YIELD AND QUALITY OF POTATO AS INFLUENCED BY DIFFERENT PROPORTION OF INORGANIC AND ORGANIC FERTILIZERS AND THEIR PERFORMANCE IN AMBIENT CONDITION

REHANA NOOR

DEPARTMENT OF AGRONOMY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA-1207
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By

REHANA NOOR
Reg. no. 15-06880

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Approved By:

Prof. Dr. Tuhin Suvra Roy
Department of Agronomy
SAU, Dhaka
Supervisor

Prof. Dr. H. M. M. Tariq Hossain
Department of Agronomy
SAU, Dhaka
Co-supervisor

Prof. Dr. Md. Fazlul Karim
Chairman
Examination committee
Department of Agronomy

SAU, Dhaka

DEPRTMENT OF AGRONOMY

Sher-e-Bangla Agriculture university (SAU)
Sher-e-Bangla Nagar, Dhaka-1207

CERTIFICATE

*This is to certify that the thesis entitled, "**YIELD AND QUALITY OF POTATO AS INFLUENCED BY DIFFERENT PROPORTION OF INORGANIC AND ORGANIC FERTILIZERS AND THEIR PERFORMANCE IN AMBIENT CONDITION**" submitted to the DEPARTMENT OF AGRONOMY, **Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka** in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **AGRONOMY** embodies the result of a piece of bona fide research work carried out by **REHANA NOOR, Reg. No. 15-06880** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated:
Place: Dhaka, Bangladesh

____

(Prof. Dr. Tuhin Suvra Roy)
Department of Agronomy
Sher-e-Bangla Agricultural University
Supervisor

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The Author

YIELD AND QUALITY OF POTATO AS INFLUENCED BY DIFFERENT PROPORTION OF INORGANIC AND ORGANIC FERTILIZERS AND THEIR PERFORMANCE IN AMBIENT CONDITION

ABSTRACT

An experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka during the period from November, 2014 to April, 2015 to study the yield and quality of potato (*Solanum tuberosum L.*) as influenced by different proportion of inorganic and organic manures and their performance in ambient condition. Five varieties such as, ‘Asterix’, ‘Lady rosetta’, ‘Courage’, ‘Diamant’ and ‘BARI TPS-1’ and different proportion of inorganic and organic manure application practices viz., 100% recommended fertilizer, cowdung, poultry litter and ACI organic manure were considered for the study. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Application of different organic manures may improve the quality of potato. Results revealed that, different potato varieties and/or organic manure applications had significant effect on most of the yield and quality contributing parameters studied in this experiment. Among the five varieties ‘Diamant’ produced maximum tuber, the highest weight of marketable tuber (t ha^{-1}), the highest firmness. But Lady rosetta showed the highest dry matter, specific gravity, glucose and sucrose content. In terms of organic manure applications, different organic manure practices showed different results. The control (100% recommended fertilizer) showed the highest tuber yield (t ha^{-1}). The organic manure practices with 50% RDF + ACI organic manure showed the highest dry matter content, specific gravity, reducing sugar content, sucrose and starch content. In case of combined effect variety and organic manure applications; different treatment combination gave different responses. Among the twenty treatment combinations of “Diamant x 100% RDF” showed the highest tuber yield (57.23 t/ha), where “Lady rosetta x 50% RDF + ACI organic manure” showed the highest dry matter content (22.02), specific gravity (1.07), reducing sugar content (1.498mg/g FW) and starch content (13.653 mg/g FW).

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CHAPTER I

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a tuber crop belonging to the family Solanaceae. It is originated in the central Andean area of South America (Keeps, 1979). It is the fourth world crop after wheat, rice and maize. The Food and Agriculture Organization reported that the world production of potato in 2013 was about 368 million tons which was higher (364 million tons in 2012) than that of the previous year (FAOSTAT, 2013). Bangladesh is the seventh potato producing country in the world (FAOSTAT, 2013). In Bangladesh, it ranks second after rice in production (FAOSTAT, 2013).

The total area under potato crops, per ha yield and total production in Bangladesh are 444534.41 hectares, 19.35 t ha^{-1} and 8603000 metric ton respectively (BBS, 2013). The total production is increasing day by day as such consumption also rapidly increasing in Bangladesh (BBS, 2013). Potato varieties cultivated during the winter in all the districts of Bangladesh. Potato consumption as processed and fresh food is also increasing considerably in Bangladesh (Brown, 2005). Now-a-days potato being the third staple vegetable crop could contribute in poverty alleviation and food security in Bangladesh. It is a carbohydrate-rich crop, and is consumed almost absolutely as a vegetable in Bangladesh. The annual demand for potato in Bangladesh is 6.5-7 million tons against its production of 8.9 million tons (BBS, 2013). It was reported that, in 2009, both the fresh and processed potato consumption was 28.94 kg/capita/year that increased to 46.40 kg/capita/year in 2013 indicating the increasing demand of potato consumption in Bangladesh (BBS, 2013). Additionally the increasing demands of potato processed food specially chips has been gaining popularity indicating the demands of the varieties with good processing quality with the attributes beneficial for human health. A lot of research efforts have been made considering the yield potential of potato varieties but very few observations were made on the processing quality and health concern issue. Processing quality of potato tubers is determined by high dry matter, specific gravity, sugar content, low reducing sugar, flavonoids and phenol contents (Abong *et al.,* 2009).

