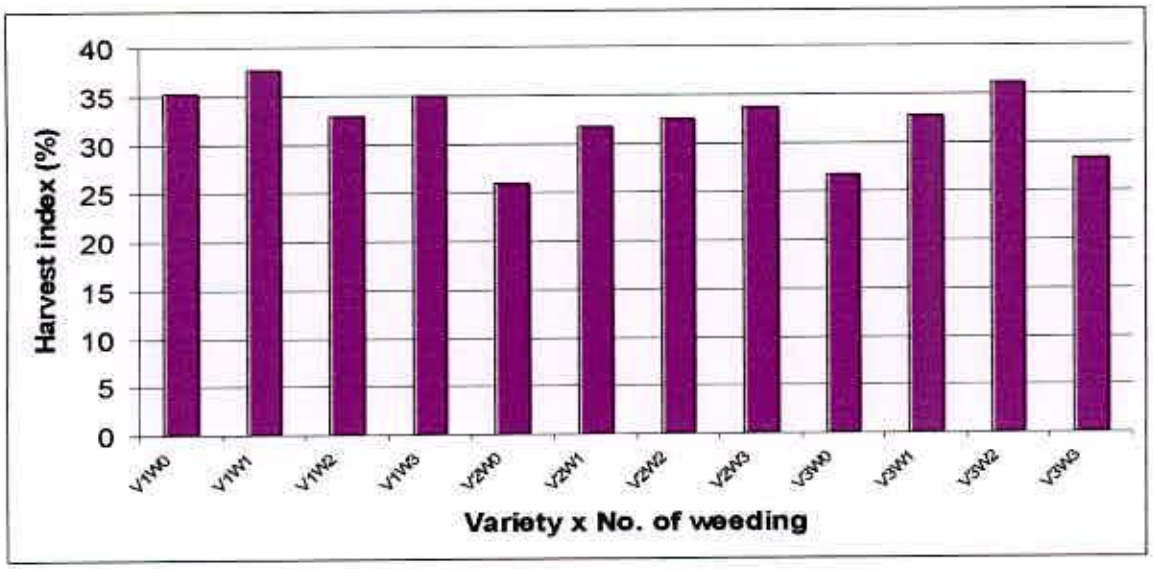
Effect of weeding

Weeding significantly effected the harvest index (Appendix 5 and Table 4). One weeding produced the highest harvest index (34.08%) which was statistically similar two weedings and three weedings treatments (33.87%) and (32.33%)

respectively. No weeding treatment showed the lowest value of harvest index (29.30%).

Interaction effect of variety and number of weeding

Harvest index was influenced by different varieties and number of weeding (Fig.13). The highest harvest index (37.72%) was observed in Improved Tori-7 with one weeding. The second highest harvest index (36.19%), was observed in SAU sarisha-1 with two weedings that similar with Improved Tori-7 in no weeding (35.26%) that followed by (34.92%) in Improved Tori-7 with three weedings. The lowest harvest index (25.91%) was obtained in the interaction of BARI Sarisha-12 with no weeding.

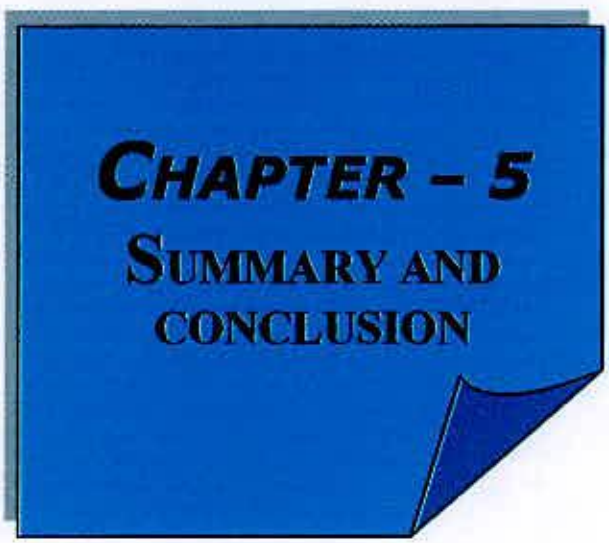


V_1 = Improved Tori-7 V_2 = BARI sarisha-12 V_3 = SAU sarisha-1

W_0 = No weeding W_1 = One weeding at 20 DAS

W_2 = Two weedings at 20 DAS and 30 DAS W_3 = Three weedings at 20, 30 and 40 DAS

Figure 13. Interaction effect of variety and number of weeding on harvest index of rapeseed. ($LSD_{0.05}$ = 4.391)


