OPTIMIZING THE PRODUCTIVITY AND PROFITABILITY OF ONION SEED BY APPROPRIATE MANAGEMENT OF ORGANIC MANURE AND BULB SIZE

BY

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Approved by:

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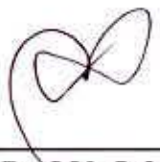

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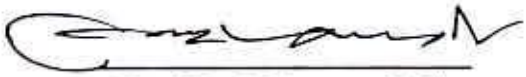

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CERTIFICATE

This is to certify that thesis entitled, "Optimizing the productivity and profitability of onion seed by appropriate management of organic manure and bulb size" submitted to the Institute of Seed Technology, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of ***MASTER OF SCIENCE IN SEED TECHNOLOGY****, embodies the result of a piece of bona fide research work carried out by Mr. Md. Asadur Rahman, Registration No.: 08-02725 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated: December, 2014
Place: Dhaka, Bangladesh

(Dr. Tahmina Mostarin)
Supervisor

DEDICATED

TO

ADRITA AND ANISHA

LIST OF ABBREVIATIONS

Full word	Abbreviations	Full word	Abbreviations
Agricultural	Agril.	Kilogram	Kg
Agriculture	Agric.	Meter	m
Agro-Ecological Zone	AEZ	Meter squares	m^2
And others	*et al.*	Least Significant Difference	LSD
Applied	*App.*	Milligram(s)	mg
Association of Official Seed Analyst	AOSA	Nitrogen	N
Bangladesh Agricultural Research Council	BARC	Manganese	Mn
Bangladesh Agricultural Research Institute	BARI	Mustard oil cake	MOC
Bangladesh Agricultural University	BAU	Non-significant	NS
Bangladesh Bureau of Statistics	BBS	Negative logarithm of hydrogen ion concentration (-log[H+])	pH
Bangladesh Institute of Nuclear Agriculture	BINA	Percentage	%
Centimeter	cm	Phosphorus Penta Oxide	P_2O_5
Coefficient of Variance	CV	Poultry manure	PM
Cultivar (s)	cv.	Parts per million	ppm
Cowdung	CD	Science	Sci.
Days after planting	DAP	Sher-e- Bangla Agricultural University	SAU
Degree Celsius	°C	Soil Resource Development Institute	SRDI
Environment	Environ.	Sulphur	S
Etcetera	etc.	Ton per hectare	t/ha
Food and Agricultural Organization	FAO	Triple Super Phosphate	TSP
Gram	g	Variety	var.
Hectare	ha.	Weight	Wt.
Horticulture	Hort.	Zinc	Zn
International	*Intl.*	Videlicet (namely)	viz.
Journal	*J.*		

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The Author

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OPTIMIZING THE PRODUCTIVITY AND PROFITABILITY OF ONION SEED BY APPROPRIATE MANAGEMENT OF ORGANIC MANURE AND BULB SIZE

BY

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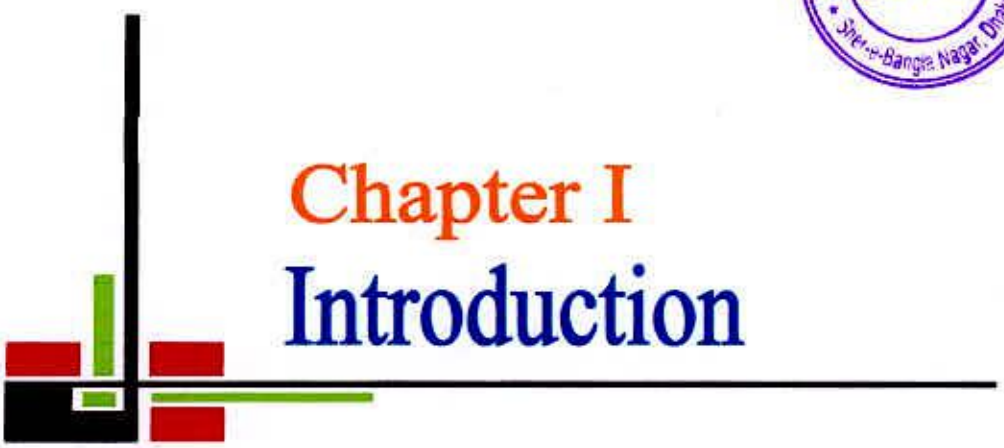
ABSTRACT

An experiment was conducted in the central research farm of Sher-e-Bangla Agricultural University, Dhaka, during the period from October 2013 to March 2014, to study optimizing the productivity and profitability of onion seed by appropriate management of organic manure and bulb size. The experiment consisted with two factors. Factor A: Four combination of organic manures such as M_1 = control, M_2 =15 t/ha Cowdung+10 t/ha Poultry manure, M_3 = 15 t/ha Cowdung+2.2 t/ha Mustard oil cake and M_4 = 15 t/ha Cowdung+10 t/ha Poultry manure +2.2 t/ha Mustard oil cake. Factor B: Four sizes of onion bulbs such as S_1 =2g, S_2 = 4g, S_3 = 6g and S_4 = 8g. The experiment was laid out in a Randomized Complete Block Design with 16 treatment combinations. Application of different organic manures and bulb size significantly influenced by plant height and number of leaves per plant at different growth stages, days required to first bolting, number of umbels/plant, days required to first anthesis, number of seeds per umbel, seed yield per plant, per plot and per hectare, weight of 1000 seeds and seed vigor index. But it did not show any significant effect on seed germination (%).The maximum seed yield 567.3 Kg/ha with net income (Tk 126,07,65) and BCR (2.74) was obtained from M_4S_4 treatment combination which was statistically identical to M_4S_3 treatment combination and the minimum seed yield 185.3 Kg/ha with net income (Tk 245086.2) and BCR (1.61) was observed from M_1S_1 treatment combination. The BCR (2.94) from M_4S_3 treatment combination is higher than BCR (2.74) from M_4S_4 treatment combination. So economic analysis revealed that the M_4S_3 treatment combination appeared to be the best for achieving higher productivity and profitability of onion seed production.



Chapter I
Introduction

CHAPTER I

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the family Alliaceae is one of the most important bulb and spice crops in the world including Bangladesh. It is originated in Iran and the Northern Mountain regions of Pakistan (Purseglove, 1972). The major onion producing countries of the world are India, China, Korea, Netherlands, Israel, Japan, Turkey, Syria, Egypt, USA and Lebanon (FAO, 2012). It is grown almost in all the districts of Bangladesh , it is mainly cultivated in the greater districts of Faridpur, Pabna, Rahshahi, Jessore, Dhaka, Mymensingh, Comilla and Rangpur (BBS, 2012).

Onion is extensively cultivated during winter season in our country and it is a thermo-photosensitive plant (Jones and Mann, 1963). In Bangladesh, the total area under onion cultivation is 1, 26,274 hectares with the total production of about 134 thousand metric tons (BBS, 2012) with average yield of onion was 8.34 tons/ha.On an average, the total annual requirement of onion in Bangladesh is about 16, 50,000 metric tons but production is 10, 52,000 metric tons (Anonymous, 2012). To meet this shortage, Bangladesh has to import onion from India and China every year (Hossain and Islam, 2006).

Judicious uses of manures are an important factor in quality onion seed production. Organic manure contains nutrient elements that can support crop production and enhance the chemical and physical properties of soil. The chemical fertilizers use in crop production is causing health hazards and creating problems to the environment including the pollution of air, water and soil. When chemical fertilizers uses continuously then affects badly the soil texture and structure thus decreasing the soil organic matter and hampering the soil microbial activity due to soil toxicity. Organic matter improves the soil structure as well as increases its water holding capacity and supports the soils microbial activity, which contributes to release both major and minor nutrients (Stephens, 2002). Manure like cowdung, mustard oil cake, poultry manure is

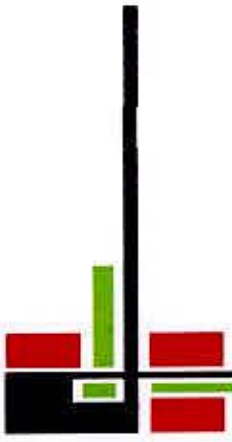
becoming popular and they are also available locally due to establishment of live stock farming, mustard oil mill and poultry farming. Cowdung contains much higher amount of essential nutrients such as 0.5-1.5% N, 0.4-0.8% P, and 0.5-1.9% K. Mustard oil cake contains 5.1-5.2% N, 1.8-1.9% P and 1.1-1.3% K and poultry manure contains1.6-4.5% N, 1.1-3.0% P and 0.5-1.3% K which can help growth and development of plants. Research on this aspects is so much important and to find out the appropriate combination of manures.

In Bangladesh, onion is mainly propagated by three methods viz. direct sowing, seedling transplanting and bulb planting. About 30% of onion is produced from bulb to bulb method and rest 70% of onion is produced from seed to bulb (seedling transplanting) method (Rahim *et al.*, 1982). The quality of onion seeds available in the market is often poor. The demand of onion is increasing day by day because of gradual increase in population. It is not possible to increase the area of crop due to the limitation of land. The only way to solve the problem is to increase per hectare seed yield and this can be done in many ways such as cultivars, planting time, soil, climate, proper doses of fertilizer and manures, bulb size, intercultural operations etc.

Bulb size can greatly influence the umbel growth and seed yield of onion (Rahim *et al.*, 1982). When used small size bulb for seed production then bulb produce weak plants with small size umbel, which can ultimately produce low seed yield. On the other way, when used large size bulb then plant produce large size umbel and higher seed yield but it is not profitable because cost will be more to buy large size bulb. Some farmers use small size bulb, while others medium or large size ones. So, optimum bulb size is so much important for profitable seed yield and this work has not been done in the country.

Therefore, the present study was conducted to investigate optimizing the productivity and profitability of onion (Var. Taherpuri) seed by appropriate management of organic manure and bulb size with the following specific objectives:

i. to investigate the effect of organic manure on the productivity and profitability of onion seed,
ii. to find out the optimum bulb size on the productivity and profitability of onion seed and
iii. to identify the combined effect of organic manure and bulb size on the productivity and profitability



Chapter II

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

Onion is an important bulb as well as spice crop grown all over the world. In Bangladesh, there are a little study on the influence of bulb size and organic manure on the yield of onion seed. However, available literature and research findings related to the present study have been presented in this chapter.

2.1 Effect of organic manure

Suthamathy and Seran (2011) conducted an experiment to evaluate the growth and yield response of red onion (*Allium ascalonicum* L.) growth with sandy soil, cattle manure, coir dust and paddy husk ash. The results indicated that potting materials have significant ($p<0.01$) effect on the growth, yield and nutrient contents of red onion grown in different potting media. Maximum number of leaves per plant, highest plant height and maximum yield were recorded in sandy soil: cattle manure: paddy husk ash at ratio of 6:2:1. It was also noted that the yield per plant increased more than two fold in sandy soil: cattle manure: paddy husk ash at ratio of 6:2:1 over control (medium 1). Usage of paddy husk ash as a potting material in medium preparation would improve the growth and yield performances of red onion grown in pot culture technique. Parwada*et al.* (2011) found that the higher yield of sweet potato was recorded on effect of mustard oil cake compared with chicken manure.

An experiment was conducted by Yoldas *et al.* (2011) to find the influence of both organic and mineral fertilizer on the quality and yield of onion (*Allium cepa* L.) and also on the macro and micro element contents of onion bulb. Cattle manure was applied at 0, 20, 40 and 60 t/ha. Nitrogen:Phosphorus: Potassium was applied at the recommended dose of 120:100:150 with half of the recommended rate of NPK. Yield, yield components and macro-micro element contents were measured. In the first year, bulb width and number of storage leaf were influenced significantly.

Adewale *et al.* (2011) studied to assess the effect of different rates of poultry manure on the yield of garlic. The treatments compared were five poultry manure rates (0, 5,10,15,20 t/ha). The lowest yield was obtained from the yield of the control; all the treatments had significantly higher yields than the control. The highest yield was recorded on plants that received poultry manure at 20 t/ha. This could be attributed to increase the quality of nutrients from this rate of poultry manure.

Nasreen *et al.* (2009) investigated on the response of garlic (var. BARI Garlic-2) to zinc, boron and poultry manure application along with a blanket dose of 150 kg N, 50 kg P, 100 kg K and 40 kg S/ha was evaluated through field trails in the Grey Terrace Soil under AEZ 25. Application of zinc, boron and poultry manure significantly increased plant height, number of leaves/plant, cloves/bulb, diameter and weight of bulb and yield/ha. The highest yields were obtained from the Zn_5B_1 kg/ha plus 5 t/ha poultry manure treatment and it was significantly higher than all other treatments.