Potato is not only a vegetable crop but also an alternative food crop against rice and wheat. Nutritionally, the tuber is rich in carbohydrates or starch and is a good source of protein, vitamin C and B, potassium, phosphorus and iron. Most of the minerals and protein are concentrated in a thin layer beneath the skin, and skin itself is a source of food fiber. Bangladesh has a significant agro-ecological potential of growing potato. The area and production of potato in Bangladesh has been increasing during last decades but the yield per unit area remains more or less static. The yield is very low in comparison to that of the other leading potato growing countries of the world, 40.16 t ha-1 in USA, 42.1 t ha^{-1} in Denmark and 40.0 t ha^{-1} in UK (FAO, 2009). Storage problem is also a serious problem in Bangladesh. In tropical and subtropical areas like Bangladesh it is difficult to produce seed tubers of potato due to lack of appropriate storage facilities and transport, as well as the presence of viral diseases (Omidi *et al.,* 2003).

In recent years, the Tuber Crops Research Centre of BARI has collected many new varieties of potato from the International Potato Research Centre, Peru, and from other sources. These are being tested under Bangladesh field conditions, to determine whether they can be recommended for cultivation in the country. The Centre has already made good contribution towards the development of some high yielding potato varieties. Several dozens of high yielding varieties (HYV) of potato were brought to Bangladesh and tried experimentally under local conditions before being recommended for general cultivation. Through constant evaluation of the traits, varietal performance and considerations of other characteristics, about 10 HYV have been released for cultivation in the country. However, the Bangladesh Agricultural Development Corporation (BADC) is working for distribution seed among farmers and imports huge amount of potato seeds every year in this regard. "Diamant" a variety from Holland with oval to oblong shape, pale yellow tubers, smooth skin and shallow eyes is quite disease resistant.

The fundamental setbacks in cultivation of potato in Bangladesh are lack of quality seed, new cultivar and appropriate doses of fertilizers. This situation can be overcome by using improved potato cultivars having better yield potential and also adopting proper nutrient management practices.

From inner quality point of view, potatoes are mainly valued for its starch, reducing sugar, non-reducing sugar, polyphenol, vitamin C content and especially for the high content of vitamin C (Asghari-Zakaria *et al.*, 2009). Sometimes potato produced in Bangladesh is not of good quality enough in respect of dry matter content, starch content, non-reducing sugar content etc. which are not present at optimum level in produced product (Keijbets, 2008). So using different mulch materials may put contribution for improving quality of potato in Bangladesh condition.

Potato is a perishable commodity and three variables determine storage losses in potatoes: i) quality of the tuber at the beginning of the storage, ii) storage conditions and iii) duration of storage (Barton *et al.*, 1989). Storage losses are often specified as weight losses and losses in the quality of potatoes which are caused by respiration (Basker 1975); sprouting (Amoros *et al.*, 2000); evaporation of water from the tubers (Kabira and Berga 2003); changes in chemical composition and physical properties of the tuber (Cronk *et al.*, 1974; Maga 1980) and damage by extreme temperatures (Linnemann *et al.*, 1985).

The trend of organic farming is getting momentum because people prefer to consume vegetable free from chemical residues. On the other hand, the ecological concerns regarding residual toxicity due to indiscriminate and excessive use of chemicals by means of fertilizers and pesticides and their harmful effects on soil health as well as on biodiversity indicates an urgent need for a shift to available organic resources as manure along with fertilizers. The organic manures not only supply the nutrients but also improve the physical environment for better plant and tuber growth. These manures are low analysis nutrient carriers yet play a significant role in the fertilizer economy. The yields obtained with combined use of organic manures and fertilizers are higher than fertilizer alone. As such, the knowledge of fertilizers equivalent to organic manures is essential for making a sound fertilizers programme. The manures alone are poor sources of nitrogen for obtaining optimum potato yield but improve organic carbon status of soil.

Presently, FYM is a major source of organic matter and nutrients, besides poultry manure and vermicompost. These organic sources generally contain low level of nutrients and are required in higher amounts to fulfill the needs of crop; therefore, it is essential to supply the nutrient in integrated manner. By this way the dependence on fertilizer can be reduced in the days to come and in the meantime the soil will also develop its quality and fertility status by the continuous use of organic sources. Application of organic sources in conjunction with fertilizers ensures environmental safety, besides improving the fertilizer use efficiency and tuber yield in potato crop (Krishnamurthy *et al.*, 1999). The quantity of nutrient taken up by a crop is not necessarily an indication of responsiveness to fertilizers but potato because of poorly developed root system is highly responsive to the applied plant nutrients.

Depending on the above discussion, a research was undertaken to find out the effect of different organic manures on the yield and quality of potato varieties in ambient storage condition with the following objectives:

1) To study the effect of different proportion of inorganic and organic manure on yield and quality of potato,

2) To compare the different physical characteristics and sugar contents of the potato tuber with different levels of inorganic and organic manures at the ambient storage condition and

3) To find out superior potato variety/s for processing purpose.

