EFFECT OF MULCHING AND FERTILIZERS ON GROWTH AND YIELD OF TURNIP (*Brassica rapa* sub sp. *rapifera*)

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EFFECT OF MULCHING AND FERTILIZERS ON GROWTH AND YIELD OF TURNIP (*Brassica rapa* sub sp. *rapifera*)

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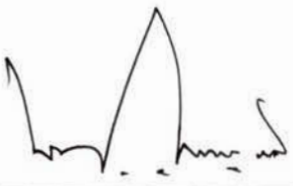
CERTIFICATE

This is to certify that the thesis entitled "**Effect of Mulching and Fertilizers on Growth and Yield of Turnip** (*Brassica rapa* sub sp. *rapifera*)" submitted to the Dept. of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in HORTICULTURE, embodies the result of a piece of bona fide research work carried out by **TASHNUVA MOZUMDER**, Registration No. **00740/27585** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:

Dhaka, Bangladesh



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Dedicated

to

My parents

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The Author

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By

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ABSTRACT

An experiment was conducted in the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November 2006 to January 2007 to study the effect of mulching and fertilizers on growth and yield of turnip. No mulch (M_0) and mulch of water hyacinth ((M_1)) were used for mulching treatment and 6 levels of fertilizers vis. without fertilizer (F_0), Cowdung (F_1), Oil cake (F_2), Cowdung + Oil cake (F_3), Urea + Triple Super Phosphate + Muriate of potash (F_4) and Cowdung + Urea + Triple Super Phosphate + Muriate of potash (F_5) were used. The tallest plant (57.40 cm), maximum total fresh weight per plant (571.31 g), highest yield per hectare (35.98 t) was recorded from M_1 At harvest the tallest plant (61.60 cm), maximum total fresh weight per plant (650.06 g), highest yield per hectare (40.22 t) was recorded from F_5. At harvest the highest gross return Tk. 322,800 was obtained from M_1F_5 and the highest net return Tk. 174,312 was obtained from M_1F_5 and the maximum (2.17) benefit cost ratio was attained from M_1F_5.

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Chapter 1

INTRODUCTION

Turnip (*Brassica rapa* sub sp. *rapifera*) is a herbaceous biennial and winter vegetable crop under the family of Cruciferae (Rashid, 1999). It is mainly grown for the sake of its storage organ, the hypocotyls and the swollen upper part of the root and lower part of the stem. It has a crisp white flesh and a zesty mustard-like flavor and a rapidly maturing crop. Its root is called under ground modified root, which is napiform in shape (Langer and Hill, 1983). The stem is short at vegetative stage but elongated at the reproductive stage.

Turnips have been cultivated in Europe for over 4,000 years. It is a native of central and southern Europe and has now spread all over the world. It is a newly introduced crop in our country. It has considerable nutritive value considering other cole crops. The fleshy root and young leaves are edible portion and nutritionally not so poor as commonly believed. A thousand gram of edible roots contain 1.4 g protein, 6.2 g carbohydrate, little fat, 0.6 g mineral salt, 0.03 mg vitamin B-1, 0.02 mg vitamin B-2, 15 mg vitamin-C, 24 mg calcium, 0.4 mg iron and 21 Kilocalories. One hundred gram of edible leaf contains-4 g protein, 9.4 g carbohydrate, 1.5 g fat, 2.2 g minerals salt, 0.31 mg vitamin B-1, 0.57 mg vitamin B-2, 180 mg vitamin C, 710 mg calcium, 28.4 mg iron, 9396 µg calcium, 28.4 mg carotene and 67 kilocalories energy (Purseglove, 1988).

Mulch can be put over the line emitter to increase the effectiveness of watering and to control weeds. Since the mulch reduces the loss of fertilizers by eliminating downward movement during heavy rain, it is possible to reduce near about 25% amount of fertilizer (Diane, 2000). Mulching can make all the difference between a vegetable garden that is a joy to work and watch and one that is tedious and untidy. Among mulch's greatest attributes is its ability to help control weeds. Mulch also helps conserve soil moisture by 50% or more by covering the soil to slow down evaporation (Holmer, 1998). Nutrients do not leach so readily under

mulches because less rainwater penetrates. Vegetables remain cleaner in mulched gardens because they have less contact with the soil. Finally, organic mulches can keep soils cool. Soils will remain cool longer in the spring under organic mulches, because the sun does not strike the soil. Most of organic mulches will compact and start to decompose by fall. They can be tilled under easily, adding valuable organic matter to the soil. Some gardeners prefer to maintain permanent mulch, adding organic materials as it becomes available. In the spring, they simply pull back the mulch in spots for transplants or in rows for direct-seeded vegetables. This method is a good way to build a rich garden soil (Ahmad *et al.*, 1999).

Mulching will increase yields, conserve moisture, prevent weed growth, regulate soil temperature, and lessen losses caused by ground rot of many vegetable crops. Organic mulches can be made of straw, leaves, grass, bark, compost, sawdust, or peat moss. Organic mulches incorporated into the soil will improve the soil tilth, aeration, and drainage. The amount of organic mulch to use depends upon the type, but 1 to 2 inches of organic material applied to the garden surface around growing plants is adequate. In turning organic mulches under for subsequent crops, add additional fertilizer at the rate of about 1 pound per 100 square feet to help soil organisms break down the additional organic matter (Zerle, 2003).

To attaining considerable production and quality yield for any crops it is necessary to proper management including ensuring the availability of essential nutrient components. Turnip thrives well in a fertile, clay loam soil because it requires considerable amounts of nutrients to sustain rapid growth in short time. A large amount of manures and fertilizer is required for the growth of the non-heading leaves (Opena *et al.*, 1988). A shortage of manures and fertilizer during early growth may lead to the condition known as "buttoning" when plant becomes stunted (Tindall, 1983).

For vegetables to produce lush, continuous growth throughout the season, need a uniform supply of nutrients. However, many chemical fertilizers are very soluble, so the initial application may leach beyond the root zone before the growing season ends. Thus, many gardeners side dress their crops with an extra application of fertilizer during the growing season. A combination of chemical fertilizer, organic fertilizer and mulch makes a good side dressing. The chemical fertilizers give the initial boost required by young plants; organic fertilizers provide nutrients uniformly throughout the season; and mulch keeps the soil more evenly moist and the nutrients more uniformly available (Sam and Frank, 2006).

Considering the above circumstances, the present investigation was undertaken with the following objectives:

1. to investigate the effect of mulch material on the growth, development and yield of turnip

2. to identify the effect of fertilizers on consideration of growth and yield of turnip

3. to measure the combined effect of mulch material and fertilizers on growth and yield of turnip

Chapter II

REVIEW OF LITERATURE

2.1 Effect of mulching

Kalisz and Cebula (2001) carried out an experiment in Poland to conclude the effect of soil mulched with polythene film and plant covered with non-woven polypropylene and perforated polythene film on the growth and yield turnip during the period 1997-98. Plants coverings were given directly after planting the transplants. Soil mulching was spread 1-2 days before the beginning of the field experiment. They observed that plant height, root diameter and the number of leaves and their area build-up by the plastic covers considerably improved plant growth. Among the treatments, non-woven polypropylene recorded the highest (90.38 and 60.74 t/ha in 1997 and 1998, respectively) and the control treatment recorded the lowest yields (28.80 and 26.37 t/ha).

Efficiency of different mulches is again a point to be considered in an experiment while Hossain (1999) working with different mulches on the growth and yield of cabbage in the Department of Horticulture, Bangladesh Agricultural University, Mymensingh and observed maximum gross and marketable yields (116.67 t/ha and 97.53 t/ha, respectively) from black polythene mulch and the lowest (92.33 t/ha and 40.56 t/ha) was from the control condition.

In an experiment on the effect of mulches (black paper, black polythene, straw) on turnip, leeberg, lettuce, bulterhead lettuce, Chinese cabbage and leeks in the Netherlands, Poll and Gaven (1996) observed that mulches increased yields of turnip, lceberg and bulterhead lettuces and Chinese cabbage. Nitrogen leaching to ground water was decreased with mulches.

Saifullah *et al.* (1996) while working with mulches and irrigation in the Horticulture Farm, Bangladesh Agricultural University, Mymensingh and reported that yield and most of the

yield contributing characters like plant height, number of loose leaves per plant, diameter and thickness of head, weight of loose leaves, stem, roots, head, whole plant and total dry matter per head were significantly increased by the application of irrigation and mulches. Mulching was found to be more effective during the early stage of plant growth. The highest marketable yield was obtained by irrigation treatment (37.09 t/ha) followed by black polythene (33.16 t/ha), water hyacinth (26.91 t/ha), sawdust (20.66 t/ha) and straw (24.64 t/ha) and the lowest (12.68 t/ha) by the control condition. They concluded that as an alternative to irrigation, water hyacinth and straw can be adopted as feasible mulches to increase the yield by conserving the residual soil moisture.

Santipracha and Sadoodee (1995) conducted an experiment in Panjab Agricultural University, India during September, 1992 to January 1993 to study the effect of plastic sheets or nylon net and reported that cabbage grown under rain protection showed better growth than control. The highest head weight (913.5 g) and yield (11.39 t/ha) were observed for plastic sheets. Rahman (1995) reported similar results for black polythene mulching while conducting an experiment in Bangladesh Agricultural Research Institute, Gazipur, Bangladesh, adding that paddy husk had been found to be more effective in increasing the growth and yield of cabbage which straw mulch had adverse effects.

Hembry *et al.* (1994) conducted an experiment in Horticulture Research International, Warwick, UK to evaluate a range of ground cover mulches including black paper, black polythene and straw for their effect on weed control. They reported excellent weed control and maximum yield with all mulches except straw.

Roy *et al.* (1990) carried out an experiment in the department of Crop Botany, Bangladesh Agricultural University, Mymensingh to study the effect of water hyacinth, rice straw and sawdust mulches. They reported that mulches increased crop growth rate, net assimilation

rate and leaf area index. Water hyacinth significantly increased chlorophyll-b content, growth and yield.

An investigation was conducted by Benoit and Ceustermans (1990) to estimate the influence of mulch in National Vegetable Research Station, UK and found that the yield was better at double layer than that of single layer mulch. It was recorded that double layer of paper mulch had better temperature condition for the growth of the twenty outer leaves than single layer.

Gattorsen (1992) conducted an experiment to evaluate the effects of plastic mulch on the yield and yield contributing characters and reported that the double layer produced the higher yield than single layer mulching.

Subhan (1989) carried out an experiment with mulching in Indonesian Institute of Horticulture, Indonesia and found that mulching increased significantly the yield. Gunadi and Asandhi (1990) while working in Vegetable Research Institute, Seoul, Korea Republic, noticed that straw and plastic mulches encouraged growth of early season.

In an experiment conducted by Yoon *et al.* (1984) to study the effect of mulches in Vegetable Research Institute, Seoul, Korea Republic and found that black polythene, straw and clear polythene gave higher rate of growth and development.

Oh *et al.* (1984) while conducting an experiment in Seoul, Korea Republic, to investigate the effect of different mulches on growth and they found that black polythene mulch increased the growth and ensure the optimum soil temperature for proper growth and development as well as higher yield.

Braggnolo and Miclniezuk (1990) also reported that mulches increased the growth and yield and as well as marketable yield. Similar results also reported by Ashworth Harrison (1983)

conducted an experiment with mulches in the Department of Botany, University of Edinburgh, UK and found that mulching increased the marketable yield.

An experiment was carried out by Hill *et al.* (1982) in Connecticut Agricultural Experiment Station, New Haven, USA to study the effect of mulches on the growth and yield. They found that temperature and moisture regimes of soil were greatly influenced by mulching. They also stated that mulching influenced the growth producing well developed root system, highest plant height, spread of plant, stem length, number of loose leaves.

While conducting an experiment in Behar Agricultural College, India, Acharya, B.C. (1988) and reported that mulching significantly increased the yield. Similar results were also found by Oyabu *et al.* (1988) when carried out an experiment in Indonesian Institute of Horticulture, Indonesia.

The allelopathic potential of isothiocyanates released by turnip with mulch was evaluated by Petersen *et al.* (2001) in Germany. Six different mulches were identified for turnip cultivation. In their recorded results it was found that yield and yield contributing characters was reportable than the control condition. Again, in the soil where mulch was incorporated, only low amounts of weeds were recorded.

Stolze *et al.* (2000) reported a comprehensive overview of European research focused on the relationship between organic production practices and environmental quality. The study was designed to provide a qualitative assessment of the impact of organic farming on the environment and resource use compared with that of conventional farming practices. Besides addressing water quality issues such as nitrate leaching and runoff from compost piles, this review also addresses flora and fauna diversity, energy use, animal health and welfare, and food quality of organically produced foods. Rated on a scale from "much better" to "much

worse" (overall) organic farming was rated "the same as" conventional farming systems in about 40 percent of the categories, "better" in 40 percent, and "much better" in 20 percent.

Conacher and Conacher (1998) begin with a discussion of environmental benefits commonly attributed to organic farming systems, including improvements in soil structure and porosity, water infiltration and water-holding capacity, nutrient cycling and nutrient retention, and buffering against pest and disease infestations. In reference to Australia the authors stress the ability of organic farming practices to build up soil organic matter reserves to restore hydrological balances and enhance soil structure in saline soils.

Drinkwater *et al.* (1998) reported that Nitrogen and carbon losses from organic and conventionally managed fields were analyzed over 15 years. Immobilization of nitrogen by soil organisms and soil organic matter caused nitrogen to accumulate in organically managed fields. Conventional fields had less nitrogen immobilization and more nitrate leaching than the organic plots. Nitrate-leaching was 50% more in the conventionally managed fields compared to the organically managed fields. In addition, organic fields had higher water infiltration rates, higher water holding capacity, reduced soil erosion, and increased soil productivity.

Pang and Letey (2000) estimates the rates and amounts of nitrogen mineralized from organic materials are not consistent with nutrient needs of turnip and other crops grown under organic production methods. To meet nutrient demands of turnip, excessive amounts of manure must be applied. As this manure mineralizes, nitrate not taken up by the crop plants is susceptible to leaching. Turnip varieties have a narrow time period during which they require high nitrogen availability to obtain optimum yields. Nitrogen mineralization occurs too gradually to meet these peak demands, resulting in sub-optimal yields. Mineralization that continues beyond the time of peak nitrogen uptake can release nitrate, which is then subject to leaching.

Related studies show that nitrogen leaching was greatest when poor growing conditions resulted in rapid nitrogen mineralization but limited nitrogen uptake by plants. The authors suggested that the lack of synchrony they observed between nitrogen mineralization and nitrogen uptake was due to the use of nitrogen responsive.

Mikkelsen (2000) reported about nutrient management practices, processes used to manage land in organic farming, and potential problems that could arise in the certification of organic farms. The case study describes an organic vegetable farming operation that uses poultry manure as a source of organic matter and nutrients. Unfortunately, the manure additions have resulted in buildups of copper and zinc in the soil because these compounds were used as feed supplements for poultry. The concentrations of these heavy metals in the soil have limited the farmer's ability to grow certain copper-sensitive crops and are causing him problems in trying to keep his organic certification.