Magdi *et al.* (2009) conducted a field experiment to evaluate yield performance of onion cv. (Giza 6) fertilized with animal or chicken manures or mineral fertilizer. The results obtained showing that the yield and quality of onion were significantly influenced by fertilizer types. The highest yield of onion was obtained by the application of chicken manure in both seasons compared to animal manure and mineral fertilizers in 2004/2005 (7.04, 7.74, respectively) and in 2005/2006 (5.55, 7.17 ton/feddan, respectively). Additionally, the application of chicken manure increased dry matter, weight of individual bulb and bulb diameter of onion.

Yahaya (2008) found the yield of garlic to be increased as the quantity of poultry manure increased. Plants that received poultry manure at 20 t ha^{-1} had the highest average number of cloves per bulb of 5.7, followed by those that received poultry manure at 15 t ha^{-1} with an average of 5.3 cloves per bulb. The ability of poultry manure to increase the performance of garlic could also be

attributable to the fact that organic manures improve both physical and chemical soil properties.

Shaheen *et al.* (2007) showed that organic fertilizers had positive effect on root growth by improving the root rhizosphere conditions (structure, humidity, etc.) and also plant growth is encouraged by increasing the population of microorganisms. They also observed higher plant growth from chicken manure compared to cattle manure.

Linderman and Davis (2004) conducted an experiment on growth response of onion (Allium cepa cv. guardsman). They found that root and shoot growth in onion were significantly increased when organic fertilizers were used at the 1× rate. These results indicate that the release of nutrients from organic fertilizers, as a result of microbial activity, favoursarbuscular mycorrhizas (AM) establishment and function more than most inorganic fertilizers, unless P levels of the later are low.

Halvin *et al.* (2003) stated that mustard oil cake might be ascribed to increase the availability of nutrients in the soil for uptake by plant roots that might have enhanced vegetative growth through increasing cell division and elongation.

Jablonska *et al.* (2002) stated that the highest yield of onion cultivated in the second year after organic fertilizer application were obtained after ploughing the field pea, farmyard manure and the mixture of oat + field pea.

Abdelrazzag (2002) conducted an experiment on the effect of chicken and sheep manure at rates of 20, 40 and 80 t ha^{-1}, as well as inorganic fertilizers at rate of 400 kg N ha^{-1}, 200 kg P_2O_5 ha^{-1}, 100 kg K_2O ha^{-1} on yields, nutrient content, leaf area and dry weight of onion yield. The results revealed that there was no significant difference in yield due to chicken manure and inorganic fertilizer. The yield increased significantly with sheep manure and inorganic fertilizer. In general the yield of onion was higher in the second year compared with the first year. There was a significant difference in leaf area on onion only

between sheep manure at level of 20 and 40 t ha^{-1} of chicken manure only in first year.

Zakaria and Vimala, (2002) found the high nutrient content (nitrogen) of composted dairy manure and cattle manure contributed to a higher yield (fresh and dry mass) of onion than that of vegetables treated with poultry manure or alkaline stabilized composted dairy manure. However, the combination of organic fertilizer (green manure, palm oil mill effluent) and inorganic fertilizer (N, P and K) produced yields of cucumber and cabbage that were higher than those of plants treated with green manure or palm oil mill effluent alone.

Belay *et al.* (2001) reported that organic fertilizers might be considered as a source of organic matter for soil. It may be used as a substitute to the chemical fertilizers because it gives plants food elements for longer period and also increases soil fertility by increasing the activity of soil microorganisms.

Salman (2001) examined the effect of plant growth in carrot with the application of digested poultry slaughterhouse waste with mustard oil cake as nitrogen source supported that the applied poultry waste gave higher yield.

Frank (2000) applied mustard oil cake which affected on number of onion leaves. Plants that received mustard oil cake at 4.5 t/ha had the highest value of number of leaves while the yield of onion also showed highest.

Rahman (2000) carried out an experiment and found that plant height of TPS seedlings was significantly influenced by the application of cowdung. The highest plant height (75.28 cm.) at 100 days was obtained from the highest dose of cowdung (100 t/ha).

Nambiar *et al.* (1998) reported sustainable crop production through the integrated use of organic manure and chemical fertilizers. A suitable combination of organic and inorganic sources of nutrients is necessary for a sustainable agriculture that will provide good quality true seeds of onion. Integrated use of organic manures and chemical fertilizers would be quite

promising not only in providing greater stability in production, but also in maintaining higher soil fertility status.

Singer *et al.* (1998) found that addition of organic fertilizer improved soil structure, which can encourage root development and leads to encourage growth of different crops.

Barman and Das (1996) treated greengram (*Vigna radiata*) with organic amendments: cowdung, poultry manure and mustard oil cake each at 2 t/ha alone and reported that the highest yields were given by mustard oil cake.

Meena and Gupta (1996) conducted a field experiment by supplying 10 t/ha of FMY, Gobar gas spent slurry or digested willow dust, or 3 t mustard oil cake, or 0-120 kg N/ha to potato cv. Kufri Chandramukhi. Result showed that tuber yield was highest with mustard oil cake (16.2 t/ha) and 120 kg N (16.3 t/ha).

Barman and Das (1996) treated greengram (*Vigna radiata*) with organic amendments: Neem cake, poultry manure and mustard oil cake each at 2 t/ha alone and in combined application of seed dressing, followed by organic amendments at 1 t/ha each. It was found effective in improving plant growth characteristics and yield.

Majumdar and Mondal (1994) made a study on the effect of soil amendment with NPK (40:20:20), mustard and Neem oil cake on rosella (*Hibiscus sabdarifa*). The fibre yield/plant with NPK and mustard oil cake at 1 t/ha showed significantly higher values compared with control; besides, higher disease incidence was revealed in the treated rosella.

Adhikari*et al.* (1992) conducted a field trial on carrot cv. Kufri Badshah, using 150 kg nitrogen as urea + 40 t cowdung, 3.2 t mustard oil cake or 20 t cowdung, 1.6 t mustard oil cake or 10 t poultry litter/ha to give a total nitrogen application in each treatment of about 310 kg/ha. Carrot yield and net profit were highest with application of 150 kg nitrogen as urea + 20 t poultry litter/ha.

Arozarena*et al.* (1991) conducted a field trial in Cuba, potatoes cv. Desiree were supplied with 50 or 50 or 100 kg N/ha, and 0, 40 or 80 tons filter press cake. Tuber yield increased with nitrogen and filter press cake rates from 17.3 t with 50 kg nitrogen to 33.3 t/ha with 100 kg nitrogen + 80 t filter cake.

Mondal and Mazumder (1986) showed that, when 100, 50 or 25% of the added nitrogen was derived from groundnut cake or 50 or 25% was provided by FYM, average yields were 27.6, 26.3, 28.4, 24.7 and 22.7 t/ha, respectively.

Sharma *et al.* (1986) conducted field trails during 1982-84 and found that, nitrogen used as Neem cake coated urea gave significantly higher yields than nitrogen as urea. Emergence was not effected significantly.

Hussain (1985) stated that use of mustard oil cake at the rate of 700-900 kg/ha was better for higher potato production. Sahota and Singh (1985) gave nitrogen as urea or Neem cake in field trials on potatoes cv. KufriuChandramukhi. Neem cake had no significant effect.

2.2 Effect of bulb size

Kumar and Signh (2007) conducted a field experiment in Uttar Pradesh, India, during 2002-03 and 2003-04 to study the effect of bulb size (3.0-4.0, 4.0-5.0 and 5.0-6.0cm), cultivar (Hisar-2 and Nasikred) and spacing (30×10, 30×20 and 30×30cm) on the growth and seed yield of onion. Hisar-2 bulbs of 5.0-6.0cm and planted at 30×30cm spacing gave the maximum number of flowers per head, number of seeds per umbel, seed weight per umbel, seed yield plant, plant height, number of shoots per plant, shoot diameter and number of leaves per plant and the earliest days to the first umbel formation.

Mirshekari and Mobasher (2006) conducted a field experiment to investigate the effects of sowing date, plant density and bulb size on the seed yield of onion cv. Azarshahr Red at the Islamic Azad University of Tabriz in Iran. Treatments comprised of four sowing dates (2 and 20 March and 7 and 23 October) four onion sizes (3.5-4.5, 4.5-5.5, 5.5-6.5 and larger than 6.5cm) and

the densities (14.3, 11.4 and 9.5 plants/m^2). Analysis of variance indicated that seed yield, stem lodging percentage, umbel diameter, seed yield per plant and all traits except the remaining parts percentage were influenced by sowing dates, bulb size and plant density. There are significant correlations between seed yield and remaining plants percentage, umbel diameter, seed yield per plant and stem height. The results showed that sowing bulbs larger than 6.5cm diameter and density of 1, 43,000 plants per hectare on 20 March is the best treatment combination in the Tabriz area.

Singh and Ahmed (2005) carried out an experiment during 2002-2003 in Ladakh, Jammu and Kashmir, India to evaluate the effects of bulb size (1.5, 3.0 and 4.5cm diameter) and plant spacing (30×10, 30×15, 30 ×20cm) on the seed production of onion cv. Sindhu Sweta. Bulbs with 4.5 cm diameter and planted at 30×10 cm showed maximum plant height , while the minimum plant height was observed under the widest spacing and in the smallest bulbs. The maximum number of sprouts/hill, number of umbels and seed number per umbel was recorded from the largest bulb size and the widest spacing. The maximum average seed yields (10.50 and 11.50 q/ha) were observed when medium size bulbs were planted at 30×20cm. Nonetheless seed germination was unaffected by the treatments.

Shaikh *et al.* (2002) conducted an experiment in India, during rabi season to evaluate the effect of bulb size: large, medium and small, and 5 growth regulators viz., Gibberellic acid (25 and 50 ppm), miraculan (1000 and 2000ppm), NAA (100 and 200ppm), maleic hydrazide (10-20ppm) and chlormequat (500 and 1000ppm) on the seed yield and quality of onion cv. Nasik Red. Large bulbs gave significantly higher values for plant height, number of leaves per plant, number of umbels per plant, umbel diameter and seed weight per umbel, seed yield per plant and per hectare, seed germination and seedling vigor compared to medium and small bulbs. Large or medium bulbs sprayed with gibberellic acid at 50 ppm, miraculan at 2000 ppm or

maleic hydrazide at 20 ppm gave significantly higher seed yields per hectare, germination and vigor values compared to other combinations.

Yadav *et al.* (2002) investigated the effects of bulb size (4.02-5.0 or 5.5-6.5 cm), spacing (45×30 or 60×30 cm) and planting date (14, 24 October, 3 November, 13 or 23 November) on the performance of onion cv. Kalyanpur Red Round in Kalyanpur, Uttarpradesh, India during rabi season of 1998-1999. Large bulbs (5.5-5.6cm) planted on 3 November at the spacing of 45×30 cm resulted in high number of umbels per plant and the highest seed yield (8.20 quintal/ha). However, the optimum seed yield of 7.64 quintal/ha was obtained with large bulbs planted from 24 October and 13 November at the spacing of 45×30cm.

Abedin *et al.* (1999) studied the effect of planting date and bulb size on the yield and quality ofonion seed at BAU, Mymensingh. The two bulb sizes were large (7±0.5g) and small (4±0.5g). Large sized bulb gave higher seed yield (771.70kg/ha) while the small sized bulb lower (698.10kg/ha).

Dadhania and Gajipara (1998) studied the effect of different combinations of 4 bulb diameters (1.6-2.5cm,B_1; 2.6-3.5cm,B_2; 3.6-4.5cm,B_3; and 4.6-5.5cm,B_4) and different plant spacing (30×30cm,S_1; 45×45cm,S_2; 60×30cm,S_3 and 60×45cm,S_4) treatments were used in a field experiment conducted in tunagdh, Gujrat, India during rabi season of 1994-95. Observations on plant height and seed yield were recorded. The highest plant height (58.60cm) and umbel number (7.0) were recorded from B_4S_3 and B_4S_4, respectively. The highest seed yield of onion per plant (21.85g) was recorded B_4S_1.

Singh and Sachan (1998) carried out a field experiment in India to study the response of different cultivars and bulb size on onion seed yield. Three bulb sizes (2.5-3.0, 3.0-4.0 and 4.0-5.0cm) and two cultivars (Kalyanpur Round Red and Nasik Red) were tested. The larger bulb produced taller plants, a greater number of leaves and umbel per plant, a higher 1000 seed weight and seed yield per hectare for both the cultivars.

Ali *et al.* (1998) observed a field experiment in Peshawarand to study larger onion bulbs (5.5-7.0 cm) enhanced seed yield per plant (3.30 g), 1000 seed weight (2.08 g) and seed yield per hectare (322.88 kg) significantly compared to (2.28 g),(1.93 g) and (224.0 kg) respectively; from planting the smallest bulbs (3.5-4.5 cm).