CHAPTER II
REVIEW OF LITERATURE

Organic manure applications with different varieties, both are important factors influencing the yield quality of potato and also in storage condition. The average yield of potato in Bangladesh is much lower than that of the other countries of the world. Storage facilities are also rare in Bangladesh. Many research works have been conducted on the effect of different organic manure application with different varieties of potato on the growth, yield, storage and quality of potato in various parts of the world. Some of the important research reports regarding potato cultivar, yield, storage and quality have been reviewed here in this chapter.

2.1 Influence of variety on yield and quality of potato

Kassim *et al.* (2014) found that reducing sugar, physiological functions of above ground part of potato plant (leaf area and total chlorophyll content) decreased with the number and the weight of tuber decreased, so the productivity of the plant decreased.

Cota and Hadzic (2013) conducted a two-year experiment included four potato varieties (Desire, Romano, Bistra and Kis Sora). The aim was to select new varieties for cultivation. Productive characteristics of potato varieties (yield, weight and number of tubers per box) were examined. In the frame of qualitative properties, dry matter content and starch were examined. Higher average yield was achieved by Romano cultivar by 8% compared to Desire and Kis Sora. Dry matter content ranged from 21.80% in Romano to 22.20% in Desiree.

Sohail *et al.* (2013) reported that the local varieties consisted thick juice than HYV varieties like TPS which can be an indication of using the local varieties for ready to drink juice along with other materials like malt and flavours.

Abebe (2013) carried out an experiment at three distinct locations in the Amhara region of Ethiopia for evaluation of the specific gravity of 25 potato varieties. The pooled specific gravity values ranged from 1.058 to 1.102. The specific gravity of tubers of the improved variety Belete was the highest while that of Menagesha was the lowest. Furthermore, the specific gravity values for varieties grown at Debretabor were higher than those for the corresponding varieties grown at Adet and Merawi. He mentioned that specific gravity is the measure of choice for estimating dry matter and ultimately for determining the processing quality of potato varieties.

Behjati *et al.* (2013) conducted a field experiment to evaluate the yield and yield components on promising potato clones. Clone No. 397031-1, had the highest yield and "Lady rosetta" variety had the lowest yield compared with other varieties. The lowest and highest average number of main stems per plant, related to "Lady rosetta" and clone No. 397067-2. "Lady rosetta" variety had the highest number of tube per plant and clone No. 397067-2 had the lowest number of tubers per plant. The lowest and highest average tuber weight per plant related to clone No. 397067-2 and "Lady rosetta" variety respectively.

Schwarz and Geisel (2012) reported that storage problems most often occured because of conditions in the field and not conditions in storage. Adverse weather, disease or improper harvesting and handling of tubers can cause problems in storage. Tubers that are rotting, frozen, chilled or diseased must be managed differently than mature, sound tubers. Good storage management will help to salvage problem tuber lots, but storage will never improve a poor quality variety.

Hossain (2011) conducted three experiments with BARI released twelve potato varieties to determine the yield potentiality, natural storage behavior and degeneration rate for three consecutive years. He found that the highest emergence was observed in Granola at 34 DAP. At 50 DAP plant height (cm) of "Diamant" was (43.50), BARI TPS 1 (47.70), Felsina (52.00), "Asterix" (52.97), Granola (38.30), Cardinal (46.33). Foliage coverage (%) of "Diamant" was (83.33), BARI TPS 1 (85.56), Felsina (82.22), "Asterix" (89.44), Granola (85.56), Cardinal (81.67). No. of stems hill^{-1} of “Diamant‟ was (4.06), “BARI TPS-1‟ (3.21), Felsina (3.14), “Asterix‟ (4.03), Granola (3.30), Cardinal (3.89). Tuber yield hill^{-1} (g) of “Diamant‟ was (244.2), “BARI TPS-1‟ (227.9), Felsina (300.1), “Asterix‟ (276.9), Granola (277.0), Cardinal (316.9). Under the grade 28-40mm, the highest number (48.63%) of seed tubers was produced by Granola which was statistically identical with “Asterix‟ (46.43%). Under the same grade (28-40 mm), the highest weight (43.46%) of seed tubers was produced by Patrones followed by “Asterix‟ (37.16%), Granola (36.64%) and Multa (35.39%) among which there was no significant variation.

Karim *et al.* (2011) conducted an experiment with ten exotic potato varieties (var. All Blue, All Red, Cardinal, “Diamant‟, Daisy, Granola, Green Mountain, Japanese Red, Pontiac and Summerset) to determine their yield potentiality. The highest total tuber weight per plant (344.60g) recorded in var. “Diamant‟ and total tuber weight plant^{-1} was the lowest (65.05 g) recorded in var. All red, all blue varieties showed the most potential yield in this experiment.

Guler (2009) observed that first, second, third class tuber yields and total tuber yield, tuber number per plant, mean tuber weight and leaf chlorophyll were significantly influenced by potato cultivar. There were significant correlations between chlorophyll and yield and yield related characters. Total yield significantly correlated with leaf chlorophyll. Correlations between first class yield and total yield as well as total yield and tuber number per plant were highly significant.