Truggelmann *et al.* (2000) reported that the best yield and quality results for vegetable production in Philippine soils are obtained, when a combination of organic and inorganic fertilizers is applied. Organic fertilizers such as manure and compost are needed to improve the physical, biological and chemical properties of the soil while inorganic fertilizers such as urea, muriate of potash, and others supply sufficient amounts of readily available nutrients. Organic fertilizers supply the same essential plant nutrients as inorganic fertilizers. The major difference is in their availability and concentration. Inorganic fertilizers contain nutrients that are available immediately and highly concentrated. While organic fertilizers normally do not exceed values of 3% for nitrogen, phosphorous and potassium, those are much higher in inorganic fertilizers (46% N in urea, 60% K_2O in muriate of potash, 46% P_2O_5 in DAP). If one wishes to grow crops only with organic fertilizers, it has to be considered that tons per hectare must be applied to supply typical crop nutrient needs. An excess application of organic fertilizers may also result in chemical fixation of micronutrients such as zinc.

Liu and Hu (2000) carried out an experiment on growing turnip in an area of 2960 m above sea level in Gansu, China indicated that plastic mulching would promote the growth and yield of the turnip by improving soil temperature and moisture. Compared with the control (without mulching), the crop with mulching had earlier emergence by 6 days, a 2-fold faster average growth rates, a 1.65-fold larger maximum leaf area index, a 15 days longer closed canopy, a 20.8% higher yield and increased protein, fibre, Ca and P. Highest yield was attained than control.

Crusciol *et al.* (2005) reported that straw of covering plants kept on soil surface in no-tillage system is an important source of nutrients for subsequent tillage. This study investigated the decomposition and release of macronutrients from forage turnip residues. The experiment was set under field conditions during 1998 in Marechal Candido Rondon, Parana, Brazil. Forage turnip plants were desiccated and lodged 30 days after emergence. Straw persistence and nutrient release were evaluated at 0, 13, 35, and 53 days after management. Untill per-flowering stage, the crop turnip showed a high dry matter yield (2938 kg/ha) during winter, and accumulated 57.2, 15.3, 85.7 and 14.0 kg/ha of N, P, K, Ca, Mg and S, respectively. Forage turnip management at pre-flowering stage resulted a quick straw degradation and macronutrients release. Potassium and N were released in the highest amounts and in the shortest time to subsequent tillage. The fastest liberation of nutrients occurred between 10 and 20 days after plant management.

Albayrak *et al.* (2004) conducted an experiment to identify the effects of four row spacing (20,30,40, and 50cm) on root and leaf yield and some yield components of four forage turnips (*Brassica rapa* [B. campestris]) (diploid cultivars Agressa, Slioganova, tetraploid cultivars Polybra Volenda) were evaluated under the Black Sea Coastal Area Conditions in the 2002 and 2003 growing seasons. The root yield, root dry matter yield, root crude protein yield, root diameter, root length, leaf yield, leaf dry matter yield, and leaf crude protein yield were

determined. Row spacing significantly affected most of the yield components determiner in forage turnip cultivars. Root and leaf yields and their yield components increased along with increase of row spacing. The highest root and leaf dry matter yields were obtained from the 40 cm row spacing. The Volenda cultivar had the highest yield under the Black Sea Coastal Area Conditions.

2.2 Effect of mulch and fertilizers

Akand (2003) carried out a field experiment with different levels of organic manure and mulching trail on carrot growth and yield in Horticulture Farm, BAU, Mymensingh and observed that black polythene and cowdung significantly resulted the highest yield of carrot of his experiment.

In a trials between Aug. and Nov. by Subhan (1989) at a site 1250 m a.s.l., mulched and unmulched plants received the NPK fertilizer at 0, 600, 800 or 1000 kg/ha. There was no interaction between the fertilizer and mulching with regard to plant growth and yield. Mulching had a significant positive effect on plant height but had little effect on yield. The yield was greatest with the highest NPK rate.

Widjajanto *et al.* (2003) conducted an experiment to evaluate the effects of 0, 20, 40 or 60 g water hyacinth (WH; E. crassipes) residues as source of nitrogen, on the performance were determined in a pot experiments conducted in Japan. Dry matter and yield increased with increasing rates of WH residues up to 20 and 40 g, respectively, and decreased thereafter. The yield increased with increasing WH residues up to 20 and 40 g, and decreased thereafter. Application of WH residues reduced the N recovery.

Magnusson (2002) conducted an experiment on mineral fertilizers and green to estimate the effect on nutrient uptake, yield and internal tip-urn. Large applications of mineral fertilizers in increased growth, total nitrogen and nitrate concentrations at harvest, and increased the

occurrence of internal tip-burn. Green mulch, as the only fertilizer or in combination with small amounts of mineral fertilizers, resulted in slower growth and lower total nitrogen and nitrate concentrations at harvest, and also prevented the occurrence of internal tip-burn. No visible symptoms of nutrient deficiencies were detected, but plant analyses showed that the concentrations of magnesium, zinc, manganese and copper were below the estimated sufficiency limits in all fertilizer regimes. High soil pH, 6.4-6.8, and large amounts of calcium in the soil decreased the availability of these elements. The results demonstrate the importance of simultaneous analyses of several elements in revealing suboptimal concentrations and/or imbalances that depress yield and quality but do not result in visible symptoms. The results also indicate that organic fertilizers such as green mulch may be more suitable than mineral fertilizers in preventing the occurrence of physiological disorders such as tip-burn.

Jaiswal *et al.* (1997) carried out three pre-production verification trials, one each on off-season (summer) turnip, radish, carrot and Chinese cabbage were carried out at various Outreach Research (OR) and Off-Station Research (OSR) Sites in Lumle Agricultural Research Centre's Research Command Area in an altitudinal range of 430-2000 m asl. Carrot cultivars New Kuroda and Early Nantes performed well during the off-season (summer) with Early Nantes performing slightly better than New Kuroda. On average (over 10 locations) Early Nantes out yielded New Kuroda by 14% irrespective of mulching practice. Farmers and consumers from most of the sites preferred Early Nantes for its good yield, attractive root colour and shape, and comparatively higher root sugar content.

An experiment was conducted at the Horticultural Farm of Bangladesh Agricultural University, Mymensingh during the period from October, 2000 to February, 2001 by Shamim and Kamruzzaman (2004) to study the effect of four levels of nitrogen and mulching on growth and yield and found that levels of nitrogen and mulching had significant influence on

the growth and yield. The maximum plant height, spread of plant, root length, stem length, fresh weight roots, dry matter of root, days to maturity, marketable yield (77.13 t/ha) and gross yield (103.90 t/ha) were recorded when nitrogen was applied at the rate of 240 kg/ha. The highest gross yield (104.04 t/ha) was obtained from the black polythene mulch followed by water hyacinth mulch (99.60 t/ha). Black polythene mulch produced the highest marketable yield (78.14 t/ha). The maximum gross yield (118.4 t/ha) and marketable yield (94.03 t/ha) were found in the treatment combination of 240 kg N/ha with polythene mulch.

Chapter III

MATERIALS AND METHODS

3.1 Experimental Site

An experiment was conducted at Horticulture Farm in SAU, Dhaka during November 2006 to January 2007. It was situated in $23^0 74'$ N latitude and $90^0 35'$ E longitude with an elevation of 8.2 meter from sea level (Anon., 1989).

3.2 Climate

The geographical situation of the experimental site was under the subtropical climate, characterized by three distinct seasons, the monsoon or rainy season from November to February and the pre-monsoon period or hot season from March to April and monsoon period from May to October (Edris *et al.*, 1979). The total annual rainfall of the experimental site was 218 mm and average monthly maximum and minimum temperature were 29.45^0C and 13.86^0C, respectively. Details of the metrological data of air temperature, relative humidity, rainfalls and sunshine during the period of the experiment was collected from the Bangladesh Meteorological Department and presented in Appendix II.

3.3 Soil

The soil of the experimental area was shallow red brown terrace soil and belongs to the Modhupur Tract (UNDP, 1988) under AEZ 28. The selected plot was medium high land and the soil series was Tejgaon (FAO, 1988). pH of the soil was 5.6. The characteristics of the soil under the experimental plot were analyzed in the Soil testing Laboratory, SRDI, Farmgate, Dhaka and details of the soil characteristics were presented in Appendix I.

3.4 Planting Materials

The seed of Tokyo-X (cross) a Japanese variety were used in this experiment. The seeds were collected from Dhaka Seed Store, Siddique Bazar, Dhaka.

3.5 Treatment of the Experiment

The experiment was designed to study the effect of mulching and fertilizers on growth and yield of turnip. The experiment considered of two factors. Details were presented below:

Factor A: Mulching (2 levels)

i. Non mulch/Control (M_0)

ii. Mulch of water hyacinth (M_1)

Factor B: Fertilizers (6 levels)

i. Without Fertilizers (F_0)

ii. Cowdung (F_1)

iii. Oil cake (F_2)

iv. Cowdung + Oil cake (F_3)

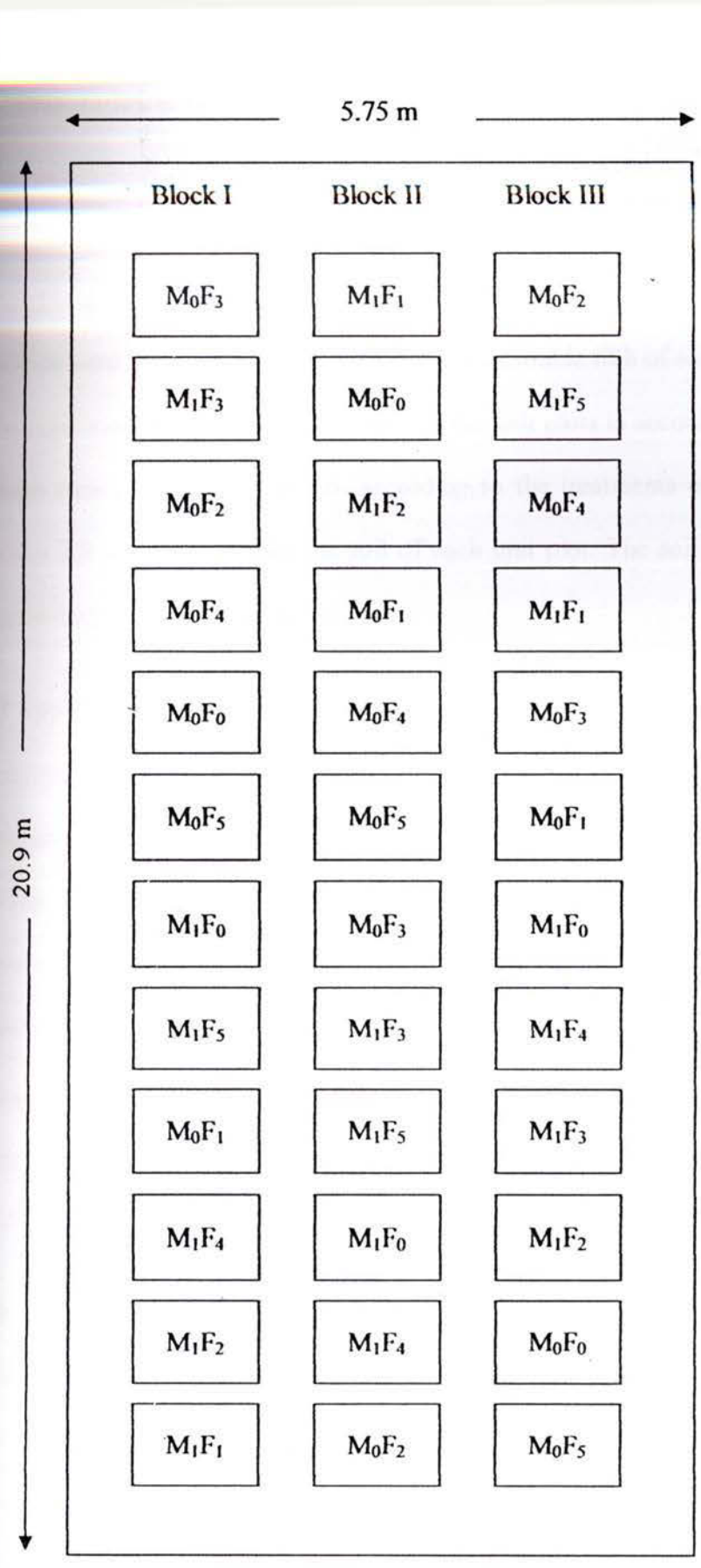
v. Urea + Triple Super Phosphate + Muriate of potash (F_4)

vi. Cowdung + Urea + Triple Super Phosphate + Muriate of potash (F_5)

There were 12 (2 × 6) treatment combinations such as M_0F_0, M_0F_1, M_0F_2, M_0F_3, M_0F_4, M_0F_5, M_1F_0, M_1F_1, M_1F_2, M_1F_3, M_1F_4, M_1F_5.

3.6 Layout of the Experiment

The experiment was laid out in two factors Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared for distributing the treatment combinations in each plot of each block. Each block was divided into 12 plots where 12 treatment combinations were allotted at random. There were 36 unit plots altogether in the experiment. The size of the plot was 125 cm × 120 cm. The distance between two blocks and two plots were kept 50 cm. The number of plant per plot is 15 and the total number of plant in the experimental plot is 540. The layout of the experiment is shown in Figure 1.



Plot size = 125 cm ×120 cm
Spacing: 40 cm ×25 cm
Plot spacing = 25 cm
Between replication=50 cm

Factors A:

M_0 = Non mulch/Control
M_1 = Mulch of water hyacinth

Factors B:

F_0=Without fertilizers
F_1= Cowdung
F_2=Oil cake
F_3=Cowdung + Oil cake

F_4=Urea+Triple Super Phosphate+Muriate of potash
F_5=Cowdung + Urea + Triple Super Phosphate + Muriate of potash
*** Cowdung=10ton/ha
Oilcake = 250 kg/ha
Urea = 310 kg / ha
TSP = 200 kg/ha
MP = 185 kg/ha

Figure 1. Layout of the experimental field

3.7 Preparation of the Main Field

The experimental plot was opened in the 1st week of November 2006 with a power tiller and was exposed to the sunlight for a week. After one week the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed and finally to obtain a desirable tilth of soil for sowing of turnip seed. The experimental plot was partitioned into the unit plots in accordance with the experimental design mentioned in section 3.6. according to the treatments of fertilizers as indicated in section 3.8 were mixed with the soil of each unit plot. The soil was treated with fungicide Cupravit against the fungal attack.