CHAPTER – 5
SUMMARY AND
CONCLUSION

SUMMARY AND CONCLUSION

The field experiment was conducted at the Agronomy Field of Sher-e- Bangla Agricultural University (SAU), Dhaka in the Rabi season (November- February) of 2006-2007 to study influence of varieties of number of weeding on their growth and yield of rapeseed. The treatment comprised of 3 varieties and 4 levels of weeding. Different varieties were Improved Tori-7, BARI sarisha-12 and SAU sarisha-1. The weeding treatments were no weeding, single weeding at 20 DAS, two weedings at 20 DAS and 30 DAS and three weedings at 20, 30 and 40 DAS. The experiment was laid out in a factorial Randomized Complete Block Design (RCBD) factorial with three replications.

The data on crop growth characters like plant height, plant dry weight were recorded at different days after sowing in the field and yield as well as yield contributing characters like number of branches plant^{-1}, siliquae plant^{-1}, number of seeds siliqua^{-1}, length of siliqua, 1000 seed weight, grain and stover yield were recorded after harvest and analysis was done using the IRRISTAT (Version 4.0, IRRI, Philippines) computer package program. The mean differences among the treatments were compared by least significant difference test at 5 % level of significance.

Results of the experiment showed that the plant height was significantly influenced by variety at 25 and 50 DAS and at harvest. At 25 DAS, the tallest plant height (16.43cm) was obtained from Improved Tori-7 and the shortest plant

height (12.77cm) was obtained from SAU Sarisha-1. At 50 DAS the tallest plant height (96.25cm) was obtained from BARI Sarisha-12 and the shortest plant height (68.46cm) was obtained from SAU Sarisha-1. But at harvest the tallest plant height was obtained from SAU Sarisha-1 (120.94cm) and the shortest plant height (97.53cm) was obtained from Improved Tori-7.

The plant height was also significantly influenced by the number of weeding at 25 and 50 DAS, but insignificant at harvest. At 25 DAS, the tallest plant height (16.52cm) was produced with no weeding. The shortest plant height (13.61cm) was produced with two weedings. At 50 DAS the tallest plant height (85.66cm) was obtained from one weeding and the shortest plant height (81.91cm) was obtained from two weeding.

At 25 DAS, the longest plant height was obtained from Improved Tori-7 with no weeding. The shortest plant height (11.58cm) was obtained from SAU sarisha-1 having two weeding. At 50 DAS, the longest plant height (99.68cm) was obtained from BARI sarisha-12 with three weedings. The shortest plant height (66.80cm) was obtained from SAU sarisha-1 having one weeding. At harvest all the interaction treatments showed similar plant height except Improved Tori-7 having one weeding.

At 25 DAS, the highest plant dry weight (2.55g) was obtained from Improved Tori-7. At 50 DAS the highest plant dry weight (16.10g) was obtained from BARI sarisha-12 that followed by Improved Tori-7. The lowest plant dry weight

(12.20g) was obtained from SAU sarisha-1. At harvest the highest plant dry weight (196.00g) was obtained from SAU sarisha-1 and the lowest plant dry weight (100.00g) was obtained from Improved Tori-7.

At 25 DAS, the highest plant dry weight (2.41g) was obtained from no weeding. The lowest plant dry weight (2.08g) was obtained from two weedings. At 50 DAS the highest plant dry weight (16.52g) was obtained from one weeding and the lowest plant dry weight (13.29g) was obtained from two weedings. But at harvest the highest plant dry weight (151.67g) was obtained from one weeding and the lowest plant dry weight (131.11g) was obtained from three weedings. Interaction effect of plant dry weight at 25 DAS, the highest plant dry weight (3.37 g) was obtained from Improved Tori-7 with no weeding. The lowest plant dry weight (1.44g) was obtained from SAU sarisha-1 with no weeding. At 50 DAS, the highest plant dry weight (18.47g) was obtained from BARI sarisha-12 with no weeding and the lowest plant dry weight (9.32g) was obtained from SAU sarisha-1 having two weedings. At harvest, the highest plant dry weight (223.33g) was obtained from SAU sarisha-1 having no weeding. The lowest plant dry weight (96.67g) was obtained from Improved Tori-7 having one weeding.

The highest number of branches per plant (10.79) produced by the variety SAU sarisha-1. In case of weeding one weeding produced the highest number of branches per plant (8.79) where no weeding treatment gave the lowest number of branches plant^{-1}. The SAU sarisha-1 and two weedings produced the highest

number of branches plant^{-1} (11.73). The lowest number of branches plant^{-1} was observed in the Improved Tori-7 and three weedings (6.53).