Haque (2007) conducted a field experiment with 12 exotic potato germplasm to determine their suitability as a variety in Bangladesh. He found that all the varieties gave more than 90% emergence at 20-35 DAP. He also observed that Plant height (cm) of Quincy was (87.8), Sagitta (65.8), “Diamant‟ (62.6); No. of stems hill-1 was counted in “Diamant‟ (7.2), Quincy (4.5), Sagitta (4.4); Plant diameter (cm) of Sagitta was (4.0), Quincy (3.7), “Diamant‟ (2.6) at 60 DAP; Foliage coverage (%) of Sagitta was (100.0), “Diamant‟ (98.3), Quincy (96.6); No. of tubers plant-1 of “Diamant‟ was (13.06), Sagitta (8.34), Quincy (6.71); Wt.

of tubers plant-1 (kg) of Quincy was (0.64), Sagitta (0.63), “Diamant‟ (0.49); dry matter (%) of Sagitta was 20.8%, “Diamant‟ 20.1% and Quincy 18.5%.

Das (2006) carried out an experiment to study the physio-morphological characteristics and yield potentialities of potato varieties. He found that Foliage coverage (%) of “Diamant‟ was (93.3), “Asterix‟ (71.7), Granola (66.7), Quincy (90.0), “Courage‟ (63.3), Felsina (83.3), “Lady rosetta‟ (83.3), Laura (78.3); No. of tubers hill^{-1} of “Diamant‟ (11.7), “Asterix‟ (8.00), Granola (11.3), Quincy (9.33), “Courage‟ (7.33), Felsina (8.00), “Lady rosetta‟ (10.3), Laura (8.33); Tuber weight hill^{-1} (g) of “Diamant‟ (380), “Asterix‟ (285), Granola (275), Quincy (300), “Courage‟ (320), Felsina (333), “Lady rosetta‟ (348), Laura (258); Dry matter (%) of “Diamant‟ (25), “Asterix‟ (17.5), Granola (23), Quincy (31), “Courage‟ (34.5), Felsina (22.5), “Lady rosetta‟ (22.0), Laura (27.0); Regarding size grade distribution of tubers the varieties “Courage‟, Espirit, Granola, “Lady rosetta‟, Laura were found superior.

Storability of tubers obtained from 9 hybrid True Potato Seed (TPS) progenies were compared with that of non-TPS cultivar “Diamant‟ under ambient conditions (22.0-34.8°C and 58.0-93.6% RH). Dormant period, days to start shrinkage and days to 100% shrinkage of all TPS progenies were significantly longer than those of “Diamant‟ especially in P-364 X TPS-67 and P-364 X TS-9. The results of correlation analysis among these parameters also indicated that the storability of the TPS progenies was superior to that of “Diamant‟ (Roy *et al.,* 2006). The rate rotten tubers of all the TPS progenies, however, were significantly higher than that of “Diamant‟ because of their high susceptibility to infectious diseases, indicating the importance of the selection of TPS progenies with high disease resistance during storage under ambient conditions. Tuber size also affected the storability of TPS progenies; small tubers were preferable to medium and large ones, except for their high shrink ability.

Rainys and Rudokas (2005) studied with early (Goda and Voke), moderately early (“Lady rosetta‟) and moderately late (Saturna and Heres) potato cultivars in Lithuania. Tuber yield was significantly affected by the fertilizers, genotype and weather conditions. The growing period and cultivar had significant effects on starch and dry matter contents of tubers. Averaged over the 3 years, the highest starch and dry matter contents were recorded for “Lady rosetta‟ (17.0-17.9 and 23.2-24.1%) and Saturna (17.1-17.4 and 23.5-23.8%). The cultivars had the highest starch and dry matter contents in 2002 (14.9-21.0 and 21.3-27.1%).

Anonymous (2005) evaluated twenty one varieties along with two standard checks “Diamant‟ and Granola at seven locations. The yields of the varieties varied from location to location as well as within location. Of all the stations, except Pahartoli, none crossed the check variety “Diamant‟ but comparatively higher yields were produced by the varieties Espirit, “Courage‟, Innovator, Quincy, Matador, Markies, Laura and “Lady rosetta‟.

Kumar *et al.* (2005) determined under water weight, specific gravity, dry matter and starch content of potatoes grown at Modipuram, Uttar Pradesh. He found that there was a positive correlation between under water weight and specific gravity (r=0.99), under water weight and dry matter (r=0.92).

Mahmood (2005) was carried out an experiment at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh to investigate the effect of planting method and spacing on the yield of potato using Cv.“BARI TPS-1‟.He found highest yield (32.5t ha^{-1}) from “BARI TPS-1‟.

Rytel (2004) reported that the rate of dry matter and starch accumulation depends on cultivar and growing conditions.

Mondol (2004) conducted an experiment to evaluate the performance of seven exotic (Dutch) varieties of potato. He found that plant height (cm) of “Diamant‟ was (18.07 cm), Granola (13.47 cm); No. of main stem hill-1 of “Diamant‟ (4.36), Granola (4.90); No. of tubers hill-1 of “Diamant‟ (12.00), Granola (10.93); Weight of tubers plant-1 (kg) of “Diamant‟ (0.57), Granola (0.39); Dry matter (%) of “Diamant‟ (17), Granola (16.30). Alam *et al.,* (2003) conducted a field experiment with fourteen exotic varieties of potato under Bangladesh condition. The highest emergence (91%) was observed from Cardinal which was statistically identical with most of the varieties except the variety Granola (63%). The highest number of stem hill-1 was recorded in Ailsa (4.59) followed by Cardinal (4.50). Significantly maximum number of leaves hill-1 was produced from the plants of the variety Ailsa (53.80), which was followed by Cardinal (49.75). The yields ranged of exotic varieties were 19.44 to 46.67 t ha^{-1}. Variety Ailsa produced the maximum yield (46.67 t ha^{-1}) which was followed by Cardinal (42.21 t ha^{-1}).