3.8 Application of Fertilizers

Fertilizers were used in accordance with the treatment. The total amount of Urea (46.5gm/plot), TSP (30gm/plot), MP (27.75gm/plot), well decomposed cow dung (1.5kg/plot) and oil cake (250gm/plot) were applied during the final land preparation. The sources of N,P,K were taken from Urea, TSP and MP respectively. We applied equal cost of fertilizers, the amount of Urea(310kg/ha),TSP(200kg/ha),MP(185/ha),well decomposed cow dung(10ton/ha) and oil cake(250kg/ha) were applied during the final land preparation.Amount of N,P_2O_5 and K_2O were found from cow dung,oil cake which presented in Appendix IX.

3.9 Application of Mulch Treatment

Water hyacinth mulch was provided immediately after emergence of seedling where small holes were made previously before used the mulch with maintaining proper spacing for seedling. The thickness of water hyacinth was maintained near about 10 cm.

3.10 Irrigation

Light over-head watered was provided with a watering can to the plots immediately after germination of seedlings. The un-mulched plot had to be watered more frequently than the

mulch plots. As a consequence, the amount of irrigation water was much higher in un-mulched plots.

3.11 Gap Filling

Dead, injured and week seedlings were replaced by healthy one from the stock kept on the border line of the experimental plot. Those seedlings were re-transplanted with a big mass of soil with roots to minimize transplanting shock. Replacement was done with healthy seedling having balls of earth with were also planted on the same date on border line. The transplanted seedlings were shading and watering for 07 days continued for the proper establishment of the seedlings.

3.12 Weeding

Minimum weed was found in the plots which were covered by water hyacinth mulches. But huge numbers of weed were found in the control condition. Weeding was done three times in these plots considering the optimum time for removal weed.

3.13 Plant Protection

The crop was protected from the attack of insect-pest by spraying Malathion @ 0.5 in 1 ha. The insecticide application were made fortnightly as a matter of routine work from seedling emergence to the end of harvest.

3.14 Harvesting

The crop was harvested depending upon the attaining good sized root. Harvesting was done manually. Enough care was taken during harvesting period to prevent damage of root.

3.15 Data collection

The data were collected from the inner rows of plants of each treatment to avoid the border effect. In each unit plot, 10 plants were selected at random for data collection. Data were collected in respect of the plant growth characters and yield of turnip. Data on plant height,

number of leaves/plant and length of leaf were counted at 25, 35, 45, 55 days after sowing and at harvest. However, for yields per plot all the 10 plants of each unit plot were considered. All other parameters were recorded at harvest. The following parameters were set up for recording data and for the interpretation of the results:

3.15.1 Plant height

The height of plant was recorded in centimeter (cm) at 25, 35, 45, 55 days after sowing (DAS) and after harvest by using a meter scale. The height was measured from the ground level to the tip of the leaf of an individual plant. Mean value of the ten selected plants was calculated for each unit plot.

3.15.2 Number of leaves per plant

Number of leaves per plant counted and the data were recorded from randomly 10 selected plants 25, 35, 45, 55 days after sowing (DAS) and after harvest. The mean value was counted and was expressed in centimeter (cm).

3.15.3 Length of leaf

Length of leaf was measured with a meter scale as the horizontal distance covered by the leaf at 25, 35, 45, 55 days after sowing (DAS) and after harvest from ten plants and mean value was recorded.

3.15.4 Fresh weight of modified root

The fresh weight of modified roots were recorded after harvest and cleaning from the average of 10 plants and expressed in gram. The weight of the modified roots was recorded immediately after harvest.

3.15.5 Fresh weight of leaves

The fresh weight of leaves was recorded after harvest and cleaning from the average of 10 plants and expressed in gram. The weight of the leaves was recorded immediately after harvest.

3.15.6 Total fresh weight per plant

The total fresh weight per plant (modified root + leaves) was recorded after harvest and cleaning from the average of 10 plants and expressed in gram. The weight of the roots was recorded immediately after harvest.

3.15.7 Dry matter content of modified root

A sample of one hundred grams chopped modified root from 10 selected plants was dried freshly in the direct sun light for two days and then it was dried in an oven at 65^0C for 72 hours, until constant weight was achieved. The dry weight of the sample was recorded in gram and the mean value was calculated. Then the percent dry matter in modified root was calculated by using following formula-

$$\% \text{ Dry matter of modified root} = \frac{\text{Dry weight of modified root}}{\text{Fresh weight of modified root}} \times 100$$

3.15.8 Dry matter content of leaves

A sample of one hundred grams chopped leaves from 10 selected plants was dried freshly in the direct sun light for two days and then it was dried in an oven at 65^0C for 72 hours, until constant weight was achieved. The dry weight of the sample was recorded in gram and the mean value was calculated. Then the percent dry matter in leaves was calculated by using following formula-

$$\% \text{ Dry matter of leaves} = \frac{\text{Dry weight of leaves}}{\text{Fresh weight of leaves}} \times 100$$

3.15.9 Days to attaining in good size root

Days to attaining good size modified root was counted from the date of sowing to the optimum time for harvest and was recorded as treatment wise and good size was measured on the basis on colour, shape, market demand.

3.15.10 Root length

The length of root was measured in centimeter (cm) with a meter scale as the vertical distance from one side to another side of the widest part of the sectioned modified root and mean value was recorded.

3.15.11 Root diameter

The modified root from sample plants was sectioned vertically at the middle position with a sharp knife. The diameter of the root was measured in centimeter (cm) with a meter scale as the horizontal distance from one side to another side of the widest part of the sectioned modified root and mean value was recorded.

3.15.12 Yield per plot

Yield of turnip per plot was recorded as the whole plant weight of all the plants within a plot and was expressed in kilogram. Yield included the weight of modified root.

3.15.13 Yield per hectare

Yield per hectare was calculated by converting the weight of plot yield to hectare and was expressed in ton.

3.16 Statistical analysis

The data obtained for different characters were statistically analyzed to find out the significance of the difference levels of N fertilizers and mulches on yield and yield contributing characters of turnip. The mean values of all the characters were evaluated and analysis of variance was performing by the 'F' (variance ratio) test. The significance of the

difference among the treatment combinations means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

3.17 Economic analysis

The equal cost was considered in the study which was analyzed in order to find out the most economic treatment of mulch and fertilizers. All input cost include the cost for lease of land and interests on running capital were considered in computing the cost of production. The interests were calculated @ 13% for six months. The market price of turnip was considered for estimating the cost and return. Analyses were done details according to the procedure of Alam *et al.* (1989). The benefit cost ratio (BCR) was calculated as follows:

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return per hectare (Tk.)}}{\text{Total cost of production per hectare (Tk.)}}.$$

Chapter IV

RESULTS AND DISCUSSION

The present experiment was conducted to find out the effect of mulching and fertilizers on growth and yield of turnip. Data on different yield contributing characters and yield was recorded. The analysis of variance (ANOVA) of the data on different growth parameters and yield of turnip are given in Appendix III-VII. The results have been presented and discussed, and possible interpretations have been given under the following headings:

4.1 Plant height

Plant height varied statistically due to the effect of mulch of turnip at 25, 35, 45, 55 DAS and at harvest (Appendix III). Mulch of water hyacinth (M_1) gave the tallest (19.61 cm) plant at 25 DAS, while the non mulch plot showed the shortest (18.23 cm). The tallest (34.43 cm) plant was observed from M_1, while the shortest (31.11 cm) was found in M_0 at 35 DAS. At 45 DAS, the tallest (53.28 cm) plant was recorded from M_1 and the shortest (49.67 cm) was found M_0. Mulch of water hyacinth (M_1) gave the tallest (53.28 cm) plant at 55 DAS, while the non mulch gave the shortest (49.67 cm). At harvest, the tallest (57.40 cm) plant was recorded from M_1 and the shortest (53.68 cm) was observed in M_0 (Figure 2). The results indicated that mulch of water hyacinth increases the growth and development of turnip which ensure the maximum plant height than non mulch condition. Moate *et al.*, (1996) reported the same results earlier from their experiment by using water hyacinth mulch, black polythene and black paper as mulch with no irrigation condition. But Stockdale *et al.*, (1997) recorded the highest plant height from black polythene mulch and at harvest highest plant height was recorded in the range of 50.55-55.45 cm which was less than water hyacinth.

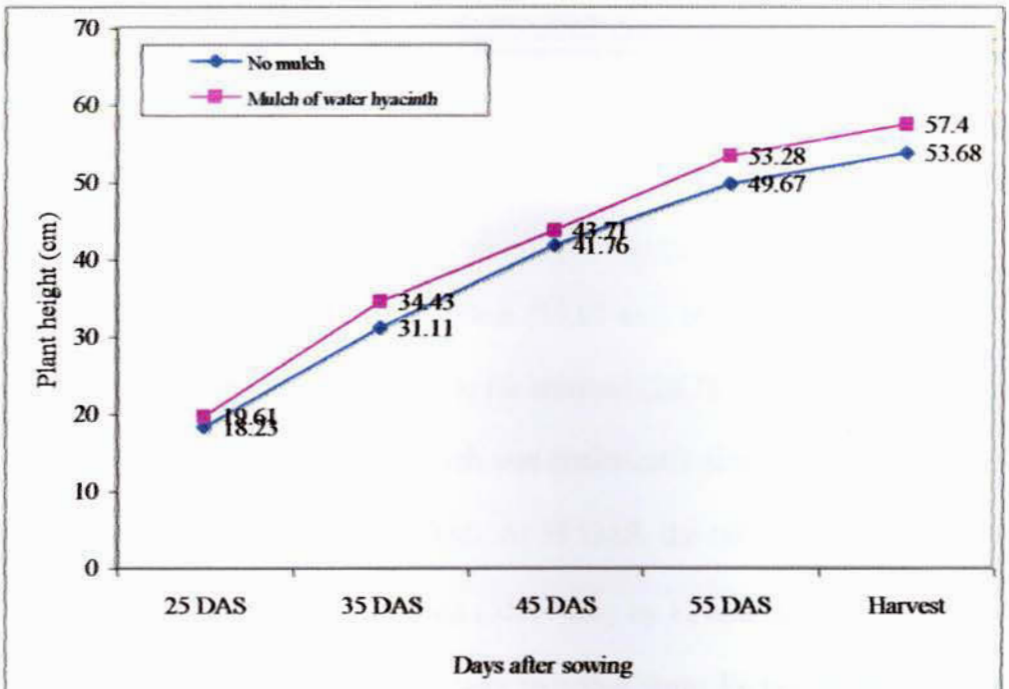


Figure 2. Effect of mulching on plant height at different days after sowing (DAS) of turnip

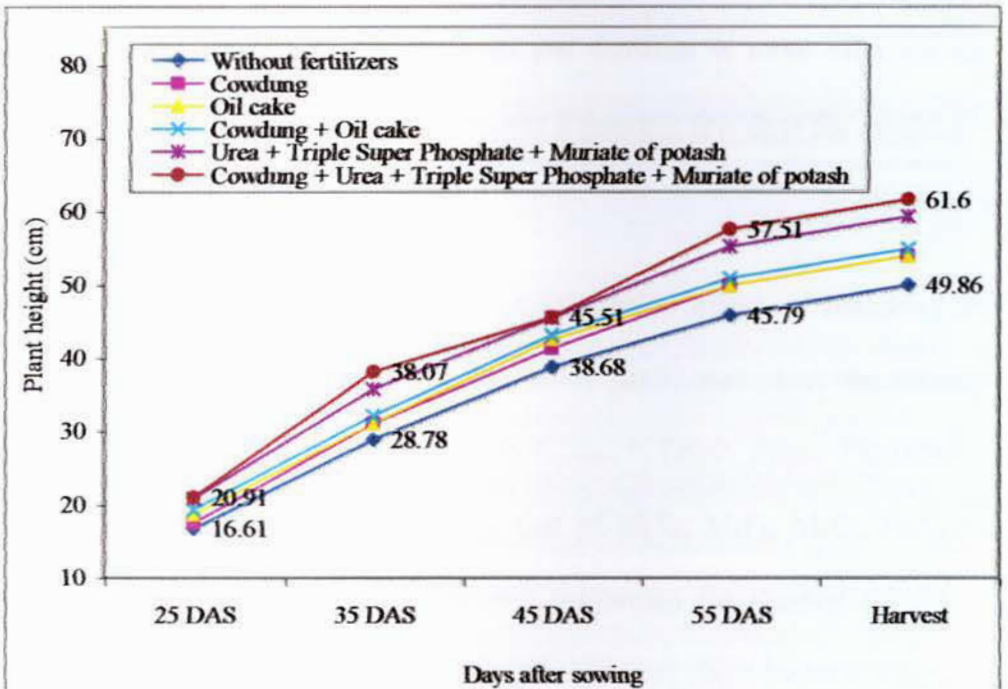


Figure 3. Effect of fertilizers on plant height at different days after sowing (DAS) of turnip

Fertilizers showed significant differences in terms of plant height at 25, 35, 45, 55 DAS and at harvest (Figure 3). The tallest (20.91 cm) plant was from Cowdung with Urea + Triple Super Phosphate + Muriate of potash (F_5) which was statistically identical (20.82 cm) with F_4 (Urea + Triple Super Phosphate + Muriate of potash) and the shortest (16.61 cm) plant was recorded from F_0 as without fertilizers at 25 DAS which was closely followed (17.39 cm) by F_1 as application of cowdung. At 35 DAS, the tallest (38.07 cm) plant was found from F_5 which was closely followed (35.73 cm) by F_4, while the shortest (28.78 cm) was from F_0. The tallest (45.51 cm) plant was recorded from F_5 which was statistically similar (45.44 cm) with F_4 and the minimum (38.68 cm) from F_0 at 45 DAS. At 55 DAS, the tallest (57.51 cm) plant was recorded from F_5 which was closely followed (55.17 cm) by F_4 and the shortest (45.79 cm) was from F_0. The tallest (61.60 cm) plant was recorded from F_5 which was closely followed (59.23 cm) by F_4 and the shortest (49.86 cm) was from F_0 at harvest (Figure 3). From the results it was found that tallest plant height was recorded from fertilizers. Wander *et al.*, (1994) reported that the combination of manures and fertilizer is more effective than individual one for short duration crop. In case of manures it requires few days for available of the nutrients for the plant.