The SAU sarisha-1 produced the highest number of siliquae plant^{-1} (240.13). Improved Tori-7 produced the lowest number of siliquae plant^{-1} (163.43). The highest number of siliquae per plant (222.70) produced by no weeding where two weedings gave the lowest number of siliquae plant^{-1} (149.14). The interaction between the variety SAU sarisha-1 and no weeding produced the highest number of siliquae plant^{-1} (251.83). The lowest number of siliquae plant^{-1} was observed in the interaction of Improved Tori-7 with one weeding (151.70).

The longest length of siliqua (6.28 cm) produced by the no weeding where three weedings gave the lowest length of siliqua (5.61cm). Improved Tori-7 produced the longest siliqua (6.54cm) with no weeding treatment. But the lowest siliqua length was observed from the interaction of BARI sarisha-12 with three weedings (5.33cm).

The highest number of seeds per siliqua (18.60) produced by the variety Improved Tori-7. The lowest number of seeds per siliqua (17.14) produced by the variety SAU sarisha-1. Two hand weedings produced the highest number of seeds per siliqua (19.37). The lowest number of seeds per siliqua (16.77) was obtained from three weedings. The highest number of seeds per siliqua (20.40) was observed in the Improved Tori-7 with two weedings and the lowest number of seeds per

siliqua (15.19) was observed in the interaction of Improved Tori-7 having three weedings.

BARI sarisha-12 produced the highest 1000 seed weight (2.92g). Two weedings plot produced the highest 1000 seed weight whereas three times weeded plot produced the lowest weight of 1000 seeds (2.35g). The highest weight of 1000 seed (3.81g) was observed in BARI sarisha-12 having two weedings. The lowest weight of 1000 seeds (1.99g) was obtained from the interaction of BARI sarisha-12 with three weedings.

Seed yield of rapeseed was not significantly influenced by the variety and the number of weeding but significantly influenced by the interaction. The highest seed yield (1.57t ha^{-1}) was obtained from the combination of SAU sarisha-1 and one weeding. The lowest seed yield (1.15 t ha^{-1}) was obtained from the interaction of BARI sarisha-12 with no weeding.

Stover yield was significantly influenced by the variety and the interaction but insignificant by the number of weeding. SAU sarisha-1 gave the highest stover yield (3.45 t ha^{-1}) which was statistically similar with BARI Sarisha-12 (3.31 t ha^{-1}). The lowest stover yield (2.95 t ha^{-1}) was observed from Improved Tori-7. Stover yield was found to be highest (3.83t ha^{-1}) with the combination of SAU sarisha-1 and no weeding and lowest (2.52 t ha^{-1}) with the treatment combination of Improved Tori-7 with three weedings.

Tori-7 produced the highest harvest index (35.21%). One weeding produced the highest harvest index (34.08%) and no weeding treatment showed the lowest value of harvest index (29.30%). The highest harvest index (37.72%) was observed in Improved Tori-7 with one weeding and the lowest harvest index (25.91%) was obtained in the interaction of BARI sarisha-12 with no weeding.

The single effect of variety and number of weeding as well as their interaction did not show as significant variation for shelling percentage.

By summarizing the above discussion, the conclusion may be drawn as follows:

The seed yield of mustard varied with varietal difference along with different weeding intervals. The growth behaviour of the three studied varieties were different and hence weeding recommendation also varied. The variety SAU sarisha-1 showed its maximum yield response with one and two weedings but BARI sarisha-12 responded better with two weedings. The variety Improved Tori-7 did not need any weeding probably due to its earlier better growth behaviour. However it is not wise to recommend with a single experiment findings and in a single location study and hence the same experiment should be counducted in different regions of the country for sustainable recommendation.