Hossain (2000) conducted an experiment to study the effects of different levels of nitrogen on the yield of seed tubers in four potato varieties. He found that the tallest plants were produced by the seedling tubers of "BARI TPS-1" (74.51 cm) and the shortest plants came from the variety "Diamant" (58.63 cm); Foliage coverage (%) of "Diamant" at 75 DAP was (79.00), "BARI TPS-1" (89.00); No. of stems hill-1 of "Diamant" was (3.50), "BARI TPS-1" (2.71); No. of tubers hill-1 of "Diamant" was (7.85), "BARI TPS-1" (9.55); Weight of tubers hill-1 of "Diamant" was (416.67), "BARI TPS-1" (491.33); Dry matter of tuber (%) of "Diamant" was (19.71), "BARI TPS-1" (18.18).

Madalageri (1999) studies on tuber uniformity and storage behavior of 7 TPS progenies (hybrids and open pollinated progenies) in comparison with tuber planted cultivars revealed that the TPS progenies were as good as those of tuber planted crops in respect of physiological loss in weight, and frequency and weight of rotten and sprouted tubers after 3 months of storage under ambient conditions. However, only hybrid populations HPS I/13, HPS II/13 and TPS-C-3 had comparable scores with the tuber planted standard varieties in respect of tuber uniformity. The produce from open pollinated TPS families recorded significantly lower uniformity scores than their counterpart hybrid populations or the tuber planted standard varieties.

Rasul *et al.* (1997) studied storage behavior of some exotic, recommended and advanced lines of potato were studied in 1991 at RARS, Jessore by storing their tubers in netted wooden box under natural condition. Much variation was observed among the varieties/lines for all the characters studied. Percent weight loss was higher in exotic varieties (12.89-35.52%). Cent percent sprouting was earlier in recommended varieties/lines (96 days) than of exotic ones (118.7 days). On an average, tubers shrank earlier in existing varieties per lines than first generation materials. Rottage of tubers by bacterial soft rot (Erwinia sp) during storage varied from 31.3 to 36.8%. Recommended varieties Kufri, Sindhuri, Cardinal, Multa, advanced lines P-93 and first generation varieties viz. Granoloa, Modial, Producent and Vital performed the best on the basis of studied storage characteristics.

Van Ittersum *et al.* (1993) reported that replanting soon after their harvest gave low yield because of dormancy and low growth vigor. In the research reported in this paper, we investigated the advancing effect of a haulm application of gibberellic acid (750 g GA ha^{-1}) 6 days before haulm pulling and its interaction with storage temperature regimes on the growth vigor of immaturely harvested seed tubers of three cultivars. The effect on tuber yield was also examined in one experiment. The storage regimes were: 18°C continuously, hot pre-treatments of different duration (different periods at 28°C and subsequently 18°C) and a cold pre-treatment (20 days at 20°C and subsequently 18°C). Both a foliar spray with GA and storage at 28°C enhanced physiological aging of the tubers and greatly advanced the growth vigor, without negative effects on the morphology of the plants. At early planting, the effect of the treatments on tuber yield were small for "Diamant" (short dormancy), but strongly positive for Desiree and Draga (long dormancy).

Hossain *et al.* (1992) reported that the maximum tuber weight loss was (31.15%) recorded in the check variety Cardinal. In case of indigenous varieties, Jalpai lost maximum weight (19.16%) and Shilbilati lost the minimum (9.15%). The authors also reported that sprouting of tubers was started after 83 days in indigenous cultivars, while Cardinal sprouted first after 54 days of storage. In case of indigenous varieties, Bograi sprouted first after 70 days and Hagrai was most delayed (97 days).

Hossain and Rashid (1991) studied storage quality of three sizes of tubers of eight TPS progenies against standard variety Cardinal for 120 days after harvest (April to July) under natural storage condition. Weight loss of tubers due to transpiration and respiration was 23.93% in TPS progenies and 11.95% in Cardinal with average monthly loss of 5.98% and 2.99%, respectively. Small size tubers were found to suffer most from dehydration. Erwinia sp. and Fusarium sp. have been identified to cause rotting of tubers in storage. The incidence of soft rot and dry rot were 33.40% and 34.15%, respectively. No rot was observed in Cardinal during the period of study. Maximum potato loss was recorded in large size tubers. Tubers of the TPS progenies sprouted earlier than Cardinal. Maximum number of sprouts per tubers and length of the longest sprout were recorded in TPS progenies. Tubers of TPS progenies shriveled earlier than Cardinal.

Usually, in Bangladesh, storage of potato starts during the month of March when both temperature and humidity rise up sharply which accelerates both physiological activities of tubers responsible for its deterioration and activities of the organisms responsible for various storage diseases. It has been reported (Anonymous, 1989) that the local varieties have a long period of dormancy and both and seed potatoes cm be stored at home without much physiological deterioration until the next planting season.