Frag and Koriem (1996) in Egypt reported that percentage of emergence, number of heads per plants, length of flower stalk and total seed yield increased significantly with the increase in bulb size from 3.5-4.5 cm (small) to 6-8 cm (large) bulb size did not significantly affect the 1000 seed weight, but seed germination decreased significantly with the increase in bulb size.

Gamie *et al.* (1996) studied the effect of mother bulb size on the seed production of onion cv. Shandaweel in Egyptian condition. They observed that number of seed stalk per plant and seed yield positively correlated with bulb size. Medium bulbs gave the highest seed germination. Total seed yield correlated positively with 1000 seed weight and seed germination percentage. Number of seed stalks per plant correlated with seed germination percentage, and seed germination percentage positively correlated with 1000 seed weight.

Alam (1995) mentioned that the highest seed yields of onion per plant and per hectare (0.93 g) and (256.96 kg) respectively were obtained from large bulbs (9.5±1 g) and declined as the bulb size was reduced.

Shah and Rahman (1995) evaluated various sizes of onion bulbs (50, 100, 150 and 200g per bulb) for days to bolting, number of leaves and seed stalk and seed yields per plant and per hectare at Peshawar, Pakistan in 1989-90. The number of days to bolting was not affected by the size of the mother bulb. However, an increase in bulb size from 50 to 200g significantly increased the number of leaf and seed stalks from 16.25 to 20.00 and 1.01 to 7.75 per plant, respectively. Likewise, average seed yield also increased from 53.7 to 248.3 g per plant (49.73 to 229.97 kg/ha) as the bulb size was increased.

Ambulker *et al.* (1995) conducted field a trial with onion cv. Local white and bulbs with diameter of 3.0-3.99 cm, 4.0-4.99 cm and 5.0-5.99 cm (S_1, S_2 and S_3, respectively) were planted at the spacing of 22.5×30.0 cm, 22.5×45.0 cm, 30.0×45.0 cm and 45.0×45.0 cm (SP_1, SP_2, SP_3 and SP_4 respectively). Plant heights were maximum with S_3 S P_4, while the number of leaves per plant was the highest with S_3SP_4. The time of emergence of leaves per plant was the first flowering stalk was the shortest with S_3SP_4 and the longest with S_1SP_2 (52 and 64 days respectively). Number of umbels per plant, umbel diameter, seed yield per umbel and seed yield per plant was highest with S_3SP_4 but seed yield per plot was the highest with S_3SP_1.

Verma *et al.* (1994) mentioned that the number of days to 100% sprouting, number of branches per plant, average branch length, number of seed stalks per plant, total seed yield per 1.62m^2 plot and average seed yield per plant increased linearly with the rise in bulb size of onion (156.42, 98.18,50.83 and 25.92 g sized bulbs were planted).

Bhardwaj (1991) obtained the highest number of umbel per plant, seeds per umbel and seed yield per plant with large bulbs (5.1-7.0 cm) planted at 60×45 cm. the maximum seed yield per plot (641.60 g) was obtained with large bulbs planted at 30×30 cm (plot size 2.25×1.80 m^2) where bulbs of 3 sizes (2.1-3.0 and 5.1-7.0 cm diameter) were planted at 5 different spacing (30×30, 45×30, 60×30 and 60×45 cm) in India.

Gill and Singh (1989) conducted an experiment at the Panjab Agricultural University, Ludhiana, India during 1977-79 using 4 grades of onion bulbs: A (>6), B(>5 and <6cm diameter), C(>5cm diameter) and D(ungraded). The highest number of bolting stems per plant (12.54) and seed yield (964 kg/ha) were obtained from the grade A bulbs. The highest number of says (14.38) to 50% bolting was observed from the grade C bulbs.

Toman *et al.* (1989) reported that 27, 47 and 62% higher seed yield with graded mother bulb having diameter of 50.1-60.0, 60.1-70.0 and 70.1-80.0 mm,

respectively. Bulbs with 30.1-40.0 mm diameter produced 35.3% lower yield than ungraded bulbs.

Ali *et al.* (1989) conducted an experiment with onion cv. Taherpuri. They grew onion from bulbs of thee size grades 25.3-28.8 g (large), 13.2-17.4 g (medium) and 5.1-7.2 g (small) under open pollinated conditions during 1984-85 at Gazipur, Bangladesh and reported that larger bulbs produced more umbels and a greater seed yield per plant (2.77 and 5.17 g respectively) than small and medium sized bulbs.

Nehra *et al.* (1988) conducted a two year trial with large, medium and small sized bulbs of cv. Hissar-2 in India. They reported that bulb of 50 g and above significantly increased plant height, number of sprouts, umbels and seed yield than small and medium size bulbs.

Mullah *et al.* (1987) reported that bulb size had significant influence on the seed yield of onion. They obtained seed yield of 450, 400 and 316 kg/ha by using large (35.0), medium (28.5) and small (24.8 mm diameter) size bulbs of onion, respectively.

Mishra (1986) conducted an experiment in India and he reported that highest seed yield from bigger (3.5-4.5 cm in diameter) mother bulbs compared to smaller ones (1.5-2.5 or 2.5-3.5 cm). The mean seed yield (659.79 kg/ha) was found from the largest bulbs with better germination percentage. It was observed that seed yield decreased significantly by using smaller bulbs.

Madan and Saimbhi (1984) conducted a two year trial with large and medium sized bulbs (5 and 3cm in diameter, respectively) of cv. Punjub 48. These were planted in rows 30 and 45 cm apart. The experiment crops received nitrogen @ 100,150 and 200 kg per hectare. Bulb size and row spacing had little effect on mean seed yield.

Tudzarov (1982) made a study on the effect of bulb weight on seed yield of onion cv. Majski Srebetljak. He used 7 weight graded fractions (from 24-40 to

more than 300 g) and planted at 70×20 cm. From the experiment he reported that the most suitable bulb weight was 60-120 g (including fractions 2 and 3), giving the best developed and most uniformly ripening seed plants. While large bulbs produced less productive flowering stalks.

Mondal and Chowdhury (1980) carried out an experiment to study the effects of size of mother bulb on seed yield of onion cv. Faridpur Bhati. The sizes of bulbs were 1.8, 2.5 and 3.8 cm in diameter. They found that seed quality and seed yield were increased in respect of large bulb size.

Rathore *et al.* (1980) conducted an experiment on the effect of date of planting and size of bulb on seed crom of onion. They planted onion bulbs cv. Patna Red either whole or cut longitudinally to different sizes on several dates between 5 October and 16 November. They also reported that cutting the bulbs (to reduce costs) was detrimental.

Pall and Padda (1972) conducted an experiment on the effect of nitrogen, plant spacing and size of mother bulb on the growth and yield of seed crop of onion in India. Onions were grown for seed from bulbs weighting 20,25 and 50g spaced at 20,35 and 50cm apart and dozes of N were 20, 40 and 60 kg/ha. They reported that the seed yield increased with the dimensional increased in bulb size. The highest seed yield was obtained from planting large size onion bulbs (50g) at almost all spacing.

Velichko and Lukomets (1976) studied the effect of onion bulb size on seed yield. They reported that seed yield increased with increasing bulb size from small (30 g) to medium (70 g), to large (110 g) bulbs.

Chapter III

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The present research work was conducted at the Central Research Farm of Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from October 2013 to April 2014. This chapter presents a brief description of the experimental site, soil, climate, design, treatments, cultural operations, collection and preparation of soil samples and analysis of different parameters for data collection under the following headings-

3.1 Description of the experimental site

3.1.1 Geographical Location

The experimental area was situated at 23°77'N latitude and 90°33'E longitude at an altitude of 8.6 meter above the sea level (Anon., 2004). The experimental field belongs to the Agro-ecological zone of "The ModhupurTract", AEZ-28 (Anon., 1988a). This was a region of complex relief and soils developed over the Modhupur clay, where floodplain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils as 'Islands' surrounded by floodplain (Anon., 1988b). The experimental site was shown in the map of AEZ of Bangladesh in (Appendix I).

3.1.2 Climate

The experimental area falls under the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April- September) and less rainfall associated with moderately low temperature during the rabi season (October to March). Weather information regarding temperature, relative humidity, rainfall and sunshine hours prevailed at the experimental site during the study period was

presented in Appendix II.

3.1.3 Soil

Soil of the experimental site belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH ranged from 6.0- 6.6 and had organic matter 0.84%. Experimental area was flat having available irrigation and drainage system and above flood level. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done by Soil Resource and Development Institute (SRDI), Dhaka. Physicochemical properties of the soil are presented in (Appendix III).

3.2 Planting materials used for the experiment

The research work was conducted with the bulb of 'Taherpuri'onion variety. Planting materials (bulb) were collected from local market of Manikgonj. Four sizes of bulb on the basis of their weight were used, i.e., 2 g, 4 g, 6 g and 8 g.

3.3 Experimental Treatments

The experiment had two factors. The factors were different organic manures and bulb sizes. They are shown below:

Factor-A: Organic manure (It comprised 4 types combination)

M_1 = Control (no organic manure)

M_2 = 15 t/ha Cowdung + 10 t/ha Poultry Manure

M_3 = 15 t/ha Cowdung + 2.2 t/ha Mustard Oil Cake

M_4 = 15 t/ha Cowdung + 10 t/ha Poultry Manure + 2.2 t/ha Mustard Oil Cake

Factor-B: Bulb size (It included 4 bulb sizes)

S_1 = 2 g

S_2= 4 g

S_3 = 6 g

S_4= 8 g

There were 16 (4 x 4) treatment combinations as follows:

M_1S_1, M_1S_2, M_1S_3, M_1S_4, M_2S_1, M_2S_2, M_2S_3, M_2S_4, M_3S_1, M_3S_2, M_3S_3, M_3S_4, M_4S_1, M_4S_2, M_4S_3 and M_4S_4.

3.4 Design and Layout of experiment

The two factors experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. An area of 16.5 m x 9.5 m was divided into three equal blocks. Each block consisted of 16 plots. Thus, the total numbers of plot were 48. The layout of the experiment was prepared for distributing the treatment combinations were allotted at random. The size of a unit plot was 1.5 m ×1 m. The distance maintained between two blocks and two plots were kept 0.75 m and 0.5 m respectively.

3.5 Details of the field operations

The particulars of the cultural operations carried out during the experiment are presented below:

3.5.1 Preparation of land

The experimental area was first opened on October 11, 2013 by a disc plough to open direct sunshine to kill soil borne pathogens and soil inhabitant insects. It was prepared by several ploughing and cross ploughing with a power tiller followed by laddering to bring about a good tilth. The land was leveled, corners were shaped and the clods were broken into pieces. The weeds, crop residues and stables were removed from the field. The experimental field was

partitioned onto the unit plots in accordance with the experimental design mentioned in figure 1. Total organic manures were applied according to their treatment and finally leveled. The soil of the plot was treated by Furadan 5G to protect the young plants from the attack of mole cricket, ants and cutworm. The land was prepared a month before planting the bulbs.

3.5.2 Required manures:

To get 15tons cowdung, 10 tons poultry manure and 2.2 tons mustard oil cake per hectare, 2.25 kg, 1.5 kg and 330 g respective manures were needed for each 1.5 m^2 plot size.

3.5.3 Planting of bulbs

Different size of bulbs (2 g, 4 g, 6 g and 8 g) were planted in the selected unit plots in 4 rows and there were 15 bulbs in each row. Sixty bulbs were planted in each unit plot. The planting was done on 11th November, 2013. The distance between the rows and between the bulbs in a row was maintained at 25 cm and 10 cm respectively. Border plants were also grown by planting bulbs around the experimental plots in the same date. Bulbs were set upright at a depth of 2.5 cm.

3.5.4 Intercultural operations

3.5.4.1 Gap filling

The unsprouted bulbs were replaced by healthy plants taken from the border after 20 days of plantation. The damaged plants were also replaced by border plants through gap filling.

3.5.4.2 Weeding and mulching

Weeding and mulching were done whenever necessary to keep the crop free from weeds, for better soil aeration and to conserve soil moisture.

3.5.4.3 Irrigation

The young plants were irrigated by a water cane and at later stage irrigation was done by flooding of each plot whenever necessary.

3.5.4.4 Diseases and pests management

Prior to the planting of the bulb, Furadan 3G was mixed with soil of each plot to protect the bulb from termites and ants damage. At the emergence stage, some plants were attacked by cutworm (*Agrotis ipsilon* R.) and field cricket (*Brachytrypes portentosus* L.). These insects were controlled mechanically. Purple blotch disease caused by *Alternaria porri* was found in many plants of the experimental plot at later stages of crop growth. The disease was controlled by spraying Rovral 50 WP at 7 days interval at the rate of 0.05 kg in 6.7 liter of water.