The plant height was significantly influenced by the interaction effect of mulching and fertilizers (Table1 and appendix III). At 25 DAS, the tallest (20.92 cm) plant was recorded from M_1F_5 (Mulch of water hyacinth with Cowdung+Urea + Triple Super Phosphate + Muriate of potash) which was statistically similar to that of M_0F_4, M_0F_5, M_1F_2, M_1F_3 and M_1F_4, while M_0F_0 (Non mulch and without fertilizers) performed the shortest (15.50 cm) plant. At 35 DAS, significant variation in terms of plant height was also observed among the treatments and the tallest (38.21 cm) plant was observed from M_1F_5 where as the shortest (26.11 cm) was recorded from M_0F_0. At 45 DAS, the tallest (45.78 cm)

Table 1. Interaction effect of mulching and fertilizers on plant height at different days after sowing (DAS) of turnip

Treatment	Plant height (cm) at				
	25 DAS	35 DAS	45 DAS	55 DAS	Harvest
M_0F_0	15.50 d	26.11 g	36.37 f	42.26 e	46.08 e
M_0F_1	16.43 cd	28.59 f	40.29 e	47.39 d	51.43 d
M_0F_2	17.32 bc	28.63 f	41.19 de	47.40 d	51.47 d
M_0F_3	18.42 b	30.67 ef	42.28 cd	49.42 d	53.47 d
M_0F_4	20.82 a	34.73 bc	45.20 ab	54.17 bc	58.20 bc
M_0F_5	20.90 a	37.93 a	45.25 ab	57.39 a	61.45 a
M_1F_0	17.71 bc	31.44 de	41.00 de	49.32 d	53.63d
M_1F_1	18.35 b	33.40 cd	42.22 cd	52.19 c	56.24 c
M_1F_2	19.82 a	33.45 cd	43.68 bc	52.22 c	56.28 c
M_1F_3	20.03 a	33.37 cd	43.90 bc	52.16 c	56.23 c
M_1F_4	20.83 a	36.72 ab	45.69 a	56.17 ab	60.26 ab
M_1F_5	20.92 a	38.21 a	45.78 a	57.63 a	61.75 a
Significance level	*	*	**	**	**
CV (%)	7.05	6.56	5.18	8.08	6.51

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

** : Significant at 0.01 level of significance; * : Significant at 0.05 level of significance

M_0 : Non mulch M_1 : Mulch of water hyacinth

F_0 : Without fertilizers F_1 : Cowdung
F_2 : Oil cake F_3 : Cowdung + Oil cake
F_4 : Urea + Triple Super Phosphate + Muriate of potash
F_5 : Cowdung + Urea + Triple Super Phosphate + Muriate of potash

plant was recorded from M_1F_5 which was statistically similar with M_1F_4,M_0F_4 and M_0F_5. The shortest (36.37 cm) plant was recorded from M_0F_0. The tallest (57.63 cm) plant was recorded from M_1F_5 which was followed by M_0F_5 and M_1F_4. The shortest (42.26 cm) was from M_0F_0 at 55 DAS. At harvest, the tallest (61.75 cm) plant was recorded from M_1F_5 which was statistically similar with M_1F_4 and M_0F_4. The shortest (46.08 cm) plant was found from M_0F_0. From the results it was reveals that both mulch of water hyacinth and fertilizers interact on plant height.

4.2 Number of leaves per plant

Statistically significant variation was recorded in terms of number of leaves per plant varied statistically due to the mulching of turnip at 25, 35, 45, 55 and at harvest (Appendix IV). At 25 DAS mulch of water hyacinth (M_1) gave the maximum (6.46) number of leaves per plant, while the non mulch plot gave the minimum (5.99). The maximum (11.76) number of leaves per plant was observed from M_1, while the minimum (10.59) was from the M_0 at 35 DAS. At 45 DAS, the maximum (13.91) number of leaves per plant was recorded from M_1 and the minimum (13.21) was found from the M_0. Mulch of water hyacinth gave the highest (15.84) number of leaves per plant at 55 DAS, while the non mulch showed the minimum (14.72) number. At harvest, the maximum (15.97) number of leaves per plant was recorded from M_1 and the minimum (14.81) was from M_0 (Figure 4). Mulch of water hyacinth increases the growth and development of turnip and the maximum number of leaves per plant was found than non mulch condition. Mikkelsen (2000) recorded maximum number of leaves with mulching condition using black polythene mulch and water hyacinth.

Fertilizers showed significant differences in terms of number of leaves per plant at 25, 35, 45, 55 DAS and at harvest (Figure 5). The maximum (6.88) number of leaves per plant was from Cowdung + Urea + Triple Super Phosphate + Muriate of potash of F_5 which was statistically identical (6.86) with F_4 (Urea + Triple Super Phosphate + Muriate of potash) and the minimum (5.42) number of leaves per plant was recorded from F_0 as without

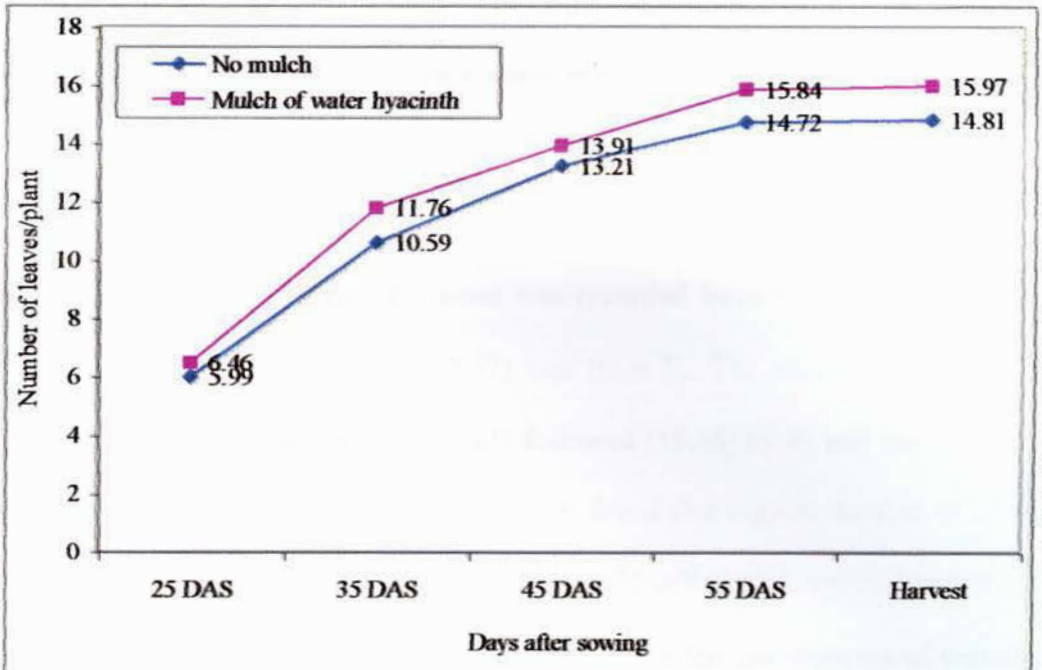


Figure 4. Effect of mulching on number of leaves per plant at different days after sowing (DAS) of turnip

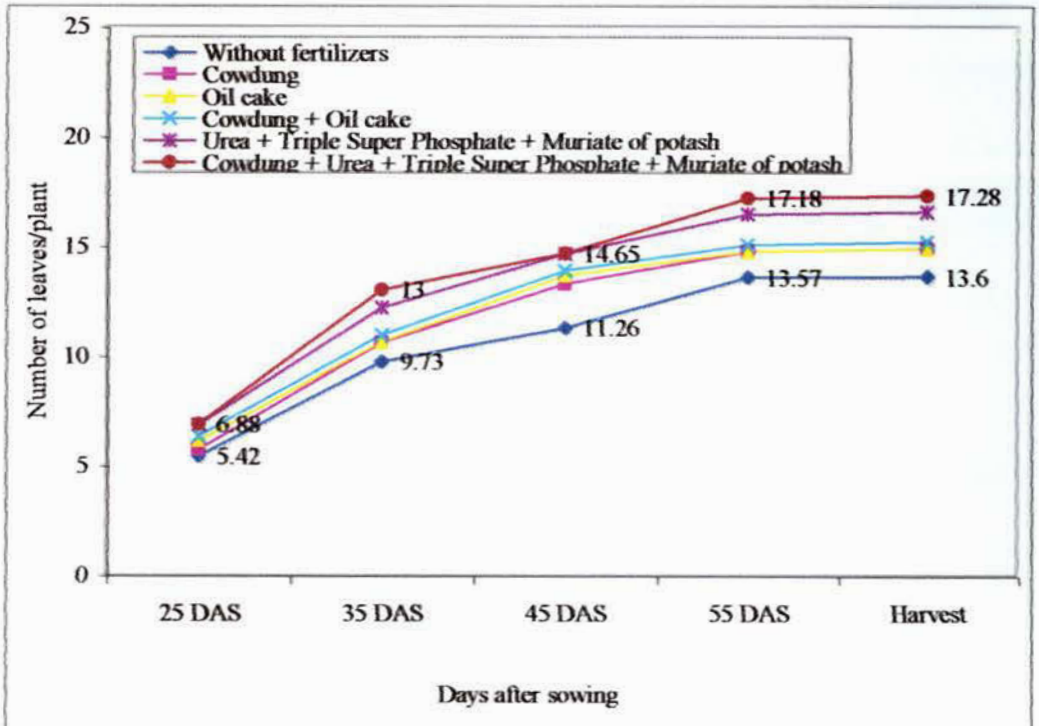


Figure 5. Effect of fertilizers on number of leaves per plant at different days after sowing (DAS) of turnip

fertilizers at 25 DAS.At 35 DAS, the maximum [13.00]number of leaves per plant was found from F_5 which was closely followed [12.20]by F_4 while the minimum[9.73]was obtained from F_0.The maximum [14.65] number of leaves per plant was recorded from F_5 which was statistically similar (14.62) with F_4 and the minimum (11.26) from F_0 at 45 DAS. At 55 DAS, the maximum (17.18) number of leaves per plant was recorded from F_5 which was closely followed (16.44) by F_4 and the minimum (13.57) was from F_0. The maximum number of leaves17.28 per plant was recorded from F_5 closely followed (16.55) by F_4 and the minimum (13.60)found from F_0 at harvest. From the results it was found that highest number of leaves per plant was recorded from the equal cost of fertilizers. Caldwell (2001) reported earlier that the maximum number of leaves from an experiment with using the combination of manures and fertilizers.

The number of leaves per plant was significantly influenced by the interaction effect of mulching and fertilizers under the present trial (Appendix IV). The maximum (6.87) number of leaves per plant was recorded at 25 DAS from the combination of M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash), while M_0F_0 (No mulch and without fertilizers) gave the lowest (5.00) number of leaves per plant (Table 2).

At 35 DAS significant variation in terms of number of leaves per plant was also observed among the treatments and the maximum (13.05) number of leaves per plant was observed from M_1F_5 whereas the minimum (8.72) was recorded from M_0F_0. At 45 DAS the maximum (14.74) number of leaves per plant was recorded from M_1F_5 and the minimum (10.32) number of leaves per plant was recorded from M_0F_0. The maximum (17.24) number of leaves per plant was recorded from M_1F_5 and the minimum (12.54) was from M_0F_0 at 55 DAS. At harvest, the maximum (17.33) number of leaves per plant was recorded from M_1F_5 and the minimum (12.61) number of leaves per plant was recorded from M_0F_0.

Table 2. Interaction effect of mulching and fertilizers on number of leaves per plant at different days after sowing (DAS) of turnip

Treatment	Number of leaves per plant at				
	25 DAS	35 DAS	45 DAS	55 DAS	Harvest
M_0F_0	5.00 d	8.72 g	10.32 f	12.54 e	12.61 e
M_0F_1	5.39 cd	9.77 f	12.97 d	13.97 d	14.10 d
M_0F_2	5.71 bc	9.78 f	13.24 cd	13.98 d	14.11 d
M_0F_3	6.08 b	10.46 ef	13.61 c	14.60 d	14.73 d
M_0F_4	6.85 a	11.88 bc	14.53 ab	16.14 bc	16.24 bc
M_0F_5	6.90 a	12.94 a	14.57 ab	17.12 a	17.24 a
M_1F_0	5.84 bc	10.73 de	12.20 e	14.59 d	14.79 d
M_1F_1	6.06 b	11.42 cd	13.59 c	15.49 c	15.62 c
M_1F_2	6.54 a	11.43 cd	14.09 b	15.50 c	15.62 c
M_1F_3	6.60 a	11.41 cd	14.12 b	15.48 c	15.60 c
M_1F_4	6.87 a	12.53 ab	14.70 a	16.74 ab	16.86 ab
M_1F_5	6.87 a	13.05 a	14.74 a	17.24 a	17.33 a
Significance level	*	**	**	**	**
CV (%)	5.28	7.05	6.02	9.12	7.13

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

** : Significant at 0.01 level of significance; * : Significant at 0.05 level of significance

M_0 : Non mulch M_1 : Mulch of water hyacinth

F_0 : Without fertilizers F_1 : Cowdung
F_2 : Oil cake F_3 : Cowdung + Oil cake
F_4 : Urea + Triple Super Phosphate + Muriate of potash
F_5 : Cowdung + Urea + Triple Super Phosphate + Muriate of potash

From the results it was reveals that both mulch of water hyacinth and fertilizer interact on number of leaves per plant significantly and the highest was recorded from M_1F_5.

4.3 Length of leaf

Length of leaf showed statistically significant variation due to the mulching and the application of fertilizers of turnip at 25, 35, 45, 55 and at harvest (Appendix V). In the present trial mulch of water hyacinth (M_1) showed the tallest (16.34 cm) length of leaf at 25 DAS, while the non mulch plot showed the shortest (14.97 cm). The tallest (31.53 cm) length of leaf was observed from M_1, while the shortest (28.21 cm) was from M_0 at 35 DAS. At 45 DAS, the tallest (38.72 cm) length of leaf was recorded from M_1 and the shortest (36.74 cm) was from found M_0. Mulch of water hyacinth (M_1) performed the tallest (45.70 cm) length of leaf at 55 DAS, while M_0 performed the shortest (42.06 cm). At harvest, the tallest (48.37 cm) length of leaf was recorded from M_1 and the shortest (45.85 cm) was obtained from M_0 (Figure 6). The results indicated that mulch of water hyacinth increases the growth and development of turnip which ensure the tallest length of leaf.