Sowa and Kuzniewicz (1989) studied the causes of loss during potato storage and indicated that the main causes of storage losses were respiration, evaporation and storage rot. In that study, storability was largely a varietal trait, although environmental conditions during both growth and storage were also important. Storage losses were lowest in the clone Clamp (4.4%) which increased with increasing temperature in the store (about 9%). Overall storage losses ranged from 9.4% in Janka to 32.5% in Sasanka. Storage losses due to rots ranged from 0.8% in Azalia to 22.69% in Sasanka.

Anonymous (1989) observed that during storage period sprouting of tubers is an important evaluatary character of varieties. As soon as sprouting starts, the tubers rapidly loss its quality. Unfortunately, the potato tubers cannot store for more than 4 to 5 months without much deterioration of quality under ordinary storage conditions. Exotic varieties sprouted earlier than the local ones. Sprouting in local varieties was first to observed after 102 days. It was also observed that the average dormancy period was higher in local varies (95 days) than the exotic varieties (83 days).

Lisinska and Leszezynski (1989) stated that all the losses observed during potato storage, in respective of storage methods could be divided into two groups. Quantitative losses included weight losses of tubers due to vital process of tubers (respiration, evaporation, sprouting) and those resulting from parasites and pathogenic micro flora. The extent of such losses, apart from varietal properties is affected by the maturity and wholesomeness of tubers as well as internal condition of storage house. Quantitative losses are more difficult to detect since they do not reveal any decrease in the weight of tubers. They include quantitative losses of specific components but total content of dry matter not change significantly. Obviously, the difference between two groups of losses has only theoretical significance.

Picha (1986) stated that no sprouting was found when cured sweet potatoes were stored at 15.6°C and 90% RH for up to a year. The total weight loss of six cultivars was estimated. Transpiration played vital role for weight loss. Respiration contributed more total weight loss during the later period of storage than first month in storage.

In Korea Republic sweet potatoes cv. Hongmi, Eunmi, Hwangmi and Sinmi were stored in man-made cave (0-15°C, 15-75% RH) or a store house (15-18°C, 80-85% RH). After a period of three months in the cave storage, tuber decomposition was less for sweet potatoes stored in the middle of the cave than for those stored at the entrance. Decomposition became the highest at cave than in the storehouse (Lee *et al.,* 1985).

During the year 1980-81 the storage performance of some exotic and local cultivars of sweet potato was studied at the Bangladesh Agricultural University Farm. Among the cultivars studied, the storage ability of the cultivars ACC-6, TIS-3032, TIS-3247, AIS-230 and AIS-243-2 was quite good. New 10 and TIS 3032 showed the long dormancy period (Hossain *et al.*, 1984).

The indigenous potato varieties showed a capability to store well and have a general popularity for taste (Ahmad and Kader, 1981). They observed that when stored under non-refrigerated conditions, the indigenous varieties showed a longer dormancy and stored better.

Storage life of potato tubers mainly depends on temperature and humidity which influence evaporation, respiration, sprout growth and ultimately weight loss of tubers. Low temperature and high humidity in storage results gave minimum loss. The local varieties are liked by the farmers, keep well under ordinary room condition and possess a high market value (Khan *et al.,* 1981). Theses varieties show differences in certain characteristics which are very important in connection with market value and local popularity.

Ahmad (1979) reported that the farmers of the north-west part of Bangladesh use local varieties of potato instead of high yielding exotic varieties only because they had a longer dormancy and keeping quality even under ordinary storage.

2.1 Influence of organic manure on yield and quality of potato

Meena *et al.* (2012) conducted a research on to evaluate the growth, yield and economics of baby corn (Zea mays L.) potato (*Solanum tuberosum* L.)- mungbean (Vigna radiata L.) cropping system under different combinations of farm yard manure and bio-compost with chemical fertilizers at New Delhi during 2007-08 and 2008-09. The fertility level of N90P20K25 + BC equivalent to 30 kg Nha^{-1} being at par with N120P26K33 recorded the highest growth and yield parameters with 57.0 and 31.9 % more baby corn and green fodder yield compared to control, respectively. Similarly in potato application of N60P17K42 + BC equivalent to 60 kg Nha^{-1} recorded the highest growth and yield attributes with the maximum tuber yield of 24.2 tha^{-1}, which was 10.5 and 49.3 % higher as than 100% NPK and control , respectively. However, data of potato on residual fertility levels indicated that N60P13K17 + FYM equivalent to 60 kg Nha^{-1} recorded the maximum growth and yield attributes; and tuber yield while, lowest values were recorded on 100 % NPK application as fertilizer. Similarly, the highest values of yield attributes, seed and stover yield of mungbean were recorded under 50% RDF + 50% N through FYM applied to both baby corn and potato, which was found at par with 50% RDF + 50% N through BC and remained significantly superior over other treatments. The net returns (91,164/ha) and B:C ratio (1.7) of baby corn- potato-mungbean cropping system were maximum with application of 75% NPK+25% N through FYM to baby corn and 50% NPK + 25% N through FYM , respectively.