3.5.4.5 Staking

Staking was provided in each plot using bamboo and rope, to keep the plant erect and to protect them from the damage caused by storm and heavy winds.

3.6 Harvesting

The seed heads or umbels were harvested when the seeds became mature. It was harvested in several installments by cutting the mature umbels from the stalk. Harvesting was done in the morning to prevent shattering loss of seeds. The umbels were considering to be ready for harvest when about 15-20% of fruits had exposed black seeds (Vender Meer *et al.*, 1998). Harvesting was done from 25 march to 5 April, 2014.

3.7 Drying and threshing

After harvesting the umbels were dried in open sunlight on brown paper for 4-5 days. Threshing was done by hand and care was taken to avoid mechanical damaged of mature seeds, then the seeds were cleaned and finally kept in

polythene bags in sealed condition and the bags were stored in plastic pots at room temperature.

3.8 Recording data

The following data were collected during the study period:

3.8.1 Pre harvest data collection

Data were collected on the following parameters from the sample plants taken at random except border rows and plants of extreme ends of the inner rows.

3.8.1.1 Plant height (cm)

Plant height was measured from 10 sample plants per plot in centimeter from the ground level to the tip of the longest leaf at 30, 40, 50, 60 and 70 days after planting bulbs. Mean height was then calculated.

3.8.1.2 Number of leaves per plant

Total number of leaves was counted from the 10 sample plants at 30, 40, 50, 60 and 70 days after planting bulbs. Mean of total number of leaves was then calculated.

3.8.1.3 Days required to first bolting

The number of days required for first emergence of flower stalk was recorded.

3.8.1.4 Number of umbels per plant

The average number of umbels per plant was recorded from 10 randomly selected plants after completion of flowering.

3.8.1.5 Days required to first anthesis

The number of days required for first opening of flower was recorded.

3.8.2 Post harvest data collection

3.8.2.1 Number of seeds per umbel

Seeds of 10(ten) umbels from each treatment were counted and average number of seeds per umbel was recorded.

3.8.2.1 Yield of seeds per plant (g)

The seeds obtained from the 10 samples plants were weighed by an electric balance to determine the yield of seeds per plant by using following formula:

$$\text{Seed yield per plant(g)} = \frac{\text{Total weight of seeds taken from ten plants}}{10}$$

3.8.2.2 Yield of seeds per plot (g)

All plots were harvested individually and the average yield of seeds per plot was recorded.

3.8.2.3 Yield of seeds per hectare (kg)

Yield of seeds per hectare was determined by converting the seed yield per plot.

3.8.2.4 Weight of 1000 seeds (g)

For each treatment for 3 replications thousand seeds were counted and weighted by an electric balance to determine the weight of 1000 seeds.

3.8.3 Quality control parameters

3.8.3.1 Germination percentage of seeds

After harvest, the seeds of each treatment germinated in the laboratory to determine the germination percentage. The germination test was conducted taking 50 seeds for each treatment in each petridish with blotter paper as substratum.

$$\text{Germination percentage} = \frac{\text{Number of normal seedling produced}}{\text{Number of seeds set for germination}} \times 100$$

3.8.3.2 Seed vigor index

From the Seed vigor index we can evaluate the vigor of seed. High quality seeds germinate faster than poor quality seeds. The number of normal seedlings recorded in the first count represents the population of fast germinating seeds and thus functions as a vigor measurement. The seed lot showing the higher seed vigor index in considered to be more vigor. According to Islam et al. (2012) following formula is used to calculate the seed vigor index:

$$\text{Vigor index} = \frac{\text{No.of germnated seed}}{\text{Days of first count}} + \ldots\ldots\ldots + \frac{\text{No.of germnated seed}}{\text{Days of final count}}$$

3.9 Statistical analysis

The collected data from the experiment on seed production were statistically analyzed following factorial experiment in RCBD wherever necessary. The means for all the treatments were calculated and the analyses of variance for the most of the characters under investigation were performed by "F" variance test. The significance of difference between pair of means was performed by Least Significance Difference (LSD) test taking the probability level 5% as the maximum unit of significance.

3.10 Economic analysis

The cost of production was analyzed in order to find out the most economic treatment of organic manures and varieties of tomato. All the non-material and material input costs and interests on running capital were considered for computing the cost of production. The interests were calculated for six months @ 14% per year. The price of one kg onion seed was considered to be Tk. 3500.

The benefit cost ratio (BCR) was calculated by the following formula.

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return (Tk/ha)}}{\text{Total cost of production (Tk/ha)}}$$

Chapter IV

Results and Discussion

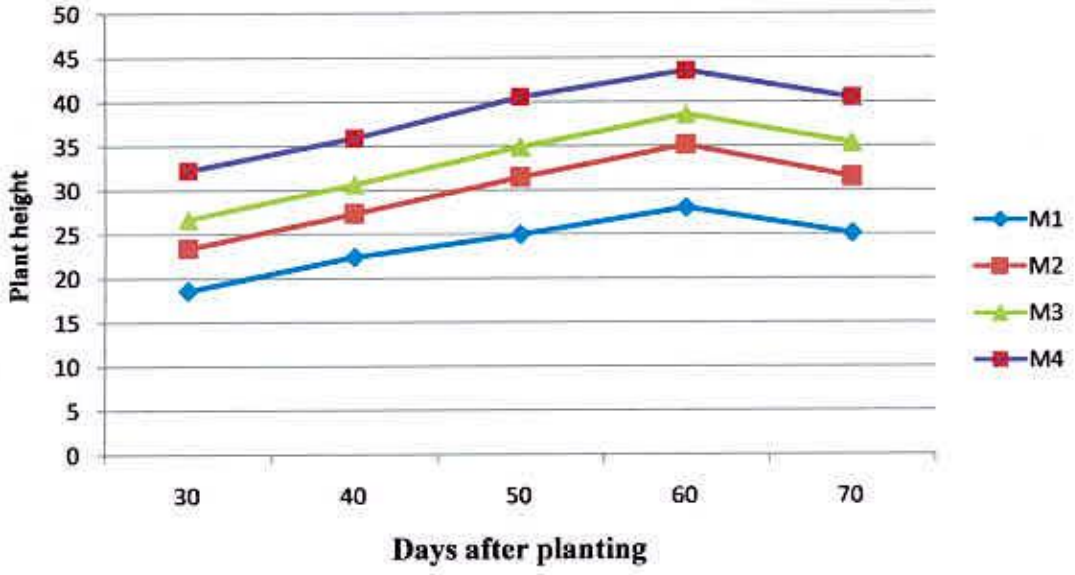
CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to investigate the management of different organic manures combination and appropriate size of onion bulb on the growth and yield of onion seed production. The analyses of variances for different characters have been presented in the appendices IV to VIII. Data on different parameters were analyzed statistically and the results have been presented in the Tables 1 to 9 and Figures 1 to 4. The results of the present study have been presented and discussed in this chapter under the following headings.

4.1 Plant height (cm)

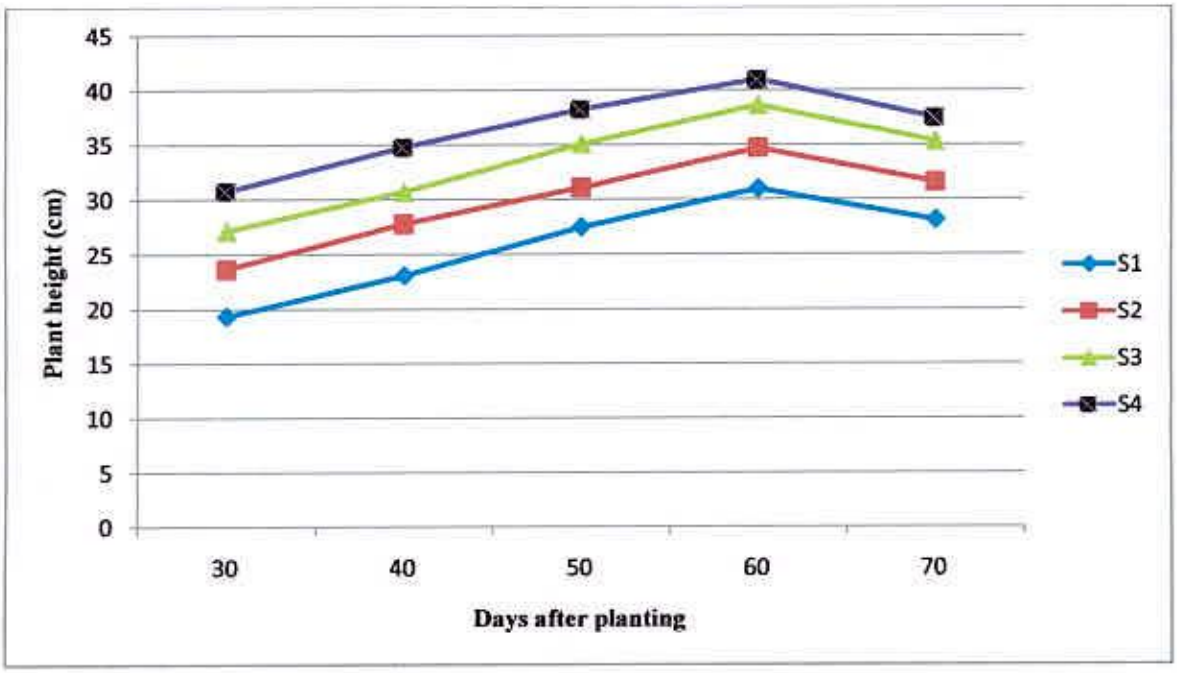
The result showed significant differences on plant height with the application of different organic manures combination (Appendix IV). Organic manures combination significantly increased the plant height throughout the growth period. At 60 DAP the maximum plant height (43.5 cm) was noted from M_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC) and minimum plant height (28.0 cm) was obtained from M_1 (control) treatment (Fig. 1). Shaheen *et al.* (2007) also observed the effect of organic manure on plant height.



M_1=control, M_2=(15t/ha CD+10t/ha PM), M_3=(15t/ha CD+2.2t/ha MOC), M_4=(15t/ha CD+10t/ha PM + 2.2t/ha MOC)

Fig. 1. Effect of organic manure on plant height at different days after planting

Plant height at 30, 40, 50, 60 and 70 DAP was significantly affected by bulb size (Appendix IV). In this experiment, plant height was increased up to 60 DAP and then decreased probably due to drying of leaf. At 60 DAP the maximum plant height (40.97 cm) was recorded from S_4 (8 g bulb) treatment 60 DAP was from S_4 (8g bulb) treatment, while the minimum plant height (30.97 cm) was recorded from S_1 (2 g bulb) treatment (Fig. 2). Khan *et al.* (2005) found the similar nature of result. So the superiority of large bulbs may be explained on the basis of higher food reserves in those. This naturally gives a better start to the growing plants.



S_1= 2g bulb, S_2= 4g bulb, S_3= 6g bulb, S_4= 8g bulb

Fig. 2.Effect of bulb size on plant height at different days after planting

Combined effect of organic manures and bulb size was significantly influenced by plant height (Appendix IV). At 60 DAP thehighest plant height (49.47 cm) was obtained from M_4S_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) treatment combination, which was statistically identical M_4S_3 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC + 6 g bulb)treatment combination and the lowest plant height (24.6 cm) was found from M_1S_1 (Control + 2 g bulb) treatment at 60 DAP (Table 1). This result proved that plant height was increased by the increase in bulb size on the other hand plant hieght was increased by the higher combination of organic manure.