Fertilizers showed significant differences in terms of length of leaf at 25, 35, 45, 55 DAS and at harvest (Figure 7). The tallest (17.66 cm) length of leaf was from Cowdung + Urea + Triple Super Phosphate + Muriate of potash (F_5) which was statistically identical (17.54 cm) with F_4 (Urea + Triple Super Phosphate + Muriate of potash) and the shortest (13.35 cm) length of leaf was recorded from F_0 at 25 DAS which was closely followed (14.12 cm) by F_1. At 35 DAS, the tallest (35.18 cm) length of leaf was found from F_5 which was closely followed (32.82 cm) by F_4 and while the shortest (25.86 cm) was found from F_0. The tallest length (40.53 cm) of leaf was recorded from F_5 which was statistically similar (40.47 cm)

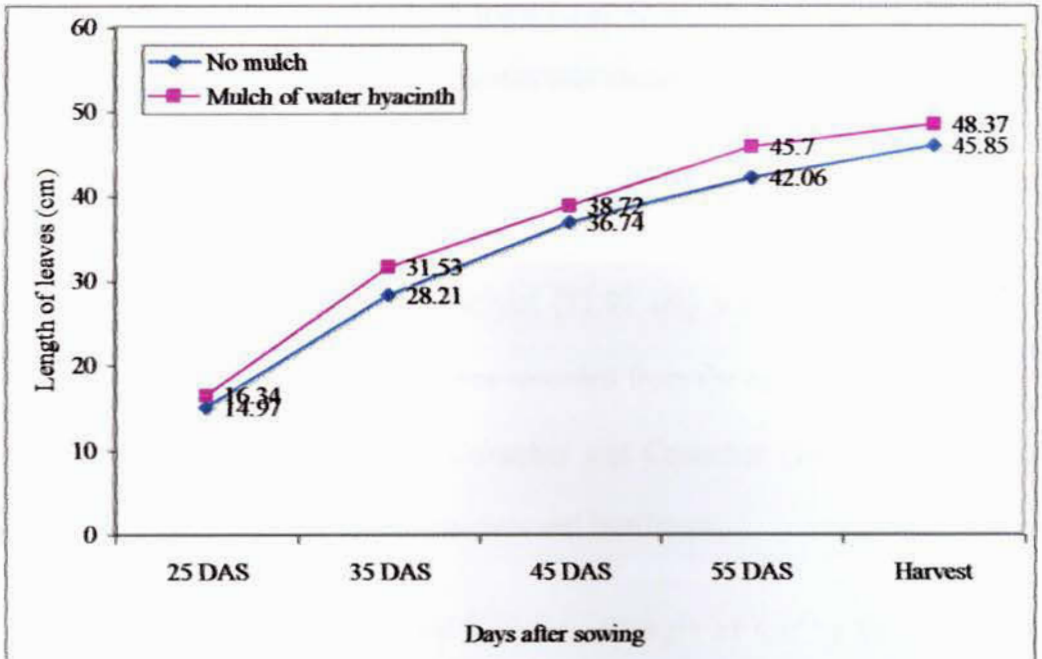


Figure 6. Effect of mulching on length of leaf at different days after sowing (DAS) of turnip

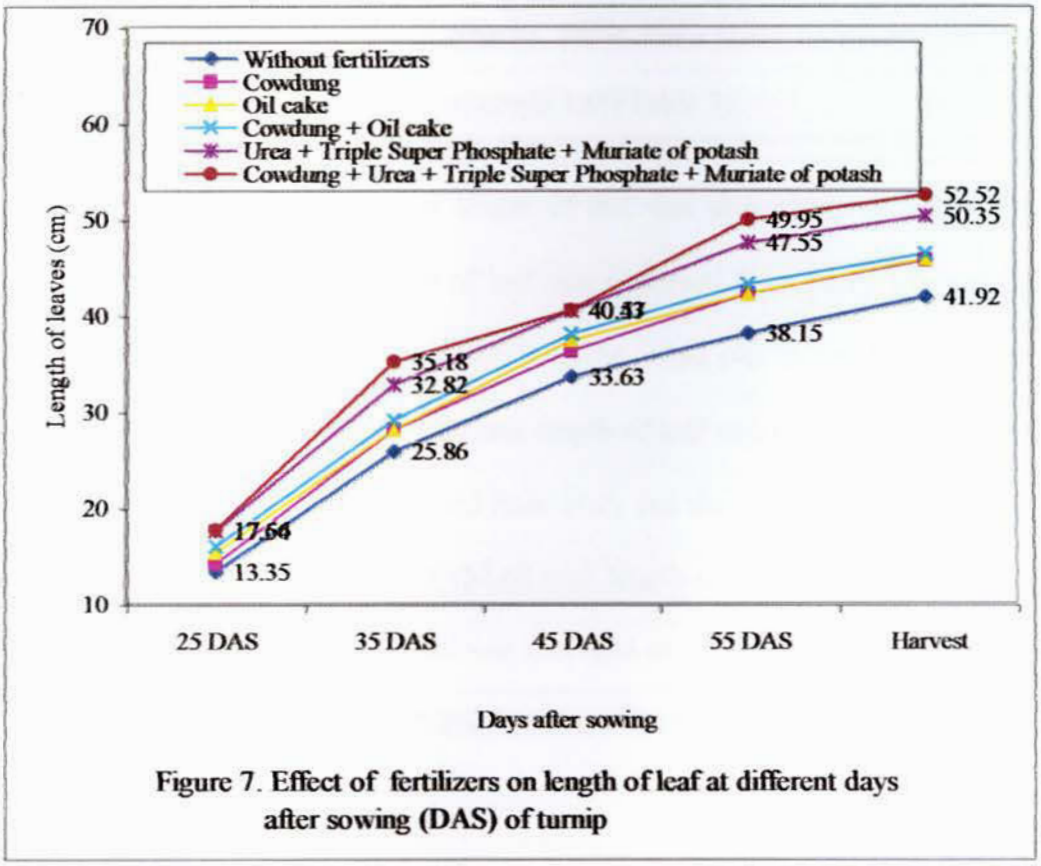


Figure 7. Effect of fertilizers on length of leaf at different days after sowing (DAS) of turnip

with F_4 and the shortest (33.63 cm) was found from F_0 at 45 DAS. At 55 DAS, the tallest (49.95 cm) length of leaf was recorded from F_5 which was closely followed (47.55 cm) by F_4 and the shortest (38.15 cm) was found from F_0 which was closely followed (42.21 cm and 42.23 cm) by F_1 and F_2. The tallest (52.52 cm) length of leaf was recorded from F_5 which was closely followed (50.35 cm) by F_4 and the shortest (41.92 cm) was recorded from F_0 at harvest. It was found that tallest length of leaf was recorded from the equal cost of fertilizers and the shortest from the control condition. Conacher and Conacher (1998) recorded the longest leaf earlier from their experiment for manures and fertilizers.

Statistically significant variation was recorded in terms of length of leaf by the interaction effect of mulching and fertilizers under the present trial (Appendix V). The tallest (17.67 cm) length of leaf was recorded at 25 DAS from M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash), while M_0F_0 (Non mulch and without fertilizers) gave the shortest (12.24 cm) length of turnip leaf (Table 3).

At 35 DAS, significant variation in terms of length of leaf was also observed among the treatments and the highest (35.31 cm) length of leaf was observed from M_1F_5 whereas the shortest (23.19 cm) was recorded from M_0F_0. At 45 DAS the tallest (40.78 cm) length of leaf was recorded from M_1F_5 and the shortest (31.29 cm) length of leaf was recorded from M_0F_0. The tallest (50.12 cm) length of leaf was recorded from M_1F_5 and the shortest (34.64 cm) was from M_0F_0 at 55 DAS. At harvest, the tallest (52.62 cm) length of leaf was recorded from M_1F_5 and the shortest (38.77 cm) length of leaf was recorded from M_0F_0. From the results it was reveals that both mulch of water hyacinth and fertilizers interact on length of leaf.

Table 3. Interaction effect of mulching and fertilizers on length of leaves per plant at different days after sowing (DAS) of turnip

Treatment	Length of leaf (cm) at				
	25 DAS	35 DAS	45 DAS	55 DAS	Harvest
M_0F_0	12.24 d	23.19 g	31.29 f	34.64 e	38.77 e
M_0F_1	13.17 cd	25.70 f	35.28 e	39.79 d	44.15 d
M_0F_2	14.04 bc	25.72 f	36.11 de	39.84 d	44.08 d
M_0F_3	15.16 b	27.76 ef	37.23 cd	41.82 d	45.67 cd
M_0F_4	17.54 a	31.83 bc	40.23 ab	46.52 bc	50.04 b
M_0F_5	17.65 a	35.05 a	40.27 ab	49.77 a	52.42 a
M_1F_0	14.46 bc	28.53 de	35.98 de	41.67 d	45.06 d
M_1F_1	15.07 b	30.52 cd	37.23 cd	44.62 c	47.27 c
M_1F_2	16.56 a	30.54 cd	38.70 bc	44.62 c	47.50 c
M_1F_3	16.76 a	30.47 cd	38.89 b	44.57 c	47.13 c
M_1F_4	17.55 a	33.80 ab	40.70 a	48.59 ab	50.65ab
M_1F_5	17.67 a	35.31 a	40.78a	50.12 a	52.62 a
Significance level	*	*	**	**	**
CV (%)	6.47	7.33	5.89	9.04	6.36

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

** : Significant at 0.01 level of significance; * : Significant at 0.05 level of significance

M_0 : Non mulch M_1 : Mulch of water hyacinth

F_0 : Without fertilizers F_1 : Cowdung
F_2 : Oil cake F_3 : Cowdung + Oil cake
F_4 : Urea + Triple Super Phosphate + Muriate of potash
F_5 : Cowdung + Urea + Triple Super Phosphate + Muriate of potash

4.4 Fresh weight of modified root

A statistically significant variation was recorded in terms of fresh weight of modified root due to the mulching and the application of fertilizers of turnip under the present trial (Appendix VI). In the present trial mulch of water hyacinth (M_1) showed the maximum (359.82 g) fresh weight of modified root, on the other hand the non mulch plot showed the minimum (323.65 g) fresh weight of modified root. (Table 4)

Fertilizers showed significant differences in terms of fresh weight of modified root at harvest (Table 4). The maximum (402.17 g) fresh weight of modified root was recorded from Cowdung + Urea + Triple Super Phosphate + Muriate of potash (F_5) which was closely followed (378.64 g) with F_4 (Urea + Triple Super Phosphate + Muriate of potash) and the minimum (284.83 g) fresh weight of modified root was recorded from F_0.

Interaction effect of mulching and fertilizers performed statistically significant differences under the present trial (Appendix VI). The maximum (403.51 g) fresh weight of modified root was recorded from the combination of M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash). On the other hand M_0F_0 (Non mulch and without fertilizers) gave the minimum (249.48 g) fresh weight of modified root (Table 5).

4.5 Fresh weight of leaves per plant

Fresh weight of leaves per plant showed a statistically significant variation due to the mulching and the application of fertilizers of turnip (Appendix VI). In the present trial mulch of water hyacinth (M_1) showed the maximum (211.49 g) fresh weight of leaves per plant, on the other hand the non mulch plot showed the minimum (178.27 g).

Table 4. Main effect of mulching and fertilizers on fresh and dry weight per plant of modified root and leaves during harvest of turnip

Treatment	Fresh weight of modified root (g)	Fresh weight of leaves /plant (g)	Total fresh weight per plant (g)	Dry matter content of modified root (%)	Dry matter content of leaves (%)
Mulch					
M_0	323.65 b	178.27 b	501.93 b	16.94 b	13.85 b
M_1	359.82 a	211.49 a	571.31 a	18.33 a	15.23 a
Significance level	**	**	**	**	**
CV (%)	5.89	7.14	5.28	7.05	5.44
Fertilizers					
F_0	284.83 d	155.01 d	439.84 d	15.33 c	12.20 c
F_1	324.80 c	177.19 c	501.99 c	16.09 c	13.00 c
F_2	325.07 c	177.45 c	502.52 c	17.31 b	14.17 b
F_3	334.90 c	187.35 c	522.25 c	17.93 b	14.85 b
F_4	378.64 b	224.40 b	603.04 b	19.54 a	16.47 a
F_5	402.17 a	247.90 a	650.06 a	19.63 a	16.54 a
Significance level	**	**	**	**	**
CV (%)	5.89	7.14	5.28	7.05	5.44

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

** : Significant at 0.01 level of significance

M_0 : Non mulch M_1 : Mulch of water hyacinth

F_0 : Without fertilizers F_1 : Cowdung
F_2 : Oil cake F_3 : Cowdung + Oil cake
F_4 : Urea + Triple Super Phosphate + Muriate of potash
F_5 : Cowdung + Urea + Triple Super Phosphate + Muriate of potash

Table 5. Interaction effect of mulching and fertilizers on fresh and dry weight per plant of modified root and leaves during harvest of turnip

Treatment	Fresh weight of modified root (g)	Fresh weight of leaves/ plant (g)	Total fresh weight per plant (g)	Dry matter content of modified root (%)	Dry matter content of leaves (%)
M_0F_0	249.48 e	128.53 g	378.01 f	14.21 d	11.06 d
M_0F_1	300.74 d	153.12 f	453.85 e	15.13 cd	12.03 cd
M_0F_2	300.95 d	153.30 f	454.25 e	16.05 bc	12.89 bc
M_0F_3	321.29 d	173.75 ef	495.04 de	17.11 b	14.08 b
M_0F_4	368.63 bc	214.40 bc	583.03 bc	19.55 a	16.48 a
M_0F_5	400.82 a	246.54 a	647.36 a	19.61 a	16.55 a
M_1F_0	320.19 d	181.48 de	501.67 d	16.44 bc	13.33 bc
M_1F_1	348.87 c	201.26 cd	550.13 c	17.06 b	13.98 b
M_1F_2	349.18 c	201.60 cd	550.78 c	18.56 a	15.45 a
M_1F_3	348.51 c	200.94 cd	549.45 c	18.74 a	15.61 a
M_1F_4	388.64 ab	234.40 ab	623.04 ab	19.53 a	16.46 a
M_1F_5	403.51 a	249.26 a	652.77 a	19.64 a	16.54 a
Significance level	**	*	**	*	*
CV (%)	5.89	7.14	5.28	7.05	5.44

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

** : Significant at 0.01 level of significance; * : Significant at 0.05 level of significance

M_0 : Non mulch M_1 : Mulch of water hyacinth

F_0 : Without fertilizers F_1 : Cowdung
F_2 : Oil cake F_3 : Cowdung + Oil cake
F_4 : Urea + Triple Super Phosphate + Muriate of potash
F_5 : Cowdung + Urea + Triple Super Phosphate + Muriate of potash

Fertilizers showed significant variations in terms of fresh weight of leaves per plant at harvest (Table 4). The maximum (247.90 g) fresh weight of leaves per plant was recorded from

(Cowdung + Urea + Triple Super Phosphate + Muriate of potash) F_5 and the minimum (155.01 g) fresh weight of leaves per plant was recorded from F_0.

Interaction effect between mulching and fertilizers showed statistically significant variation in terms of fresh weight of leaves per plant (Appendix VI). The maximum (249.26 g) fresh weight of leaves per plant was recorded from the combination of M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) and M_0F_0 (non mulch+without fertilizers) gave the minimum (128.53 g) fresh weight of leaves per plant (Table 5).

4.6 Total fresh weight per plant

A statistically significant variationwas observed difference was recorded due to mulching and the application of fertilizers in turnip in terms of total fresh weight per plant (Appendix VI). Mulch of water hyacinth (M_1) performed the maximum (571.31 g) total fresh weight per plant. Again the non mulch plot gave the minimum (501.93 g) total fresh weight per plant.

Fertilizers showed statistically significant variation in terms of total fresh weight per plant at harvest (Table 4). The maximum (650.06 g) total fresh weight per plant was recorded from (Cowdung + Urea + Triple Super Phosphate + Muriate of potash) F_5 and the minimum (439.84 g) total fresh weight per plant was recorded from F_0.