Baishya *et al.* (2010) conducted a field experiment during summer seasons of 2005 and 2006 at Shillong in split plot design having three potato varieties in the main plots and six organic-inorganic nutrient combinations in the sub-plots with four replications. Among the varieties, Kufri Megha recorded significantly higher tuber yield when compared with Kufri Giriraj and Kufri Jyoti. Number of tubers plant^{-1}, mean tuber weight, marketable and total tuber yield of potato increased significantly due to the use of recommended dose of fertilizers (RDF) i.e. 120-52.4-50 kg N-P-K ha^{-1} or 75% RDF + 25% recommended dose of N (RDN) through FYM. The yield components and tuber yield decreased gradually as the crop received higher proportion of plant nutrients through FYM. Accordingly, substitution of RDN by FYM resulted in lower tuber productivity which was significantly lower than those of other organic-inorganic combinations except control. Kufri Megha receiving RDF or 75% RDF + 25% RDN through FYM produced the highest tuber yield (27.11/26.98 t ha^{-1}) among all treatment combinations. High net return was obtained from the crop receiving 100% RDF or 25% RDN through FYM + 75% RDF. Kufri Megha at RDF or 75% RDF + 25% RDN through FYM may be recommended for better growth, higher tuber yield and greater net return from potato cultivation in the North Eastern Hill Region of Meghalaya.

Raghab *et al.* (2007) conducted a field experiment at Vegetable Research Centre, Pantnagar, Uttarakhand during 2003-04 and2004-05 with potato cultivar K. Chipsona-2. The growth parameters and yield of potato was significantly influenced by the organic manures and chemical fertilizers. Maximum plant height (68.66 cm), number of haulms per hill (7.55), number of tubers per hill (8.33), weight of tuber per hill (626.66 g), dry matter content of tuber (26.30%), total soluble solids (5.03oB), specific gravity (0.975 g/cm3) and yield (245.60 g ha^{-1}) were recorded with the application of 100% recommended dose of NPK (160:100:120 kg ha^{-1}) + 10 t FYM followed by 100% of recommended dose of NPK alone. Maximum number and weight of A and B grade tubers were recorded in treatment T4 and T5, respectively. The highest net income as well as benefit: cost ratio (1:25) were obtained with the application of 100% NPK.

Chhonkar *et al.* (2011) conducted a field experiment during winter season at research farm of Shri F.H. (P.G) College, Nidhauli Kalan, Etah in Uttar predesh (270 2' north latitude, 720 9' east latitude at 175.13m above mean sea level). The soil of experimental field was sandy loam with organic carbon 0.27 percent. The soil has 210.60 kg ha^{-1} available N, 22.4kg ha^{-1} Olson'P and 176.3 kg ha^{-1} available K. The experiment was lead out in randomized block design with factorial concept and each treatment four times these were ten treatment combinations, involving two fertility levels and five bio fertilizer treatments. Each treatment combination allocated randomly in each plot of block. The treatment comprised two fertility levels 100% N (150 kg ha^{-1}) and P(80 kg ha^{-1}) and phosphorus (60 kg ha^{-1}) and bio fertility treatments (Control, Soaking tuber in solutions of 1% each of urea and Sodium carbonate, T2 + bio fertilizer, bacillus cereus(treatment of tuber before planting) and bacillussubtilis (treatment of tuber before planting). The recommended dose of fertilizers N,P,K (150, 80, 100 kg ha^{-1}) was applied as per treatment at the last ploughing. The whole quantity of FYM @ 20 tones/ha incorporated in the soil, half quantity of N, full quantity of phosphorus and potassium were applied in row about 45 cm away from seed tubers and remaining quantity of N was applied at the time of earthling in the form of top dressing in furrow. In the tuber treatments with bio fertilizers, T1 (control) no treatment to seed tuber, in T2 200g each of Urea and sodium bicarbonate were dissolved in 20 liters of water (each of 1%) and the well sprouted healthy seed tubers of potato were soaked in this solution for 5 minutes, this solution was sufficient for 50kg of tubers, in T3 treatments, T2 (whole procedure some as T2 treatments) with treated to Azotobactor and phosphor bacteria, the jiggery solution was prepared by dissolving 100g of jaggery in one liter of water and 200g each of azotobacter and Phosphobacteria were added to this solution. The solution was spread on the tuber and was mixed thoroughly with hands to obtained uniform coating. In T4 treatments, ½ kg culture of Bacillus (strain M1) was suspended in 40 liter and a slurry was prepared by boiling of 2 kg of Jaggery in one liter of water, the tuber were dipped in this solution for 30 minutes and than tuber were taken out from solution and spread for drying in T5 treatments, Bacillus subtilis (strain B5) solution prepared and tuber treated (Proceduresome like T4 treatements) with it. The application of 1% urea and Sodium carbonate + Azotobacteria + Phosphobacteria (T3) showed the significant result for growth attributes. The maximum emergence present at 30 days was recorded (90.89%) in T3treatments and the combined effect of F x T on emergence highest in F1 T3 treatments combination (87.85%) and this treatment found to at par with the other treatment combination. The number of stems per plot at 30 days fertility levels F1 recorded maximum number of stems (367.13 per plot) than F2 fertility levels and treatments T3 recorded maximum number of stems (398.3 per plot) and found significant than other bio fertilizer. The interaction of F x T show maximum number of stems (417 per plot) under the treatment combination F1 T3 than other combination. The plot height at 30and 60 days significantly increased in F1 fertility levels (23.91 cm. and 33.85 cm.) than F2 levels and bio fertilizer treatments show highest plant height (26.90 cm. and 39.50 cm.) at 30 and 60 days under the treatment combination F1T3 other combination.