Table 1. Combined effect of organic manures and bulb size on plant height at different DAP of onion (*Allium cepa* L. cv. Taherpuri)

Treatments (Kg/ha)	Plant Height (cm)				
	30 DAP	40 DAP	50 DAP	60 DAP	70 DAP
$M_1 S_1$	14.73 h	18.08 g	21.72 i	24.60 j	21.93 k
$M_2 S_1$	18.70 g	22.32 f	26.37 gh	29.98 g-i	26.80 ij
$M_3 S_1$	20.23 fg	24.45 ef	29.23 fg	33.03 fg	30.17 gh
$M_4 S_1$	23.63 e	27.40 de	32.67 e	36.27 de	33.63 ef
$M_1 S_2$	17.63 g	22.35 f	24.07 hi	27.40 ij	24.37 jk
$M_2 S_2$	22.77 ef	26.93 de	30.60 ef	34.40 ef	31.37 fg
$M_3 S_2$	24.63 e	28.57 d	32.63 e	36.53 de	32.53 e-g
$M_4 S_2$	29.57 d	33.27 c	37.03 c	40.38 c	38.07 c
$M_1 S_3$	19.53 g	22.53 f	25.53 h	29.20 hi	26.40 ij
$M_2 S_3$	24.50 e	28.15 d	33.18 de	37.13 cde	32.80 e-g
$M_3 S_3$	28.67 d	32.57 c	36.72 c	40.30 c	37.47 cd
$M_4 S_3$	35.87 b	39.63 b	44.85 a	47.90 a	44.57 a
$M_1 S_4$	22.40 ef	26.68 de	28.60 fg	30.82 gh	27.75 hi
$M_2 S_4$	27.63 d	31.98 c	35.83 c	39.03 cd	35.20 de
$M_3 S_4$	33.17 c	37.13 b	41.05 b	44.55 b	41.40 b
$M_4 S_4$	**39.93** a	**43.37** a	**47.60** a	**49.47** a	**45.60** a
LSD (0.5)	2.46	2.77	2.92	3.03	2.56
CV (%)	5.84	5.70	5.31	5.01	5.62

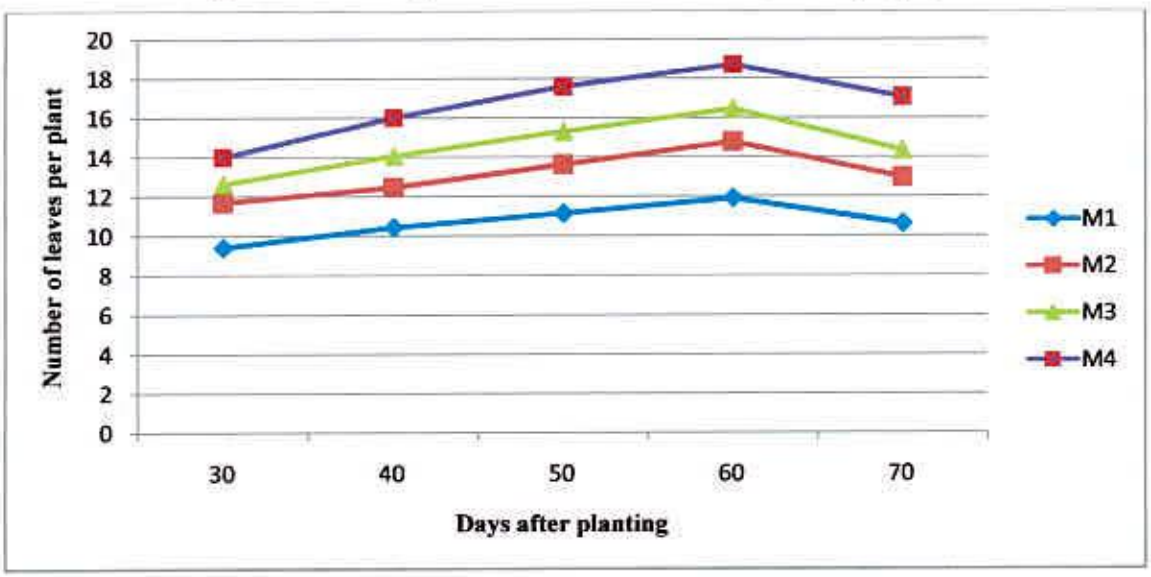
M_1= Control, M_2=(15t/ha CD+10t/ha PM), M_3=(15t/ha CD+2.2t/ha MOC), M_4=(15t/ha CD+10t/ha PM + 2.2t/ha MOC)

S_1= 2g bulb, S_2= 4g bulb, S_3= 6g bulb, S_4= 8g bulb

DAP= Days after planting

4.2 Number of leaves per plant

The variations in number of leaves per plant due to effect of different organic manures were statistically significant (Appendix IV). At 60 DAP the number of leaves per plant was highest (18.69) with the application of M_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC) treatment where the minimum nunber of leaves per plant (11.91) was found from M_1 (control) treatment. However, another two organic manure viz. M_2 (15 t/ha CD + 10t/ha PM) and M_3 (15 t/ha CD + 2.2 t/ha MOC) were statistically similar in respect of number of leaves/plants (Fig. 3).



M_1= Control, M_2=(15t/ha CD+10t/ha PM), M_3=(15t/ha CD+2.2t/ha MOC), M_4=(15t/ha CD+10t/ha PM + 2.2t/ha MOC)

Fig. 3: Effect of organic manures on number of leaves per plant at different days after planting

Number of leaves per plant was significantly influenced by bulb size throughout the growth period. Number leaves per plant were recorded at 30, 40, 50, 60 and 70 DAP at 10 days interval. In this experiment, plant leaves were increased up to 60 DAP and then decreased probably due to drying of leaf. The maximum number of leaves (17.63) were observed in S_4 (8 g bulb) treatmentwhich difffered significantly from other bulb sizes and the lowest number of leaves (13.11) were obtained in S_1 (2 g bulb) (Fig. 4). The number ofleaves was decreased with the

decrease in bulb size. This result agrees with the findings of Singh and Sachan (1998).

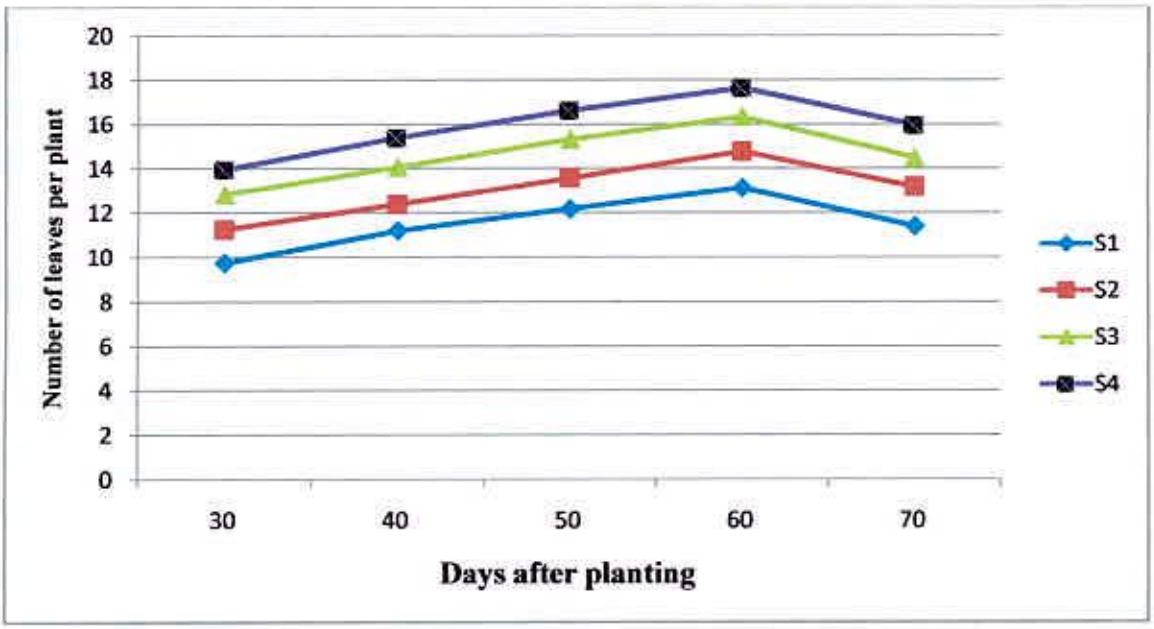


Fig. 4: Effect of bulb size on number of leaves per plant at different days after planting

Combined effect of organic manure and bulb size was found to beon number of leaves per plant. At 60 DAP the maximum number of green leaves per plant (20.63) was obtained from M_4S_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) which was statistically identical with treated with M_4S_3. The lowest number of leaves (9.633) was obtained from M_1S_1 (control + 2 g bulb) (Table 2).

Table 2.Combined effect of organic manures and bulb size on the number of leaves per plant at different DAP of onion (*Allium cepa* L. cv. Taherpuri)

Treatments	Number of leaves per plant				
(Kg/ha)	30 DAP	40 DAP	50 DAP	60 DAP	70 DAP
$M_1 S_1$	7.50 j	8.67 i	9.067 h	9.63 h	8.17 h
$M_2 S_1$	9.433 hi	10.47 gh	11.50 fg	12.53 g	11 fg
$M_3 S_1$	10.37 f-h	12.17 e	13.37 e	14.43 ef	12.13 ef
$M_4 S_1$	11.63 ef	13.47 d	14.73 d	15.83 de	14.27 cd
$M_1 S_2$	8.33 ij	9.733 h	10.57 g	11.47 g	10.23 g
$M_2 S_2$	11.20 e-g	11.87 ef	13.10 e	14.43 ef	12.87 de
$M_3 S_2$	12.13 de	13.27 d	14.53 d	15.77 de	14.20 cd
$M_4 S_2$	13.3 b-d	14.63 c	16.07 c	17.37 bc	15.43 bc
$M_1 S_3$	10 gh	10.93 fg	11.63 f	12.47 g	11.2 fg
$M_2 S_3$	12.40 c-e	12.93 de	14.07 de	15.17 ef	12.83 de
$M_3 S_3$	13.60 bc	14.57 c	15.87 c	17.07 cd	14.73 c
$M_4 S_3$	15.27 a	17.77 a	19.63 a	20.63 a	19.17 a
$M_1 S_4$	11.83 e	12.40 de	13.30 e	14.07 f	12.93 de
$M_2 S_4$	13.67 bc	14.67 c	15.83 c	16.97 cd	15.20 bc
$M_3 S_4$	14.50 ab	16.27 b	17.43 b	18.57 b	16.37 b
$M_4 S_4$	**15.80** a	**18.17** a	**19.90** a	**20.93** a	**19.33** a
LSD (0.5)	1.319	1.001	1.001	1.379	1.38
CV (%)	6.63	4.53	5.64	5.35	6.01

M_1= Control, M_2=(15 t/ha CD+10 t/ha PM), M_3=(15 t/ha CD+2.2 t/ha MOC), M_4=(15 t/ha CD+10t/ha PM + 2.2 t/ha MOC)
S_1= 2 g bulb, S_2= 4 g bulb, S_3= 6 g bulb, S_4= 8 g bulb

DAP= Days after planting

4.3 Days required to first bolting

From the result of the experiment it was observed that statistically significant variation was found among the different combinations of organic manure treatment in respect of days required to first bolting. The longest period (59.75 days) was required for first bolting in M_1 (Control) treatment while shortest period (56.5 days) was required in M_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC) treatment, which was statistically similar with M_3treatment.

Days required to first bolting were significantly varied with different bulb sizes treatment. The lowest time (56.5 days) was required to first bolting from S_4 (8 g bulb) treatment which is statistically similar to S_3 treatment and maximum time required from S_1 (2 g bulb) treatment, which is contradicted with Shah and Rahman (1995). They worked with 50, 100, 150 and 200g bulbs at Peshawar, Pakistan in 1989-90and they got the lowest time to first bolting from 50g bulbs. But in this experiment largest 8g bulb (S_4) was used which was so small compared to the bulb size used by Shah and Rahman (1995).

Combined effect of organic manure and bulb size resulted statistically significant role in respect of days required for first bolting. The maximum time required for first bolting 62 days was obsurvedfrom M_1S_1 (control + 2 g bulb) treatment combination which was statistically similar to M_2S_1, M_3S_1, $M_1S_2$and M_2S_2 treatments. The shortest period (55 days) was required from M_4S_4(15t/ha CD + 10t/ha PM + 2.2t/ha MOC + 8g bulb) treatment which was statistically similar to M_3S_4, M_2S_4, M_1S_4, M_4S_3, M_3S_3, M_2S_3, M_4S_2, M_3S_2 and M_4S_1 treatment combinations.

4.4 Number of umbels per plant

The number of umbel per plant is very important for seed yield. Organic manure has positive effect on the number of umbel per plant. The maximum number of

umbel per plant (2.69) was observed from M_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC) treatment and minimum number of umbel (1.88) per plant was observed in M_1 (control) which was statistically similar to M_2 and M_3 treatments.

The number of umbels per plant was significantly bulb size. The maximum number of umbels per plant (2.74) was found from S_4 (8 g bulb) treatment which was statistically similar to S_3 treatment. The minimum number of umbel per plant (1.67) was found from S_1 (2 g bulb) which was also statistically similar to S_2 treatment. Singh and Sachan, (1998) also reportedthe number of umbel per plant was increased with the increasing bulb size.

Combined effect of bulb size and organic manure resulted statistically significant role in respect of number of umbels per plant. The highest number of umbels per plant (3.21) was found from M_4S_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) treatment combination which was statistically similarto M_4S_3 treatment combination. Minimum umbels per plant (1.33) was recorded from M_1S_1 (control + 2 g bulb) treatment combination.