Interaction effect between mulching and fertilizers showed statistically significant variation under the present trial in respect of total fresh weight per plant (Appendix VI). The maximum (652.77 g) total fresh weight per plant was recorded from the combination of M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) and M_0F_0 (Non mulch and without fertilizers) gave the minimum (378.01 g) total fresh weight per plant (Table 5).

4.7 Dry matter content of modified root (%)

Statistically significant variation was recorded due to the mulching and the application of fertilizers of turnip in terms of dry matter content of modified root (Appendix VI). Mulch of water hyacinth (M_1) performed the highest (18.33%) dry matter content of modified root; on the other hand the non mulch plot performed the lowest (16.94%) dry matter content of modified root (Table 4)

Dry matter content of modified root showed statistically significant variation for fertilizers (Table 4). The highest (19.63%) dry matter content of modified root was recorded from Cowdung + Urea + Triple Super Phosphate + Muriate of potash of F_5 which was statistically similar (19.54%) with of F_4 (Urea + Triple Super Phosphate + Muriate of potash) and the lowest (15.33%) dry matter content of modified root was recorded from F_0 as without fertilizers which was closely followed (16.09%) by F_1 as application of cowdung under the present trial.

Interaction effect between mulching and fertilizer showed statistically significant variation under the present trial in respect of dry matter content of modified root (Appendix VI). The highest (19.64%) dry matter content of modified root was recorded from the combination of M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) which was followed by M_0F_4,M_0F_5,M_1F_3 and M_1F_4 while and M_0F_0 (Non mulch and without fertilizers) gave the minimum (14.21%) dry matter content of modified root (Table 5).

4.8 Dry matter content of leaves (%)

Mulching and the application of fertilizers of turnip in terms of dry matter content of leaves showed a statistically significant variation under the trial (Appendix VI). Mulch of water

hyacinth (M_1) showed the highest (15.23%) dry matter content of leaves. On the other hand the non mulch plot showed the lowest (13.85%) dry matter content of leaves.

Dry matter content of leaves showed statistically significant variation for fertilizers (Table 4). The highest (16.54%) dry matter content of leaves was recorded from Cowdung + Urea + Triple Super Phosphate + Muriate of potash (F_5) which was statistically identical (16.47%) with F_4 (Urea + Triple Super Phosphate + Muriate of potash) which was statistically similar with F_4 and the lowest (12.20%) dry matter content of leaves was recorded from F_0 as without fertilizers which was closely followed (13.00%) by F_1 as application of cowdung.

Interaction effect between mulching and fertilizers showed statistically significant differences under the present trial in respect of dry matter content of leaves (Appendix VI). The highest (16.54%) dry matter content of leaves was recorded from the combination of M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) and M_0F_0 (Non mulch and without fertilizers) gave the lowest (11.06%) dry matter content of leaves (Table 5).

4.9 Days to attaining in good size root

Mulching and the application of fertilizers of turnip in terms of days to attaining good size root showed statistically significant differences (Appendix VII). Mulch of water hyacinth gave the minimum (62.54) days to attaining good size root. On the other hand M_0 performed the maximum (64.68) days to attaining good size root.

Days to attaining good size root showed statistically significant variation for fertilizers under the trial (Table 6). The minimum (60.50) days to attaining good size root was recorded from Cowdung + Urea + Triple Super Phosphate + Muriate of potash (F_5) which was statistically similar (61.83) with F_4 (Urea + Triple Super Phosphate + Muriate of potash) and the maximum (66.83) days to attaining good size root was recorded from F_0 which was

statistically identical (64.72, 64.89) by F_1 and F_2 as application of cowdung and oil cake, respectively.

Interaction effect between mulching and fertilizers showed statistically significant variation under the present trial in respect of days to attaining good size root (Appendix VII). The minimum (58.67) days to attaining good size root was recorded from the combination of M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) and M_0F_0 (Non mulch and without fertilizers) performed the maximum (67.22) days to attaining good size root (Table 7).

4.10 Root length (cm)

Root length showed statistically significant differences for mulching and the application of fertilizers of turnip (Appendix VII). Mulch of water hyacinth (M_1) gave the longest (9.12 cm) root length; on the other hand the shortest (7.73 cm) root length was found from the non mulch plot.

Root length showed statistically significant variation for fertilizers under the trial (Table 6). The longest (9.31 cm) root length was recorded from (Cowdung + Urea + Triple Super Phosphate + Muriate of potash) F_5 and the shortest (7.80 cm) root length was recorded

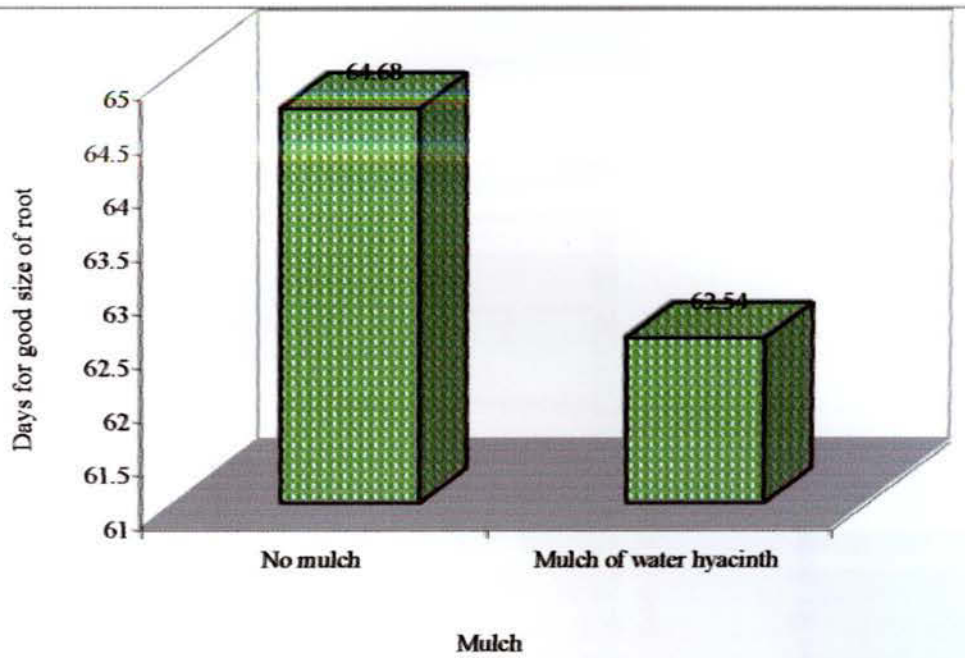


Figure 8. Effect of mulching on days for good size root of turnip

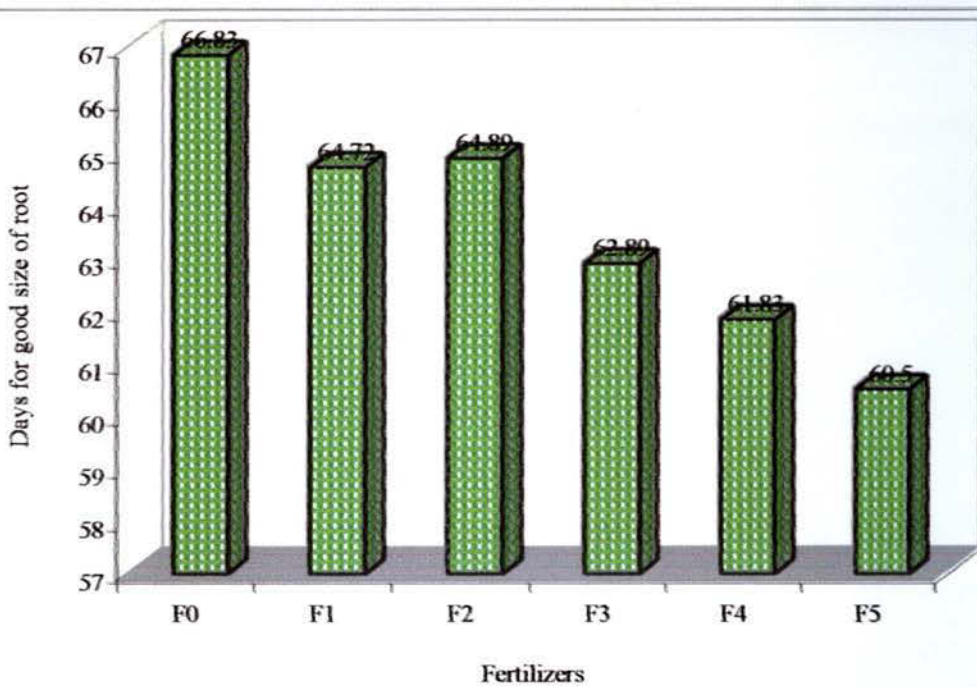


Figure 9. Effect of fertilizers on days for good size root of turnip

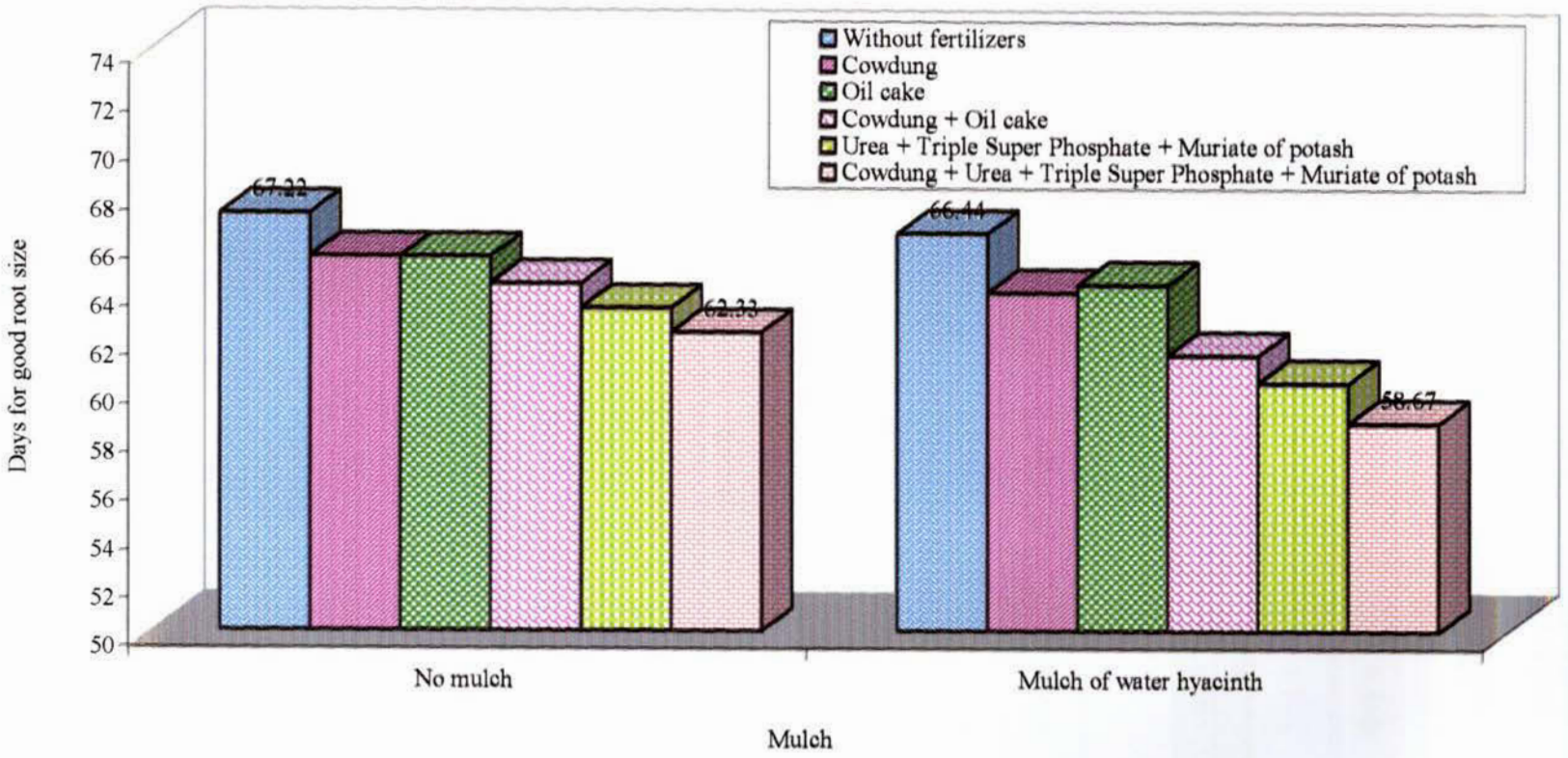


Figure 10. Interaction effect of mulching and fertilizers on days for good size root of turnip

Table 6. Main effect of mulching and fertilizers on yield and yield related characters of turnip

Treatment	Days to attaining in good size root	Root length (cm)	Root diameter (cm)	Yield (kg/plot)
Mulch				
M_0	64.68 a	7.73 b	4.34 b	4.85 b
M_1	62.54 b	9.12 a	5.71 a	5.40 a
Significance level	**	**	**	**
CV (%)	8.97	6.33	5.67	5.89
Fertilizers				
F_0	66.83 a	7.80 c	4.39 d	4.27 d
F_1	64.72 ab	8.05 c	4.64 d	4.87 c
F_2	64.89 ab	8.05 c	4.67 d	4.88 c
F_3	62.89 bc	8.52 b	5.13 c	5.02 c
F_4	61.83 cd	8.82 b	5.45 b	5.68 b
F_5	60.50 d	9.31 a	5.87 a	6.03 a
Significance level	**	**	**	**
CV (%)	8.97	6.33	5.67	5.89

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

** : Significant at 0.01 level of significance

M_0 : Non mulch M_1 : Mulch of water hyacinth

F_0 : Without fertilizers F_1 : Cowdung
F_2 : Oil cake F_3 : Cowdung + Oil cake
F_4 : Urea + Triple Super Phosphate + Muriate of potash
F_5 : Cowdung + Urea + Triple Super Phosphate + Muriate of potash

from F_0 as without fertilizers which was statistically identical (8.05) by F_1 and F_2 as application of cowdung and oil cake, respectively. Gaskell *et al.* (2000) reported the same results earlier.

Interaction effect between mulching and fertilizers showed statistically significant variation under the present trial in respect of root length (Appendix VII). The longest (9.73 cm) root length was recorded from the combination of M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) and M_0F_0 (Non mulch and without fertilizers) performed the shortest (7.13 cm) root length (Table 7).

4.11 Root diameter (cm)

A statistically significant difference was recorded for mulching and the application of fertilizers of turnip in terms of root diameter (Appendix VII). Mulch of water hyacinth (M_1) gave the maximum (5.71 cm) root diameter while on the other hand the non mulch plot showed the minimum (4.34 cm) root diameter.