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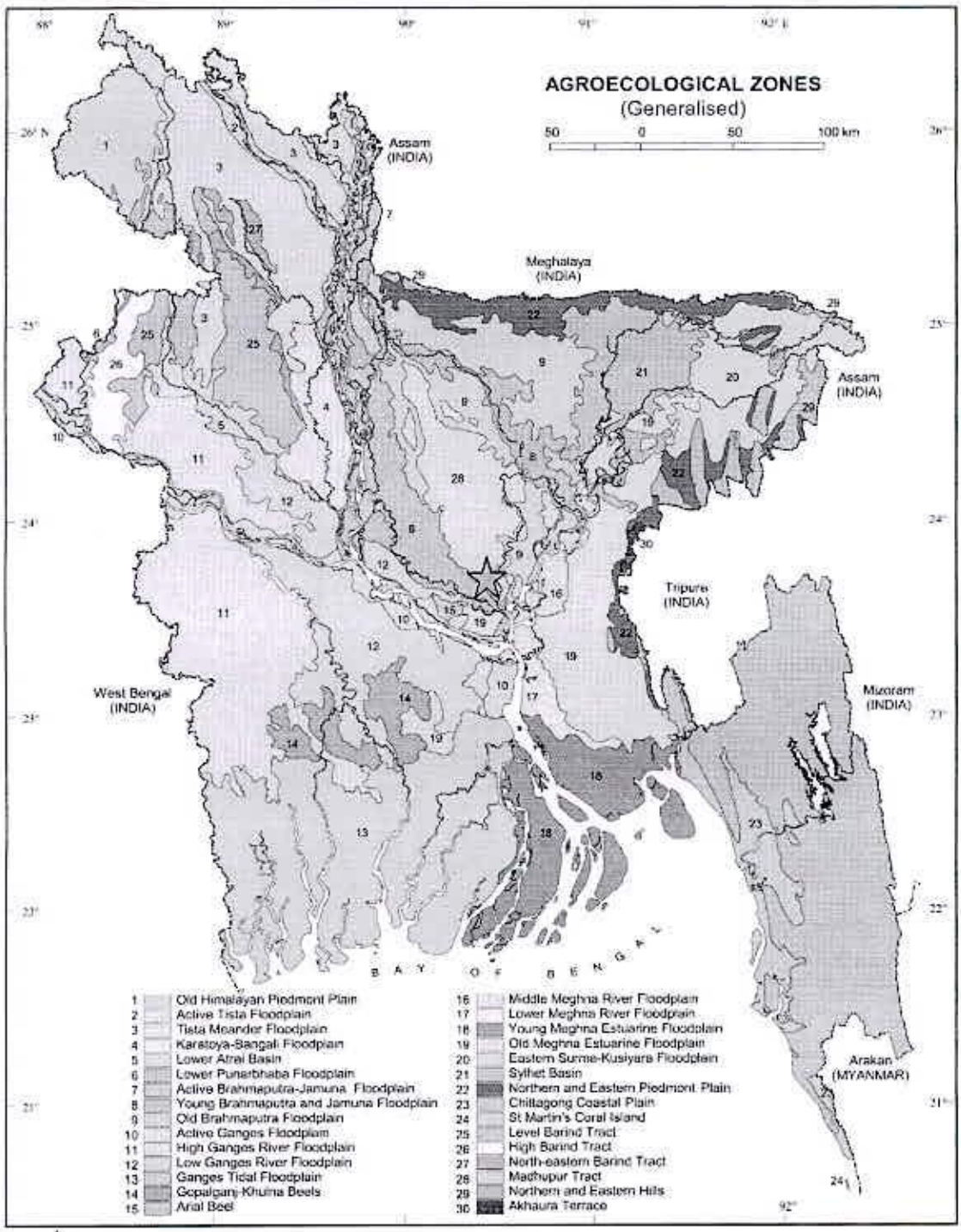
APPENDICES