4.5 Days required to first anthesis

Days required to first anthesis was statistically influenced by different combination of organic manures (Appendix VI). Longest period (70.75 days) was required for first flower opening in S_1 (control) treatment and minimum (67.5 days) was required for M_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC) treatment which was statistically similar to M_3 treatment. It may be indicated that minimum amount of nutrient is required for quick anthesis (Table 3).

The main effect of bulb size on days required to 1st anthesis was found to be significant (Appendix VI). Maximum time (70.75 days) was required for first flower opening from M_1 (control) treatment and Minimum time (67.5 days) from the planting to first flower opening was required in M_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC) treatment and (Table 4).

Combined effects of organic manures and bulb size on the days required to first anthesis was found significant influence (Appendix VI).The maximum time (73 days) was required from M_1S_1 (Control + 2 g bulb) treatment combination. Minimum time (66 days) required for first flower opening was found from M_4S_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) treatment combination which was statistically similar with M_3S_4 and M_4S_3 treatment combination. (Table 5). It may be indicated that large bulb size with different manures combination enhances quick anthesis.

4.6 Number of seeds per umbel

Number of seeds per umbel was significantly influenced by the application of different organic manures combination. The maximum number of seeds per umbel (516.20) was found from M_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC) treatment which was statistically identical with the treatment of M_3 treatment and similar with M_2 treatment and the minimum number of seeds per umbel (477.90) was found from M_1 (control) treatment which was statistically similar with M_2 treatment.

The effects of bulb size on the number of seeds per umbel were significant. The maximum number of seeds per umbel (510.20) was found from S_4 (8 g bulb) treatment which was statistically identical with S_3 treatment and the minimum number of seeds per umbel (483.6) was found from S_1(2 g bulb) (table 4). This result also partially agrees with Ambulker *et al.* (1995) they observed that large bulb produced large umbel and large umbel produce high amount of onion seed.

Combined effects of organic manures and bulb size were significant on number of seeds per umbel. Maximum numbers of seeds per umbel (530.0) was found from M_4S_4 (15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) treatment combination which was statistically similar with few treatments and whereas minimum number

of seeds per umbel (466.3) was found from M_1S_1 (control + 2 g bulb) which was also statistically similar with few treatment combination (Table 5).

Table 3. Main effect of organic manures on the yield contributing characters of onion (*Allium cepa* L. Taherpuri)

Treatments (Kg/ha)	Days required to first bolting	Number of umbels per plant	Days required to first anthesis	Number of seeds per umbel
M_1	**59.75** a	1.875 c	**70.75** a	477.9 b
M_2	58.5 b	2.025 bc	69.5 b	498.5 ab
M_3	57.5 bc	2.29 b	68.5 c	504.8 a
M_4	56.5 c	**2.69** a	67.5 d	**516.3** a
LSD(0.05)	1.121	0.3766	1.102	21.91
CV (%)	7.44	5.22	6.45	3.38

M_1= Control, M_2=(15 t/ha CD+10 t/ha PM), M_3=(15 t/ha CD+2.2 t/ha MOC), M_4=(15 t/ha CD+10 t/ha PM + 2.2 t/ha MOC)

Table 4. Main effect of bulb size on the yield contributing characters of onion (*Allium cepa* L. Taherpuri)

Treatments (Kg/ha)	Days required to first bolting	Number of umbels per plant	Days required to first anthesis	Number of seeds per umbel
S_1	**59.75** a	1.67 c	**70.75** a	483.60 b
S_2	58.50 b	2.03 bc	69.50 b	496.20 ab
S_3	57.50 bc	2.46 ab	68.50 c	507.50 a
S_4	56.50 c	**2.74** a	67.50 d	**510.20** a
LSD(0.05)	1.13	0.46	0.97	18.06
CV (%)	7.44	5.22	6.45	4.15

S_1= 2g bulb, S_2= 4g bulb, S_3= 6g bulb, S_4= 8g bulb

Table 5: Combined effect of organic manure and bulb size on yield contributing characters of onion (*Allium cepa* L. cv. Taherpuri)

Treatments (Kg/ha)	Days required to 1st bolting	Number of umbels per plant	Days required to 1st anthesis	Number of seeds per umbel
$M_1 S_1$	**62** a	1.33 h	**73** a	466.3 g
$M_2 S_1$	60 ab	1.533 g	71 b	481.2 e-g
$M_3 S_1$	59 a-c	1.8 f	70 bc	487.9 c-g
$M_4 S_1$	58 b-d	2.033 e	69 cd	498.9 b-f
$M_1 S_2$	60 ab	1.767 f	71 b	476.8 fg
$M_2 S_2$	59 a-c	1.833 f	70 bc	497.1 b-g
$M_3 S_2$	58 b-d	2.067 e	69 cd	500.3 a-f
$M_4 S_2$	57 b-d	2.433 cd	68 de	510.7 a-e
$M_1 S_3$	59 a-c	2.1 e	70 bc	483.4 d-g
$M_2 S_3$	58 b-d	2.133 e	69 cd	506.5 a-f
$M_3 S_3$	57 b-d	2.5 cd	68 de	514.6 a-d
$M_4 S_3$	56 cd	3.123 a	67 ef	525.5 ab
$M_1 S_4$	58 b-d	2.333 d	69 cd	485.0 d-g
$M_2 S_4$	57 b-d	2.6 c	68 de	509.3 a-e
$M_3 S_4$	56 cd	2.8 b	67 ef	516.6 a-c
$M_4 S_4$	55 d	**3.207** a	66 f	**530.0** a
LSD (0.05)	3.335	0.1901	1.668	31.15
CV (%)	7.44	5.22	6.45	3.38%

M_1= Control, M_2=(15t/ha CD+10t/ha PM), M_3=(15t/ha CD+2.2t/ha MOC), M_4=(15t/ha CD+10t/ha PM + 2.2t/ha MOC)

S_1= 2g bulb, S_2= 4g bulb, S_3= 6g bulb, S_4= 8g bulb

4.7 Seed yield per plant(g)

The effect of organic manure on seed weight per plant was significant. The maximum seed weight per plant (2.779 g) was observed from M_4 (15 t/ha CD+10 t/ha PM + 2.2 t/ha MOC) treatmenet and lowest seed weight per plant (1.927 g) was observed from M_1 (control) treatment.

Bulb size had significant influence on the seed yield per plant. The maximum seed yield per plant (2.65 g) was found from S_4 (8 g bulb) treatment and minimum (2.12g) was obtained from S_1 (2g bulb) treatment. Ambulker *et al.*, (1995), Abedin *et al.*, (1999) and Muktadir *et al.*, (2001) also observed this similar result.

Combined effect of bulb size and organic manure on seed weight per plant was significant. The maximum (3.10g) was obtained from M_4S_4(15 t/ha CD+10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) treatment combination which was statistically identical with M_4S_3 treatment combination. The minimum seed weight per plant (1.55 g) was found from M_1S_1 (control + 2g bulb) treatment combination.

4.8 Seed yield per plot (g)

The seed yield per plot was affected significantly due to different combination of organic manures. The maximum seed yield per plot (75.11 g)was obtained from M_4(15 t/ha CD+10 t/ha PM + 2.2 t/ha MOC) treatment and the lowest seed yield per plot (35.38 g) was observed in M_1 (control) treatment.

Different bulb size had significant effect on seed weight per plot. The maximum seed yield per plot (66.57 g) was obtained from S_4 (8 g bulb) treatment which was statistically identical from S_3 (6 g bulb) treatment. The minimum seed yield (47.56 g) was obtained from S_1 (2 g bulb) treatment. The previous workers Verma *et al.* (1994) reported that different bulb sizes had significant variation in seed yield per unit area.

Combined effect of different bulb sizes and organic manures combination on the seed yield per plot was highly significant. Maximum seed yield per plot (85.1g) was found in M_4S_4 (15 t/ha CD+10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) treatment combination which was statistically identical to M_4S_3 treatment combination. On the other hand, the minimum seed yield per plot (28.3 g) was obtained from M_1S_1 (control + 2 g bulb) treatment (table 8).

4.9 Seed yield (kg ha^{-1})

Significant influences of organic manure on seed production per hectare were observed. The maximum seed yield per hectare (500.7 kg) was obtained from M_4 (15 t/ha CD+10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) treatment while the lowest seed yield per hectare (235.1 kg) was obtained from M_1 (control) treatment (table 6).

Different bulb size had significant influence on the seed yield per hectare. The maximum seed yield per hectare (443.8 kg) was found from S_4 (8 g bulb) treatment which was statistically identical to S_3 treatment and minimum seed yield per hectare (316.2 kg) was obtained from S_1 (2 g bulb) treatment (table 7). In this experiment it is observed that large bulb produce higher seed yield per hectare. Singh and Sachan (1998) also stated similar statement.

The combined effects of different bulb sizes and combination of organic manure on the seed yield per hectare were significant. The maximum seed yield per hectare (567.3 kg) was found in M_4S_4 (15 t/ha CD+10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) treatment which was statistically identical with M_4S_3 treatment combination. On the other hand, the minimum seed yield per hectare (185.3 kg) was obtained from M_1S_1 (control + 2 g bulb) treatment combination (Table 8).

4.10 Weight of 1000 seeds

It was observed that the weight of 1000 seeds of onion varied significantly due to the application of different organic manures combination. The maximum weight of 1000 seeds(3.57 g) was found from M_4 (15 t/ha CD+10 t/ha PM + 2.2 t/ha MOC) treatment and the minimum weight of 1000 seeds (3.201 g) was observed from M_1 (control) treatment (Table 6).

The effect of different bulb size was found to be non-significant influence on the weight of 1000 seeds (Table 7).

The combined effects of organic manures and bulb size on the weight of 1000 seeds were found to be statistically significant. Maximum weight of 1000 seeds (3.66 g) was found in M_4S_4 (15 t/ha CD+10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) treatment which was statistically identical with S_3 treatment. On the other hand, the minimum weight (3.12 g) of 1000 seeds was obtained from the treatment combination of M_1S_1 (control + 2 g bulb) treatment combination (Table 8).

4.11 Seed germination (%)

The variation in the percent germination of produced seed was found to be non-significant statistically insignificant influence (Table 6).

The effect of bulb size was found to be statistically insignificant influence on the percent of seed germination (Table 7).

Combined effects of organic manure and bulb size combination on the percentage of seed germination also showed statistically non-significant (Table 8)

4.12 Seed vigor index

The variation in the seed vigor index of produced seed was significant with the treatment of different manures combination. It was observed that the highest seed vigor index (11.95) was found in M_4 (8 g 15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC) which was statistically similar to M_3 and M_2 treatments. On the other hand M_1 (control) treatment gave the lowest seed vigor index (9.463) (Table 6).

Bulb size had significant influence on the seed vigor index. The highest seed vigor index (11.76) was found from S_4 (8 g bulb) treatment which was statistically similar S_3 and S_2 treatment and the lowest (9.52) was found from M_1 (2 g bulb) treatment (Table 6).

Combined effects of organic manures and bulb size on the seed vigor index was significantly influenced. Maximum seed vigor index (13.53) was found in the treatment combination of M_4S_4 (8 g 15 t/ha CD + 10 t/ha PM + 2.2 t/ha MOC + 8 g bulb) treatment combination, which was statistically identical with M_4S_3. On the other hand, the minimum seed vigor index (8.35) was obtained from M_1S_1 (control + 2 g bulb) treatment combination which was statistically identical to M_2S_1, M_1S_2 and M_1S_3 treatments combination (Table 8).

4.13 Economic analysis

Input costs for land preparation, onion bulb cost, organic manures, irrigation and manpower required for all the operations from planting onion bulb to harvesting of onion seed were recorded for unit plot and converted into cost per hectare. Price of onion seed was considered as per market rate. The economic analysis presented under the following headings-

4.13.1 Gross return

The combination of organic manures and bulb sizes showed different gross return. The highest gross return (19,85,550 Tk/ha) was obtained from M_4S_4 treatment combination and the second highest gross return (19,72,600 Tk./ha) was found in M_4S_3. The lowest gross return (6,48,550 Tk./ha) was obtained from M_1S_1 treatment combination (Table 9).

4.13.2 Net return

In case of net return different treatment combination showed different net return. The highest net return (13,01,743 Tk/ha) was found from M_4S_3 treatment combination and the second highest net return (12,60,765 Tk/ha) was obtained from M_4S_4 treatment combination. The lowest (2,45,086.2 Tk/ha) net return was obtained M_1S_1 treatment combination (Table 9).

4.13.3 Benefit cost ratio

In the combination of organic manures and bulb sizes showed highest benefit cost ratio (2.94) was noted from M_4S_3 treatment combination and the second highest benefit cost ratio (2.74) was estimated from M_4S_4 treatment combination. The lowest benefit cost ratio (1.61) was obtained from M_1S_1 treatment combination (Table 9). From economic point of view, it was apparent from the above results that the combination of M_4S_3 treatment was more profitable than rest of the combination.