Root diameter showed statistically significant variation for fertilizers under the trial (Table 6). The maximum (5.87 cm) root diameter was recorded from (Cowdung + Urea + Triple Super Phosphate + Muriate of potash) F_5 .The minimum (4.39 cm) root diameter was recorded from F_0 as without fertilizers which was statistically identical (4.64 and 4.67 cm) with F_1 and F_2 as application of cowdung and oil cake, respectively.

Table 7. Interaction effect of mulching and fertilizers on yield and yield related characters of turnip

Treatment	Days to attaining in good size root	Root length (cm)	Root diameter (cm)	Yield (kg/plot)
M_0F_0	67.22	7.13 f	3.73 g	3.74 e
M_0F_1	65.44	7.21 f	3.80 g	4.51 d
M_0F_2	65.44	7.33 f	3.97 fg	4.51 d
M_0F_3	64.33	7.73 ef	4.35 ef	4.82 d
M_0F_4	63.33	8.06 de	4.69 de	5.53bc
M_0F_5	62.33	8.89 bc	5.52 bc	6.01 a
M_1F_0	66.44	8.46 cd	5.06 cd	4.80 d
M_1F_1	64.00	8.89 bc	5.48 bc	5.23 c
M_1F_2	64.33	8.76 bc	5.37 c	5.24 c
M_1F_3	61.44	9.31 ab	5.90 ab	5.23 c
M_1F_4	60.33	9.58 a	6.21 a	5.83 ab
M_1F_5	58.67	9.73 a	6.23 a	6.05 a
Significance level	NS	**	*	**
CV (%)	8.97	6.33	5.67	5.89

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

** : Significant at 0.01 level of significance; * : Significant at 0.05 level of significance and

NS: Non significant

M_0 : Non mulch M_1 : Mulch of water hyacinth

F_0 : Without fertilizers F_1 : Cowdung
F_2 : Oil cake F_3 : Cowdung + Oil cake
F_4 : Urea + Triple Super Phosphate + Muriate of potash
F_5 : Cowdung + Urea + Triple Super Phosphate + Muriate of potash

Interaction effect between mulching and fertilizers showed statistically significant variation under the present trial in respect of root diameter (Appendix VII). The maximum (6.23 cm) root diameter was recorded from the combination of M_1F_5 (Mulch of water hyacinth with Cow dung + Urea + Triple Super Phosphate + Muriate of potash) and the minimum (3.73 cm) root diameter was obtained from M_0F_O treatment.

4.12. Yield (kg/plot)

Mulching and the application of fertilizers of turnip showed a statistically significant difference in terms of yield per plot (Appendix VII). Mulch of water hyacinth performed the maximum (5.40 kg) yield per plot; on the other hand M_0 showed the minimum (4.85 kg) yield per plot.

Yield per plot showed statistically significant variation for fertilizers under the trial (Table 6). The maximum (6.03 kg) yield per plot was recorded from [Cowdung + Urea + Triple Super Phosphate + Muriate of potash] F_5 and the minimum (4.27 kg) yield per plot was recorded from F_0 as without fertilizers.

Interaction effect between mulching and fertilizers showed statistically significant variation under the present trial in respect of yield per plot (Appendix VII). The maximum (6.05 kg) yield per plot was recorded from the combination of M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) and M_0F_0 (Non mulch and without fertilizers) gave the minimum (3.74 kg) yield per plot (Table 7).

4.13. Yield (t/ha)

A statistically significant difference was recorded in terms of yield per hectare for Mulching and the application of fertilizers of turnip (Appendix VII). Mulch of water hyacinth (M_1) performed the highest (35.98 t) yield per hectare; on the other hand the non mulch showed the lowest (32.37 t) yield per hectare. Moate *et al.*, (1996) reported the attaining of highest

yield earlier from their experiment by using water hyacinth mulch, black polythene and black paper as mulch with no irrigation condition. But Stockdale *et al.*, (1997) recorded the highest yield from black polythene mulch which was less than water hyacinth.

Yield per hectare showed statistically significant variation for fertilizers under the trial (Table 6). The highest (40.22 t) yield per hectare was recorded from Cowdung + Urea + Triple Super Phosphate + Muriate of potash (F_5) which was closely followed (37.86 t) by F_4 (Urea + Triple Super Phosphate + Muriate of potash) and the lowest (28.48 t) yield per hectare was recorded from F_0 as without fertilizers which was statistically identical (32.48 t, 32.51 t and 33.49 t) by F_1 and F_2 as application of cowdung, oil cake and cowdung + oil cake, respectively. Wander *et al.*, (1994) reported that the combination of manures and fertilizer is gave the highest yield than individual one for short duration crop. In case of manures it requires few days for available of the nutrients for the plant.

Interaction effect between mulching and fertilizers showed statistically significant variation under the present trial in respect of yield per hectare (Appendix VII). The highest (40.35 t) yield per hectare was recorded from the combination of M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) and M_0F_0 (Non mulch and without fertilizers) gave the shortest (24.95 t) yield per hectare (Table 7).

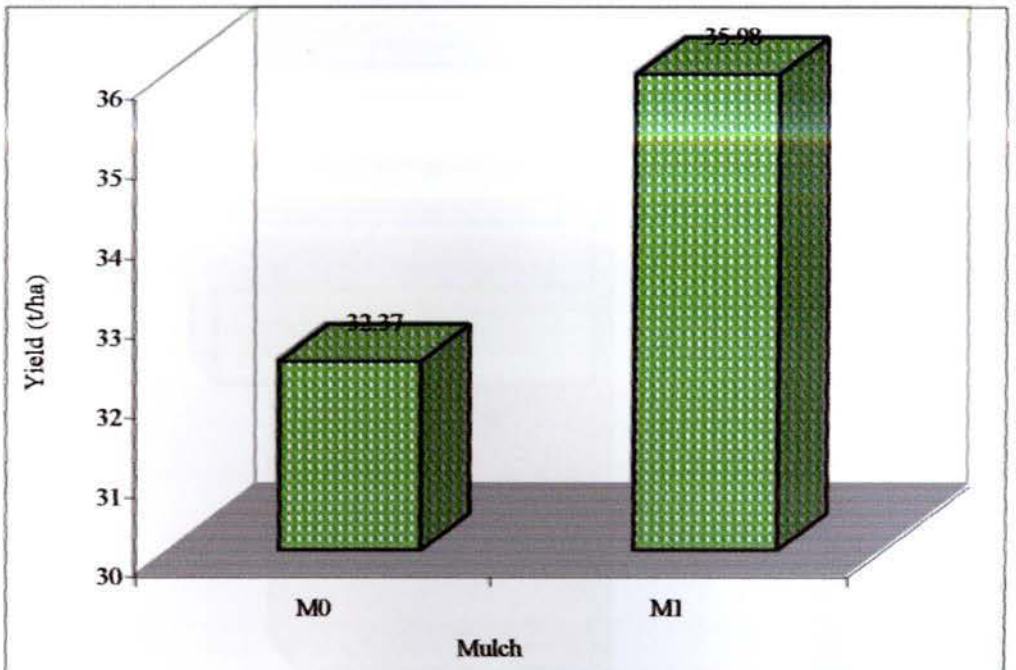


Figure 11. Effect of mulching on yield (t/ha) of turnip

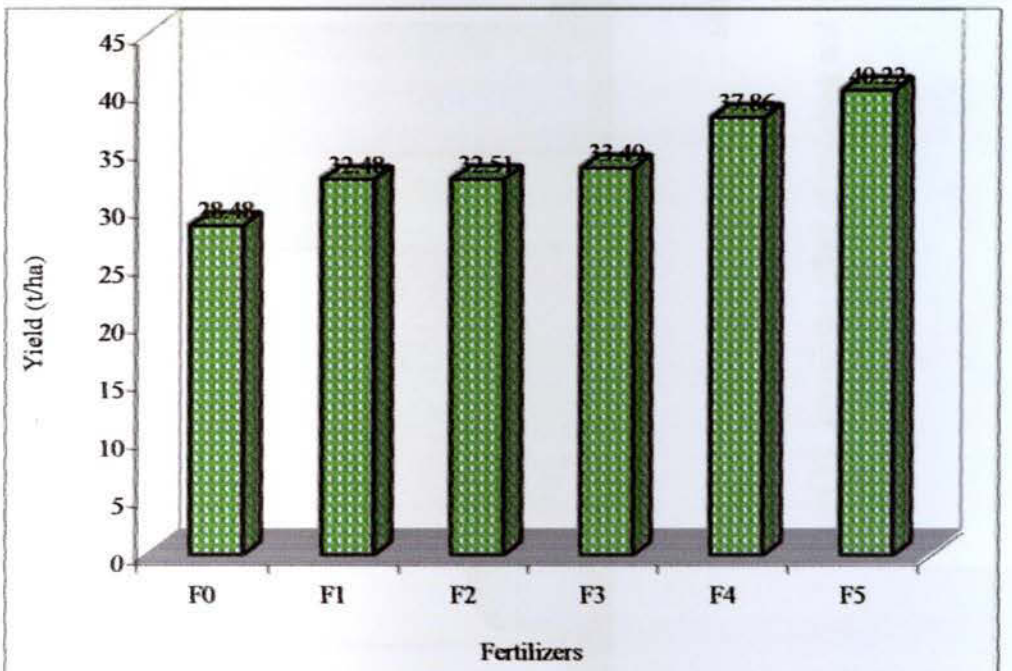


Figure 12. Effect of fertilizers on yield (t/ha) of turnip

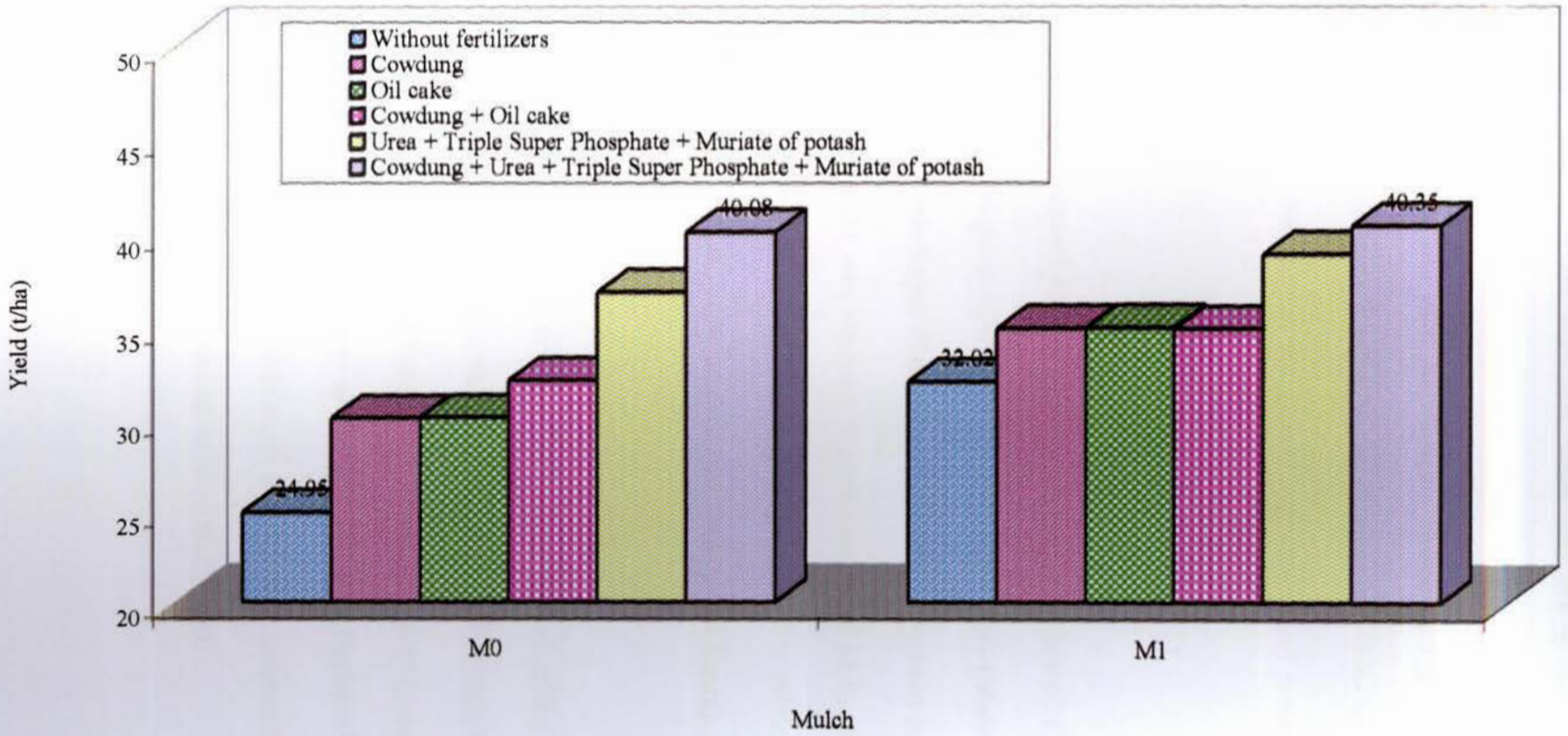


Figure 13. Interaction effect of mulching and fertilizers on yield (t/ha) of turnip

4.14 Economic analysis

Input costs for land preparation, seed cost, water hyacinth as mulch, fertilizer, irrigation and man power required for all the operations including harvesting of turnip were recorded for unit plot and converted into cost per hectare. Prices of the turnip modified root were considered in market rate basis. The economic analysis was done to find out the gross and net return and the benefit cost ratio in the present experiment and presented under the following headings-

4.14.1 Gross return

In the combination of water hyacinth mulch and fertilizers showed different gross return. The maximum (Tk. 322,800) gross return was obtained from M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) and the second maximum (Tk. 310,880) gross return was obtained in combination of M_1F_4 (Mulch of water hyacinth with Urea + Triple Super Phosphate + Muriate of potash). The minimum (Tk. 199,600) gross return was obtained in the M_0F_0 (Non mulch and without fertilizers).

4.14.2 Net return

In case of net return different treatment combination showed unlike types of net return. The maximum (Tk. 174,312) net return was obtained from M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) and the second maximum (Tk. 162,392) net return was obtained in combination of M_1F_4 (Mulch of water hyacinth with Urea + Triple Super Phosphate + Muriate of potash). The minimum (Tk. 56,704net return) was obtained in the M_0F_0 (Non mulch and without fertilizers).

4.14.3 Benefit cost ratio

The maximum (2.17) benefit cost ratio was attained from M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash). The minimum (1.40) befit cost ratio was obtained from M_0F_0 (Non mulch and without fertilizers) (Table 8). From economic point of view, it is apparent from the above results that mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash were the best combination for turnip cultivation in the present trial.