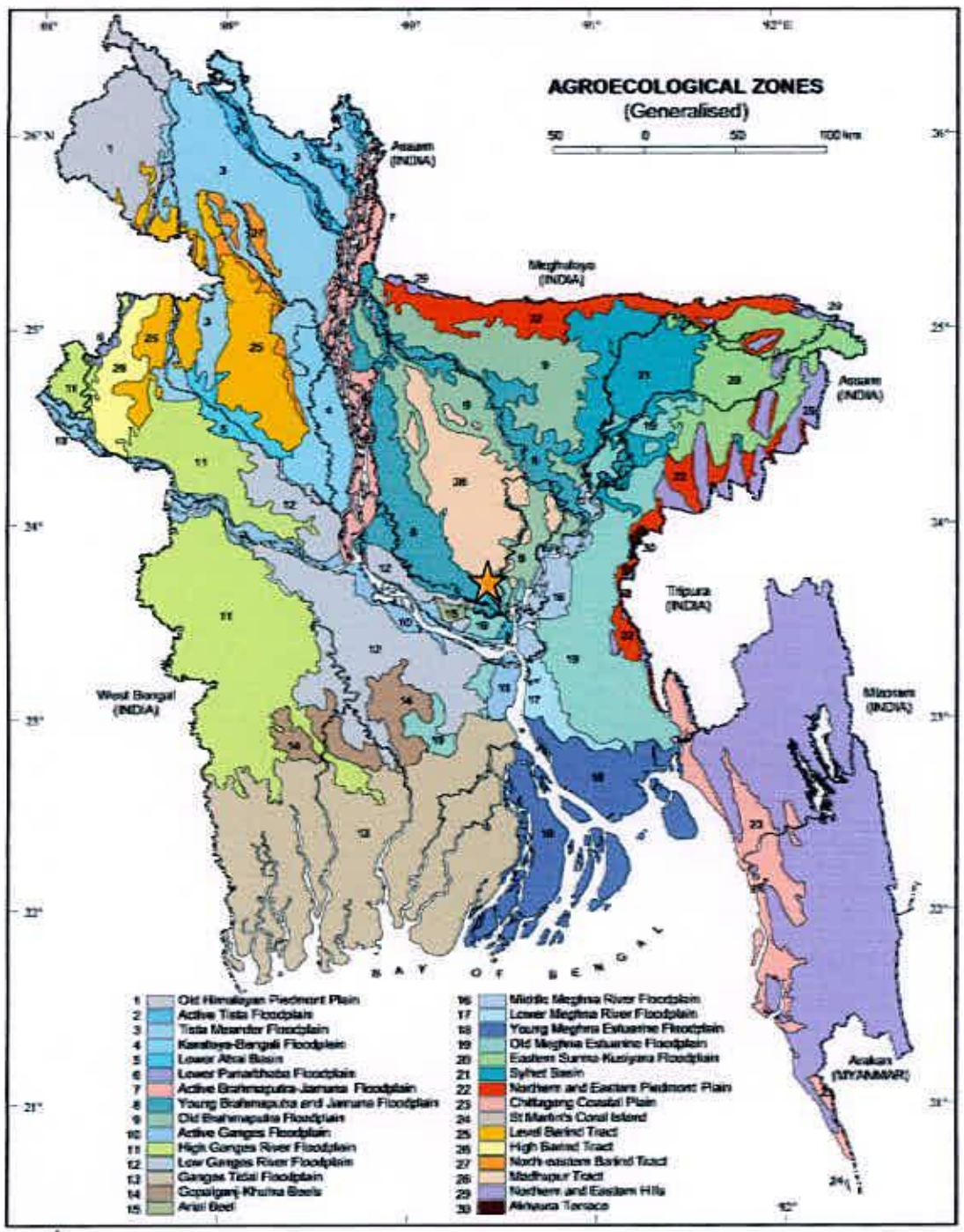
Appendix I. Map showing the experimental sites under study



☆ **The experimental site under study**

APPENDICES

Appendix I. Map showing the experimental sites under study



★ **The experimental site under study**

Appendix II. Means square values for plant height of rapeseed at different days after sowing

Sources of variation	Degrees of freedom	Means square		
		25 DAS	50 DAS	At harvest
Replication	2	0.245	6.372	287.129
Variety	2	40.193	2358.41	1941.96
Weed	3	15.791	23.199	128.914
Variety x Weeding	6	3.981	39.593	330.987
Error	22	0.193	2.095	251.260

Appendix III. Means square values for plant dry weight of rapeseed at different days after sowing

Sources of variation	Degrees of freedom	Means square		
		25 DAS	50 DAS	At harvest
Replication	2	0.000	0.958	4.861
Variety	2	1.057	52.530	28209.0
Weed	3	0.168	16.846	771.296
Variety x Weeding	6	0.774	7.915	1796.99
Error	22	0.559	1.556	32.891

Appendix IV. Means square values for yield attributes of rapeseed

Sources of variation	Degrees of freedom	Branches plant^{-1} (No.)	Siliquae plant^{-1} (No.)	Siliquae length (cm)	Seeds siliquae^{-1} (No.)	1000 seed weight (g)
Replication	2	0.572	911.268	0.148	0.374	0.027
Variety	2	54.579	18066.3	0.708	7.396	0.068
Weed	3	1.796	2480.98	0.794	10.185	2.426
Variety x Weeding	6	2.539	1693.98	0.400	7.761	0.311
Error	22	0.217	436.839	0.139	1.228	0.064

Appendix V. Means square values for yield, harvest index and shelling percentage of rapeseed

Source of variation	Degrees of freedom	Shelling percentage	Seed yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index
Replication	2	10.980	0.277	0.933	16.930
Variety	2	111.714	0.510	0.789	71.286
Weed	3	82.872	0.119	0.197	43.747
Variety x Weeding	6	54.962	0.102	0.306	29.203
Error	22	58.816	0.408	0.296	6.726