Table 6: Main effect of organic manures combination on the yield and quality parameter of onion (*Allium cepa* L. Taherpuri)

Treatments (Kg/ha)	Yield of seeds per plant (g)	Yield of seeds per plot (g)	Yield of seeds per hectare (kg)	Weight of 1000 seeds (g)	Seed germination (%)	Seed vigor index
M_1	1.93 c	35.38 d	335.1 c	3.20 c	83.50	9.517 b
M_2	2.42 b	59.46 c	396.4 b	3.43 b	84.00	10.09 ab
M_3	2.49 b	64.54 b	430.3 a	3.47 b	84.33	11.07 ab
M_4	**2.78** a	**75.11** a	**500.7** a	**3.57** a	84.83	**11.76** a
$LSD_{(0.05)}$	0.1087	3.83	29.63	0.08217	4.41	2.06
CV (%)	3.55	8.74	4.66	7.2	4.04	7.2

M_1= Control, M_2=(15t/ha CD+10t/ha PM), M_3=(15t/ha CD+2.2t/ha MOC), M_4=(15t/ha CD+10t/ha PM + 2.2t/ha MOC)

Table 7: Main effect of bulb sizes on the yield and quality parameter of onion (*Allium cepa* L. Taherpuri)

Treatments (Kg/ha)	Yield of seeds per plant (g)	Yield of seeds per plot (g)	Yield of seeds per hectare (kg)	Weight of 1000 seeds (g)	Seed germination (%)	Seed vigor index
S_1	2.122d	47.56c	316.2c	3.326	82.83	9.517b
S_2	2.307c	56.32b	375.4b	3.39	83.50	10.09ab
S_3	2.533b	64.04a	426.9a	3.46	84.58	11.07ab
S_4	**2.65**a	**66.57**a	**443.8**a	3.5	85.75	**11.76**a
LSD 0.05	0.1087	3.741	28.82	0.69	4.413	2.06
CV (%)	3.55	8.74	4.66	7.2	4.04	7.5

S_1= 2g bulb, S_2= 4g bulb, S_3= 6g bulb, S_4= 8g bulb

Table 8. Combined effect of organic manures and different bulb sizes on the yield and quality parameter of onion (*Allium cepa* L. cv. Taherpuri)

Treatments (Kg/ha)	Yield of seeds per plant (g)	Yield of seeds per plot (g)	Yield of seeds per hectare (kg)	Weight of 1000 seeds (g)	Seed germination (%)	Seed vigor index
M_1 S_1	1.55 h	28.3 k	185.3 j	3.12 a	82.33	8.347 f
M_2 S_1	2.147 f	48.6 g	324.0 g	3.34 ab	82.67	9.607 d-f
M_3 S_1	2.3 d-f	53.17 f	354.4 f	3.387 ab	83.00	9.9cd f
M_4 S_1	2.493 b-d	60.17 e	401.1 dc	3.457 ab	83.33	10.22 b-e
M_1 S_2	1.857 g	33 j	220.0 i	3.177 ab	83.00	9.4 ef
M_2 S_2	2.363 c-f	58.73 e	391.6 e	3.403 ab	83.33	9.827 de
M_3 S_2	2.417 b-e	62.9 d	419.3 d	3.446 ab	83.67	10.31 b-e
M_4 S_2	2.59 bc	70.63 b	470.9 bc	3.523 ab	84.00	10.84 b-e
M_1 S_3	2.11 f	38.7 i	258.0 h	3.223 ab	83.67	9.74d ef
M_2 S_3	2.517 b-d	63.17 d	421.1 d	3.454 ab	84.33	10.21 b-e
M_3 S_3	2.573 bc	69.77 bc	465.1 bc	3.517 ab	84.67	11.1 b-d
M_4 S_3	2.933 a	84.53 a	563.6 a	3.627 a	85.67	13.23 a
M_1 S_4	2.19 ef	41.53 h	276.9 h	3.283 ab	85.00	10.37 b-e
M_2 S_4	2.64 b	67.33 c	448.9 c	3.513 ab	85.67	11.42 bc
M_3 S_4	2.663 b	72.33 b	482.2 b	3.543 ab	86.00	11.71 b
M_4 S_4	**3.1** a	**85.1** a	**567.3** a	**3.66** a	86.33	**13.53** a
LSD $_{(0.05)}$	0.2358	2.675	22.37	0.4118	6.273	1.328
CV (%)	5.89	8.74	4.66	7.2	4.04	7.5

M_1= Control, M_2=(15t/ha CD+10t/ha PM), M_3=(15t/ha CD+2.2t/ha MOC),
M_4=(15t/ha CD+10t/ha PM + 2.2t/ha MOC)

S_1= 2g bulb, S_2= 4g bulb, S_3= 6g bulb, S_4= 8g bulb

Table 9. Cost and return analysis of onion seed considering organic manure and bulb size

Treatments	Seed yied (Kg/ha)	Gross return (Tk/ha)	Total cost of production(Tk)	Net return (Tk/ha)	Benefit cost ratio(BCR)
M_1S_1	185.3	648550	403463.8	245086.2	1.61
M_2S_1	324	1134000	476491.3	657508.7	2.38
M_3S_1	354.4	1240400	523678.3	716721.7	2.37
M_4S_1	401.1	1403850	563000.8	840849.2	2.49
M_1S_2	220	770000	457391.8	312608.2	1.68
M_2S_2	391.6	1370600	530419.3	840180.7	2.58
M_3S_2	419.3	1467550	577606.3	889943.7	2.54
M_4S_2	470.9	1648150	616928.8	1031221	2.67
M_1S_3	258	903000	511319.8	391680.2	1.77
M_2S_3	421.1	1473850	584347.3	889502.7	2.52
M_3S_3	465.1	1627850	631534.3	996315.7	2.58
M_4S_3	563.6	1972600	670856.8	**1301743**	**2.94**
M_1S_4	276.9	969150	565247.8	403902.2	1.71
M_2S_4	448.9	1571150	638275.3	932874.7	2.46
M_3S_4	482.2	1687700	685462.3	1002238	2.46
M_4S_4	567.3	1985550	724784.8	1260765	2.74

Note : price of onion seed @ 3500.00 Tk/kg

Net income = Gross income – Total cost of production

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return (Tk/ha)}}{\text{Total cost of production (Tk/ha)}}$$

Chapter V

Summary and Conclusion

CHAPTER V

SUMMERY AND CONCLUSION

A field experiment was conducted at the Central research firm of Sher-e-Bangla Agricultural University, Dhaka-1207. During the period from November, 2013 to April, 2014 with the cultivars of onion (Taherpuri) in order to optimize the production and profit of onion seed production through judicious application of different bulb size and combination of different. The experiment comprised of two factors such as (i) four combinations of organic manure viz. Control (M_1); 15 t/ha Cowdung+ 10 t/ha Poultry manure (M_2); 15 t/ha Cowdung + 2.2 t/ha Mustard oil cake (M_3) and15 t/ha Cowdung+ 10t/ha Poultry manure + 2.2 t/ha Mustard oil cake (M_4) and (ii) four sizes of bulb viz. 2 g (S_1); 4 g (S_2); 6 g (S_3); 8 g (S_4).

The experiment was laid out in RCBD with three replications. The size of each unit plot was 1.5m×1m and 60 plants were accommodated in each unit plot following a spacing 25cm×10cm and seed crop was harvested at maturity between 25 March to 5 April, 2014. Data were collected from ten randomly selected plants and seed yield was recorded from all plants of unit plots. Observations were made on plant height, number of leaves per plant, days required to first bolting, days required to first anthesis, number of umbels per plant, seed yield (g) per plant, seed yield (g) per plot, seed yield (g) per hectare, number of seeds per umbel, 1000 seed weight (g), seed germination (%) and speed of seed germination. The collected data were statistically analyzed and the means were compared with LSD values.

The highest plant height (43.5 cm) and lowest (28 cm) was obtained from M_4 and M_1 treatments, respectively at 60 DAP. The highest plant height (40.97 cm) and lowest plant height (30.97cm) was observed from S_4 and S_1 treatment, respectively at same DAP. WhereasS_3 treatment also statistically similar with S_4. Also the

maximum plant height (49.47 cm) and the minimum (24.6 cm) were obtained from M_4S_4 and M_1S_1 treatment combination, respectively at 60 DAP.

The maximum leaves number per plant (18.69) and the minimum (11.91) was obtained from the M_4 and M_1 treatments, respectively at 60 DAP. The maximum leaves number per plant (17.63) and the minimum (13.11) was obtained from the S_4 and S_1 treatment, respectively at 60 DAP and S_3 treatment was statistically similar with S_4 treatment. Also the maximum leaves number per plant (20.93) and the minimum (9.63) were obtained from M_4S_4 and M_1S_1, respectively at 60 DAP.

The minimum time (56.5 days) for first bolting were required from M_4treatment and the maximum (59.75 days) were required fromM_1 treatment. The minimum time (56.5 days) were required for first bolting from S_4 treatment which is statistically similar with S_3 treatment and the maximum (59.75 days) were obtained from the S_1 treatment. It was also obtained the minimum time required for bolting (55 days) from M_4S_4 treatment combination which was statistically similar with M_4S_1, M_2S_3, M_3S_3, M_4S_3, M_1S_4, M_2S_4, M_3S_4 treatments combination and the maximum (62 days) were obtained from the M_1S_1 which was statistically similar with M_2S_1, M_3S_1, M_1S_2, M_2S_2 and M_1S_3 treatments combination.

The highest number of umbels per plant (2.699) and lowest number of umbels per plant (1.875) was obtained from M_4 and M_1 treatments, respectively. The highest number of umbels per plant (2.735) from S_4 which was statistically similar with S_3 treatment and lowest number of umbels per plant (1.667) was observed fromS_1 treatment. Also the maximum number of umbels per plot (3.207) from M_4S_4 treatment combination which was statistically identical with M_4S_3 treatment combination and the minimum (1.33) were obtained from M_1S_1 treatment combination.

The minimum time(67.5 days) were required for 1stanthesis from M_4 treatment and the maximum (70.75 days) were required from M_1.The minimum time for

1st anthesis (67.5 days) and the maximum (70.75 days) were obtained from the S_4 and S_1, respectively. Also the minimum time for 1st anthesis (66 days) was required from M_4S_4 treatment combination which was statistically similar with M_4S_3 treatment combination and the maximum (73 days) were required from M_1S_1treatment combination.

The maximum number of seeds per umbel (516.3) from M_4treatment which was statistically identical with $M_3$and minimum (477.9) seeds were obtained from the and M_1 treatment. The highest number of seeds per umbel (510.2) from S_4treatment which was statistically identical with S_3treatment and lowest number of seeds per umbel (483.6) was obtained from S_1 treatment. It was also obtained the maximum number of seeds per umbel (530.0) from M_4S_4treatment combination which was statistically similar with M_4S_3treatment combination and the minimum (466.3) were obtained from M_1S_1 treatment combination.

The highest seed yield (500.7 kg/ha) and lowest (235.1 kg/ha) was obtained from the M_4 and M_1 treatment, respectively. The highest seed yield (443.8 kg/ha) was obtained from the S_4which was statistically identical with S_3 treatment and the lowest (316.2 kg/ha) from the S_1.Also the maximum seed yield (567.3 kg/ha)was obtained from M_4S_4treatment combination which was statistically identical (563.6) with M_4S_3treatment combination and the minimum (185.3 kg/ha) were obtained from M_1S_1.

The maximum (3.567 g) and minimum (3.201g) 1000 seeds weight were found from M_4 and M_1treatment, respectively. The maximum 1000 seed weight (3.5g) was obtained from $S_4$and minimum (3.326g) was found from S_1they both are not statistically significant. Also the maximum weight of 1000 seeds (3.66g) was found from M_4S_4treatment combination which was statistically identical with $M_4S_3$and the minimum (3.12g) were obtained from M_1S_1.

The highest percentage (84.83) and lowest percentage (83.50) was observed from $M_4$and M_1treatment, respectively. The highest germination percentage of seed (85.75) was observed from S_4treatment and lowest (82.83) from S_1 treatment. Also the maximum percentage of seed germination (86.33) from M_4S_4which was statistically identical with $M_4S_3$and the minimum (82.33) was obtained from M_1S_1. All the treatments and treatments combination were not statistically significant.

The highest speed of seed germination (11.95) was obtained from M_4 treatment which was statistically similar with M_2,M_3 treatments and lowest (9.463) was observed from M_1 treatment. The highest speed of seed germination (11.76) was observed from S_4treatment which was statistically similar with S_3 treatment and lowest (9.517) from S_1 treatment. Also the maximum speed of seed germination (13.53) from M_4S_4 treatment combination which was statistically identical to M_4S_3treatment combination and the minimum (8.347) was obtained from M_1S_1 treatment combination.