Table 8. Cost and return of turnip cultivation as influenced by mulching and fertilizers

Treatment	Cost of production (Tk./ha)	Yield of Turnip	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost Ratio
M_0F_0	142896	24.95	199600	56704	1.40
M_0F_1	154079	30.07	240560	86481	1.56
M_0F_2	154079	30.10	240800	86721	1.56
M_0F_3	154079	32.13	257040	102961	1.67
M_0F_4	154079	36.86	294880	140801	1.91
M_0F_5	154079	40.08	320640	166561	2.08
M_1F_0	137305	32.02	256160	118855	1.87
M_1F_1	148488	34.89	279120	130632	1.88
M_1F_2	148488	34.92	279360	130872	1.88
M_1F_3	148488	34.85	278800	130312	1.88
M_1F_4	148488	38.86	310880	162392	2.09
M_1F_5	148488	40.35	322800	174312	2.17

M_0 : Non mulch M_1 : Mulch of water hyacinth

F_0 : Without fertilizers F_1 : Cowdung
F_2 : Oil cake F_3 : Cowdung + Oil cake
F_4 : Urea + Triple Super Phosphate + Muriate of potash
F_5 : Cowdung + Urea + Triple Super Phosphate + Muriate of potash

Market price of turnip @ Tk. 8,000/t
Gross return = Total yield (t/ha) × Tk. 8,000
Net return = Gross return - Total cost of production
Benefit Cost Ratio (BCR) = Gross return/Total cost of production

Chapter V

SUMMARY AND CONCLUSION

An experiment was conducted in the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November 2006 to January 2007 to study the effect of mulching and fertilizers on growth and yield of turnip. For the experiment Mulching (2 levels); Non mulch/Control and Mulch of water hyacinth were used and Factor B: Fertilizer (6 levels) as without fertilizers, Cowdung, Oil cake, Cowdung + Oil cake, Urea + Triple Super Phosphate + Muriate of potash and. Cowdung + Urea + Triple Super Phosphate + Muriate of potash were used. There were 12 (2 × 6) treatment combinations M_0F_0, M_0F_1, M_0F_2, M_0F_3, M_0F_4, M_0F_5, M_1F_0, M_1F_1, M_1F_2, M_1F_3, M_1F_4, M_1F_5.

Statistically significant variation was recorded in all recorded characters due to the mulching Data on different yield contributing characters and yield was recorded. At harvest, the tallest (57.40 cm) plant was recorded from M_1 and the shortest (53.68 cm) was from M_0. At harvest, the highest (15.97) number of leaves per plant was recorded from M_1 and the lowest (14.81) was from M_0. At harvest, the tallest (48.37 cm) length of leaf was recorded from M_1 and the shortest (45.85 cm) was from M_0. Mulch of water hyacinth of treatment M_1 gave the maximum (571.31 g) total fresh weight per plant. Mulch of water hyacinth of treatment M_1 gave the minimum (62.54) days to attaining good size root. On the other hand the non mulch plot gave the maximum (64.68) days to attaining good size root. Mulch of water hyacinth treatment M_1 gave the highest (35.98 t/ha) yield per hectare; on the other hand the non mulch treatment gave the lowest (32.37 t/ha) yield per hectare.

Fertilizers showed significant differences in all recorded characters. The tallest (61.60 cm) plant was recorded from the treatment of F_5 closely followed (59.23 cm) with F_4 treatment and the minimum (49.86 cm) was from the treatment F_0 at harvest. The highest (17.28)

number of leaves per plant was recorded from the treatment of F_5 closely followed (16.55) F_4 treatment and the minimum (13.60) was found from the treatment F_0 at harvest. The tallest (52.52 cm) length of leaf was recorded from the treatment of F_5 closely followed (50.35 cm) with F_4 treatment and the minimum (41.92 cm) was from the treatment F_0 at harvest. At harvest the maximum (650.06 g) total fresh weight per plant was recorded from F_5 which was closely followed (603.04 g) with the treatment of F_4 and the minimum (439.84 g) total fresh weight per plant was recorded from F_0 as without fertilizers. The minimum (60.50) days to attaining good size root was recorded from F_5 which was statistically similar (61.83) with the treatment of F_4 and the maximum (66.83) days to attaining good size root was recorded from F_0. The highest (40.22 t/ha) yield per hectare was recorded from F_5 which was closely followed (37.86 t/ha) with the treatment of F_4 and the lowest (28.48 t) yield per hectare was recorded from F_0 as without fertilizers.

Interaction effect between mulching and fertilizers of equal cost showed statistically significant variation under the present trial. The considerable recorded found from M_1F_5 (Mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash) and the control treatment i.e. M_0F_0 (Non mulch and without fertilizers) the lowest value. The highest (Tk. 322,800) gross return was obtained from M_1F_5 and the lowest (Tk. 199,600) gross return was obtained in the M_0F_0. The highest (Tk. 174,312) net return was obtained from M_1F_5 and the lowest (Tk. 56,704) net return was obtained in the M_0F_0. The highest (2.17) benefit cost ratio was attained from M_1F_5. The lowest (1.40) befit cost ratio was obtained from M_0F_0.Above results indicate that mulch performed higher yield than no mulch.So,various mulch materials like straw,sawdust,green leaves,assam lata,satty leaves and banana leaves may be used for comparison the growth and yield of turnip.Among the used fertilizers in this study cow dung with Urea,Triple super phosphate and Muriate of potash showed better growth and yield than those of other treatments. For considering the all yield

and yield related characters mulch of water hyacinth with Cowdung + Urea + Triple Super Phosphate + Muriate of potash were the best combination for turnip cultivation in the present trial.

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performance.

2. Another type of mulch such as rice straw, green leaves, assam lata, satty leaves (*Curcuma amada*) and banana leaves etc. may be used for further study.

3. Various mulch materials with another combination of fertilizers may be used for further trial to achieve maximum growth and yield of turnip and for find out the good combination..

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APPENDICES

Appendix I. **Results of mechanical and chemical analysis of soil of the experimental plot**

Mechanical analysis

Constituents	Percent
Sand	32.45
Silt	61.35
Clay	6.10
Textural class	Silty loam

Chemical analysis

Soil properties	Amount
Soil pH	6.15
Organic carbon (%)	1.32
Total nitrogen (%)	0.075
Available P (ppm)	19.5
Exchangeable K (%)	0.2

Appendix II. **Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from November 2006 to January 2007**

Month	Air temperature (^{0}C)			RH (%) at 9 am	Total rainfall (mm)
	Maximum	Minimum	Mean		
November 06	29.18	18.26	23.72	69.52	00
December 06	25.82	16.04	20.93	70.61	00
January 07	23.55	14.32	18.94	72.55	28

Appendix III. Analysis of variance of the data on plant height of turnip at different days after sowing (DAS) as influenced by mulching and fertilizers

Source of variation	Degrees of freedom	Mean square				
		Plant height (cm) at				
		25 DAS	35 DAS	45 DAS	55 DAS	Harvest
Replication	2	0.099	4.431	1.667	3.604	2.568
Mulch (A)	1	17.084**	99.434**	34.164**	117.325**	124.285**
Fertilizers(B)	5	18.566**	71.383**	40.678**	106.114**	106.551**
Interaction (A×B)	5	1.794*	5.965*	3.523**	8.869**	9.731**
Error	22	0.611	1.922	0.869	1.765	1.947

** : Significant at 0.01 level of significance; * : Significant at 0.05 level of significance

Appendix IV. Analysis of variance of the data on number of leaves/plant of turnip at different days after sowing (DAS) as influenced by mulching and fertilizers

Source of variation	Degrees of freedom	Mean square				
		Number of leaves/plant at				
		25 DAS	35 DAS	45 DAS	55 DAS	Harvest
Replication	2	0.012	0.456	0.175	0.260	0.320
Mulch (A)	1	2.024**	12.281**	4.395**	11.210**	12.145**
Fertilizers (B)	5	2.109**	8.618**	9.341**	10.244**	10.489**
Interaction (A×B)	5	0.228*	0.786**	0.607**	0.756**	0.971**
Error	22	0.070	0.222	0.078	0.157	0.201

** : Significant at 0.01 level of significance
* : Significant at 0.05 level of significance

Appendix V. Analysis of variance of the data on length of leaves of turnip at different days after sowing (DAS) as influenced by mulching and fertilizers

Source of variation	Degrees of freedom	Mean square				
		Length of leaf (cm) at				
		25 DAS	35 DAS	45 DAS	55 DAS	Harvest
Replication	2	0.096	4.272	1.588	3.428	0.112
Mulch (A)	1	17.084**	99.235**	35.323**	118.883**	57.003**
Fertilizers (B)	5	18.544**	71.630**	41.360**	106.872**	85.140**
Interaction (A×B)	5	1.812*	6.045*	3.686**	8.476**	7.645**
Error	22	0.598	1.962	0.859	1.775	1.240

** : Significant at 0.01 level of significance
* : Significant at 0.05 level of significance

Appendix VI. Analysis of variance of the data on fresh and dry weight of turnip as influenced by mulching and fertilizers

Source of variation	Degrees of freedom	Mean square				
		Fresh weight of modified root (g)	Fresh weight of leaves (g)	Total fresh weight (g)	Dry matter content of modified root (%)	Dry matter content of leaves (%)
Replication	2	331.539	429.849	1424.676	0.028	0.139
Mulch (A)	1	11771.16**	9930.455**	43325.042**	17.264**	17.057**
fertilizers (B)	5	10635.19**	7134.527**	35058.109**	18.569**	18.993**
Interaction (A×B)	5	882.890**	594.300*	2875.427**	1.852*	1.929*
Error	22	176.789	193.578	606.886	0.640	0.626

** : Significant at 0.01 level of significance
* : Significant at 0.05 level of significance

Appendix VII. Analysis of variance of the data on yield related characters and yield of turnip as influenced by mulching and fertilizers

Source of variation	Degrees of freedom	Mean square				
		Days to attaining in good size root	Root length (cm)	Root diameter (cm)	Yield (kg/plot)	Yield (t/ha)
Replication	2	1.011	0.013	0.056	0.075	3.315
Mulch (A)	1	41.495**	17.542**	16.783**	2.649**	117.712**
Fertilizers (B)	5	31.928**	1.963**	1.902**	2.393**	106.352**
Interaction (A×B)	5	2.105	1.132**	0.178*	0.199**	8.829**
Error	22	3.563	0.107	0.067	0.040	1.768

** : Significant at 0.01 level of significance
* : Significant at 0.05 level of significance

Appendix VIII. Production cost of turnip per hectare

A. Input cost

Treatment Combination	Labour cost	Ploughing cost	Seed Cost	Water for seedling Establishment	Mulch Materials	Fertilizers					Weeding	Insecticide/ pesticides	Sub Total (A)
						Cowdung	Oil cake	Urea	TSP	MP			
M_0F_0	14000.00	11000.00	7500.00	5000.00	0.00	0.00		0.00	0.00	0.00	6000.00	10000.00	53500.00
M_0F_1	14000.00	11000.00	7500.00	5000.00	0.00	10000.00	0.00	0.00	0.00	0.00	6000.00	10000.00	63500.00
M_0F_2	14000.00	11000.00	7500.00	5000.00	0.00	10000.00	0.00	0.00	0.00	0.00	6000.00	10000.00	63500.00
M_0F_3	14000.00	11000.00	7500.00	5000.00	0.00	5000.00	5000.00	0.00	0.00	0.00	6000.00	10000.00	63500.00
M_0F_4	14000.00	11000.00	7500.00	5000.00	0.00	0.00	0.00	2000.00	5000.00	3000.00	6000.00	10000.00	63500.00
M_0F_5	14000.00	11000.00	7500.00	5000.00	0.00	1500.00	0.00	3000.00	3000.00	2500.00	6000.00	10000.00	63500.00
M_1F_0	14000.00	11000.00	7500.00	1000.00	5000.00	0.00		0.00	0.00	0.00	0.00	10000.00	48500.00
M_1F_1	14000.00	11000.00	7500.00	1000.00	5000.00	10000.00	0.00	0.00	0.00	0.00	0.00	10000.00	58500.00
M_1F_2	14000.00	11000.00	7500.00	1000.00	5000.00	10000.00	0.00	0.00	0.00	0.00	0.00	10000.00	58500.00
M_1F_3	14000.00	11000.00	7500.00	1000.00	5000.00	5000.00	5000.00	0.00	0.00	0.00	0.00	10000.00	58500.00
M_1F_4	14000.00	11000.00	7500.00	1000.00	5000.00	0.00	0.00	2000.00	5000.00	3000.00	0.00	10000.00	58500.00
M_1F_5	14000.00	11000.00	7500.00	1000.00	5000.00	1500.00	0.00	3000.00	3000.00	2500.00	0.00	10000.00	58500.00

M_0: Non mulch M_1 : Mulch of water hyacinth

F_0 : Without fertilizers F_1 : Cowdung
F_2 : Oil cake F_3 : Cowdung + Oil cake
F_4 : Urea + Triple Super Phosphate + Muriate of potash
F_5 : Cowdung + Urea + Triple Super Phosphate + Muriate of potash

Labour 175 @ Tk. 80/capita/day
Bullock 55 pairs @ Tk. 100/pair/day
Water hyacinth @ Tk. 50/bag
Oil cake @ Tk. 20/kg

Cowdung : @ Tk. 1000/t
Urea : @ Tk. 8/kg
TSP : @ Tk. 20/kg
MP : @ Tk. 15/kg

Appendix VIII. Contd.,

B. Overhead cost (Tk./ha)

Treatment Combination	Cost of lease of land for 6 months (13% of value of land Tk. 6,00000/year	Miscellaneous cost (Tk. 5% of the input cost	Interest on running capital for 6 months (Tk. 13% of cost/year	Sub total (Tk) (B)	Total cost of production (Tk./ha) [Input cost (A)+ overhead cost (B)]
M_0F_0	78000	2675	8721	89396	142896
M_0F_1	78000	3175	9404	90579	154079
M_0F_2	78000	3175	9404	90579	154079
M_0F_3	78000	3175	9404	90579	154079
M_0F_4	78000	3175	9404	90579	154079
M_0F_5	78000	3175	9404	90579	154079
M_1F_0	78000	2425	8380	88805	137305
M_1F_1	78000	2925	9063	89988	148488
M_1F_2	78000	2925	9063	89988	148488
M_1F_3	78000	2925	9063	89988	148488
M_1F_4	78000	2925	9063	89988	148488
M_1F_5	78000	2925	9063	89988	148488

M_0: Non mulch M_1 : Mulch of water hyacinth

F_0 : Without fertilizers F_1 : Cowdung

F_2 : Oil cake F_3 : Cowdung + Oil cake

F_4 : Urea + Triple Super Phosphate + Muriate of potash

F_5 : Cowdung + Urea + Triple Super Phosphate + Muriate of potash

Appendix IX

Amount of N, P_2O_5 and K_2O in Cowdung and Oil Cake

Name of Fertilizer	Amount of nutrients (%)		
	N	P_2O_5	K_2O
Cowdung	0.5-15	0.4-0.8	0.5-1.9
Oil Cake	5.15	1.85	1.2

Source : BARC, 1997