In conclusion, the results of the present experiment have revealed that recommended combination of 15 t/ha Cowdung + 10t/ha Poultry manure + 2.2 t/ha Mustard oil cake (M_4) treated plants gave highest growth, yield and quality of onion seeds. 8 g bulb (S_4) also gave highest growth, yield and quality of onion seeds. Combination of three organic manures (M_4), large sized bulb (S_4) and their combining effect (M_4S_4) were significant. But S_4 and M_4S_4 were statistically significant similar and sometimes identical with S_3 and M_4S_3. Calculating benefit cost ratio M_4S_3 gave the highest (2.94) value than M_4S_4 (2.74). So onion seed production with M_4S_3 is more profitable than M_4S_4 treatment combination in aspect of Sher-e-Bangla Agricultural University research field.

However, this is one year experiment, more researchers on this aspect are necessary to conduct at different agro-ecological zones for arriving at a definite conclusion and recommendations.

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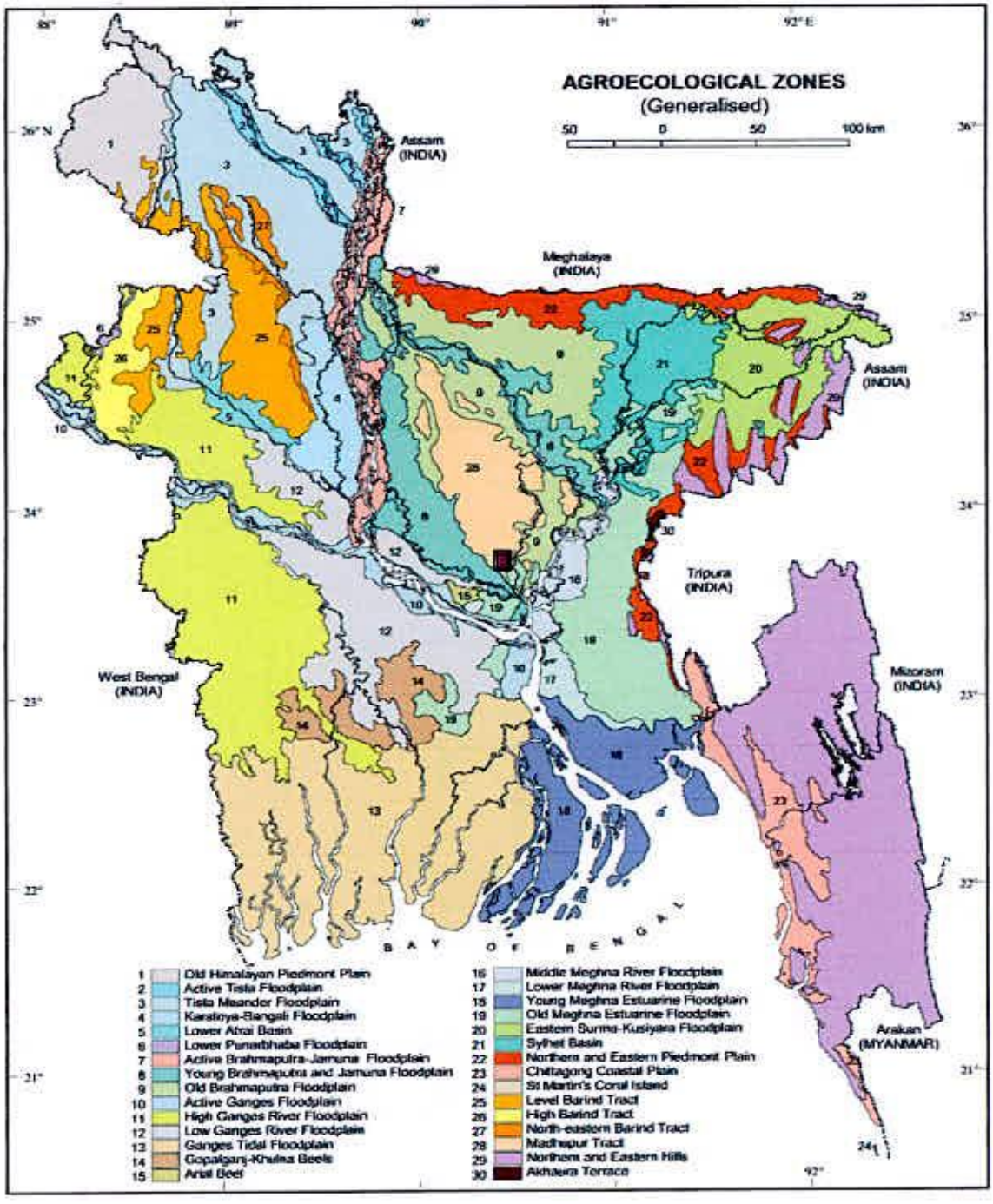
Appendices

APPENDICES

Appendix I. Map showing the experimental site under the study



Appendix II. Monthly records of air temperature, relative humidity, rainfall and sunshine hours during the period from November, 2013 to April, 2014

Month	Year	Monthly average air temperature (°C)			Average relative humidity (%)	Total rainfall (mm)	Total sunshine (hours)
		Maximum	Minimum	Mean			
Nov	**2013**	28.52	16.30	22.41	68.92	Trace	216.50
Dec	**2013**	27.19	14.91	21.05	70.05	Trace	212.50
Jan	**2014**	25.23	18.20	21.80	74.90	4.0	195.00
Feb	**2014**	31.35	19.40	25.33	68.78	3.0	225.50
Mar	**2014**	32.22	21.25	26.73	72.92	4.0	235.50
Apr	**2014**	36.45	26.15	31.13	73.72	5.0	220.50

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

Appendix III.The mechanical and chemical characteristics of soil of the experimental site as observed prior to experimentation (0 - 15 cm depth).

Mechanical composition:

Particle size	constitution
Sand	40%
Silt	40%
Clay	20%
Texture	Loamy
pH	6.00 – 6.63

Chemical composition:

Soil characters	Value
Organic matter	1.44 %
Potassium	0.15 meq/100 g soil
Calcium	3.60 meq/100 g soil
Magnesium	1.00 meq/100 g soil
Total nitrogen(%)	0.072
Available Phosphorus	21 ppm

Source: Soil Resources Development Institute (SRDI), Khamarbari, Dhaka

Appendix IV: Analysis of variance (mean square) for plant height and leaves number per plant as influenced byorganic manureand bulb size combination

Source Of variation	Degrees of Freedom	Means square									
		Plant height (cm)					Number of leaves				
		30DAS	40 DAS	50DAS	60DAS	70DAS	30DAS	40 DAS	50DAS	60DAS	70DAS
Replication	2	1.608	3.518	2.766	2.446	2.056	0.894	0.14	0.756	0.535	0.678
Organic manure (A)	3	396.03**	387.04**	508.26**	509.52**	502.98**	44.74**	67.187**	88.641**	98.096**	86.297**
Bulb size (B)	3	287.44**	292.87**	264.14**	233**	204.37**	40.662**	40.632**	45.621**	46.035**	45.189**
Interaction (A×B)	9	10.237**	9.701**	10.201**	8.372**	7.961**	0.283*	0.652*	0.99*	0.84*	1.585*
Error	30	2.172	2.749	3.069	3.306	2.347	0.626	0.36	0.661	0.685	0.683

**Significant at 5% level
*Significant at 1% level

Appendix V: Analysis of variance (mean square) for yield contributing characters as influenced by organic manure and bulb size combination

Source Of variation	Degrees of Freedom	Number of umbels per plant	Days required for 1st anthesis	Number of seeds per umbel
Replication	2	0.015	25	401.32
Organic manure (A)	3	1.567*	23.188**	3119.4**
Bulb size (B)	3	2.676**	23.188**	1775.2**
Interaction(A×B)	9	0.031*	0.188*	24.118**
Error	30	0.013	1	284.44

**Significant at 5% level
*Significant at 1% level

Appendix VI: Analysis of variance (mean square) for yield and quality as influenced by different bulb sizes and organic manure combination

Source Of variation	Degrees of Freedom	Yield / plant (g)	Yield / plot (g)	Yield / ha (kg)	1000-seed weight (g)	Germination (%)	Seed vigor index
Replication	2	0.016	0.116	63.593	0.058	10.646	0.477
Organic manure(A)	3	1.503*	3390.3**	151715**	0.29*	3.778NS	13.015**
Bulb size(B)	3	0.661*	881.37**	39665**	0.07NS	19.611NS	11.952**
Interaction(A×B)	9	0.016*	23.181**	973.38**	0.001*	0.13NS	0.828*
Error	30	0.007	2.573	331.19	0.061	11.535	0.634

**Significant at 5% level
*Significant at 1% level
NS= Not significant

Appendix VII. Per hectare production cost of onion seed production as influenced by organic manure and bulb size combination

A. Input cost

Treatment combination	Cost of production (Tk)									
	Labor	Seed bulb	Pesticides	Ploughing	Bamboo and Rope	Irrigation	Organic manures (tons)			Sub Total (A)
							CD	PM	MOC	
M_1S_1	164280	48000	3500	15000	60000	15000	0	0	0	305780
M_2S_1	164280	48000	3500	15000	60000	15000	30000	35000	0	370780
M_3S_1	164280	48000	3500	15000	60000	15000	30000	0	77000	412780
M_4S_1	164280	48000	3500	15000	60000	15000	30000	35000	77000	447780
M_1S_1	164280	96000	3500	15000	60000	15000	0	0	0	353780
M_2S_1	164280	96000	3500	15000	60000	15000	30000	35000	0	418780
M_3S_2	164280	96000	3500	15000	60000	15000	30000	0	77000	460780
M_4S_2	164280	96000	3500	15000	60000	15000	30000	35000	77000	495780
M_1S_3	164280	144000	3500	15000	60000	15000	0	0	0	401780
M_2S_3	164280	144000	3500	15000	60000	15000	30000	35000	0	466780
M_3S_3	164280	144000	3500	15000	60000	15000	30000	0	77000	508780
M_4S_3	164280	144000	3500	15000	60000	15000	30000	35000	77000	543780
M_1S_4	164280	192000	3500	15000	60000	15000	0	0	0	449780
M_2S_4	164280	192000	3500	15000	60000	15000	30000	35000	0	514780
M_3S_4	164280	192000	3500	15000	60000	15000	30000	0	77000	556780
M_4S_4	164280	192000	3500	15000	60000	15000	30000	35000	77000	591780

CD = Cowdung, PM = Poultry Manure, MOC = Mustard Oil Cake

Manures:
M_1= Control (No manures)
M_2= CD + PM
M_3= CD + MOC
M_4= CD + PM + MOC

Bulb sizes:
S_1= 2g
S_2= 4g
S_3= 6g
S_4= 8g

Manures dose:
Cowdung @ 15 t/ha
Poultry manure @ 10 t/ha
Mustard oil cake @ 2.2 t/ha

Cowdung @ Tk. 2/kg
Poultry manure @ Tk. 3.5/kg
Mustard oil cake @ Tk. 35/kg

Appendix VII. (Continued)

B. Overhead cost (Tk/ha)

Treatment Combinations	Cost of lease of land for 6 months (14.0% of value of land Tk. 800,000/year	Miscellaneous cost (Tk. 5% of the input cost	Interest on running capital for 6 months (Tk. 14.0% of cost/year	Sub total (Tk) (B)	Total cost of production (Tk/ha) [Input cost (A)+ overhead cost (B)]
M_1S_1	56,000	15289	26394.83	97683.83	403463.8
M_2S_1	56,000	18539	31172.33	105711.3	476491.3
M_3S_1	56,000	20639	34259.33	110898.3	523678.3
M_4S_1	56,000	22389	36831.83	115220.8	563000.8
M_1S_1	56,000	17689	29922.83	103611.8	457391.8
M_2S_1	56,000	20939	34700.33	111639.3	530419.3
M_3S_2	56,000	23039	37787.33	116826.3	577606.3
M_4S_2	56,000	24789	40359.83	121148.8	616928.8
M_1S_3	56,000	20089	33450.83	109539.8	511319.8
M_2S_3	56,000	23339	38228.33	117567.3	584347.3
M_3S_3	56,000	25439	41315.33	122754.3	631534.3
M_4S_3	56,000	27189	43887.83	127076.8	670856.8
M_1S_4	56,000	22489	36978.83	115467.8	565247.8
M_2S_4	56,000	25739	41756.33	123495.3	638275.3
M_3S_4	56,000	27839	44843.33	128682.3	685462.3
M_4S_4	56,000	29589	47415.83	133004.8	724784.8