The yield of tuber per hill significantly increased under fertility F1 as comparison to F2 fertility levels and bio fertilizer treatment T3show highest total yield per hill (549.89 gram $hill^{-1}$) than other treatments. Total number of tuber per plot also maximum recorded under the fertility level F1 and bio fertilizer treatment T3 as compare to other. Total tuber yield obtained maximum under fertility level F1 (285.37 g ha^{-1}) and bio fertilizer treatment T3 (316.28 g ha^{-1}) as compare to other treatment. The dry matter content of tuber showed significant result under the fertility levels F2 (22.27%) than F1 and under T1 bio fertilizer treatment (22.22%). The interaction effect of fertility levels and bio fertilizer treatment showed maximum under the combination F1 T3 in total yield of tuber per hill (570.82 g hill^{-1}), total tuber yield (343.98 q ha^{-1}) and in dry matter content of tuber (27.04%) under the combination F2T1respectively.

Singh *et al.* (2013) conducted a field experiment during winter (rabi) season of 2007 - 08 to Kharif season of 2009 - 10 to evaluate lower doses of FYM (2, 4 and 6 tonnes FYM ha^{-1}) in combination with three NPK levels (180:34.9:100, 270:52.4:150 and 360:69.8:200 kg ha^{-1}) for potato at CPRI Station, Gwalior, Madhya Pradesh . Sesame was grown on residual fertility in sequence. Integrated use of NPK 270:52.4:150 kg ha^{-1} along with 2 tonnes of FYM ha^{-1} recorded highest benefit :cost ratio (2.2). Increasing application of NPK (180:34.9:100 to 270:52.4:150 kg ha^{-1}) increased large-sized tuber yield (7.5 - 8.5 tonnes ha^{-1} and total tuber yield (28.4 - 32.4 tonnes ha^{-1}), however application of 2, 4 or 6 tonnes FYM ha^{-1} did not show any significant increase in total tuber yield. Increasing NPK levels increased potato equivalent yield from 32.2 to 37.3 tonnes ha^{-1}. Higher net return of 85.6 x 103 ha^{-1} was obtained with 2 tonnes FYM ha^{-1} compared to 4 and 6 tonnes FYM ha^{-1}. There was no significant effect of organic and inorganic nutrient doses on cutworm damage on potato crop.

Katar *et al.*(2014) conducted a field experiment atinstructional Farm of N.D. University of agriculture and technology, Narandra Nagar (Kumarganj), Faizabad during two consecutive year of 2010-11 and 2011- 12. Potato cv. Kufri Ashoka was evaluated with seven treatment T1= Full recommended NPK (150:100:120) kg ha^{-1} through inorganic fertilizer, T2= FYM @ 20t ha^{-1}, T3= FYM @ 10t ha^{-1} + ½ NPK through inorganic fertilizer, T4= Vermicompost @ 5t ha^{-1}, T5= Vermicompost @ 2.5t ha^{-1} + 1/2 NPK through inorganic fertilizer, T6= Neem cake @ 3t ha^{-1}, T7 = Neem cake @ 1.5t ha^{-1} + 1/2 NPK through inorganic fertilizer. Thus twenty seven treatment combinations were arranged in random block design with three replications. Results obtained after the successful conduct of the experiment and statistical analysis of data revealed that the height of plant, number of compound leaves hill^{-1}, number of haulms hill^{-1}, yield attributes and yield. Further number of A, B, C and D grade tubers plot^{-1}, percent of A, B, C and D grade tubers plot^{-1}, yield of A, B, C and D grade tubers plot^{-1} (kg), total number of tubers plot^{-1}, total weight of tubers per plot (kg) and tuber yield (t ha^{-1}) showed the beneficial response by the use of integrated levels of NPK, FYM, Vermicompost and Neem Cake, however, on the basis of pooled data it was also further observed that the application of 150:100:120 kg NPK, 20t FYM, 5 ton Vermicompost and 3 ton Neem Cake ha^{-1} brought paramount of improvement in growth and tuber yield of potato.

Chandresh *et al.* (2014) conducted a field experiment at Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G) during rabi 2010-11 and 2011-12.The experiment was laid out in split–split plot design with three replications. The treatments consisted of three irrigation schedule i.e. drip irrigation (125 % of OPE), drip irrigation (100 %of OPE) and control (furrow irrigation) as a main plot and four weed management i.e. weedy check, hand weeding (at 25 and 45 DAP) metribuzin (500 g a.i.ha-1 PE) and chlorimuron + quizalofop (6 + 50 g a.i ha^{-1}) at 20 DAP as sub plot and four integrated nutrient management i.e. 100 % RDF, 100 % RDF +Micro nutrient (Zinc sulphate 25 kg ha^{-1}), 75 % N inorganic fertilizer + 25 % N poultry manure + PSB +Azatobactor and 50 % N inorganic fertilizer + 50 % Npoultry manure + PSB + Azatobactor as sub sub plot.Kufri Chipsona- 2 variety was used for experiment, the spacing of crop is 60cm×20cm. Application of 75% N inorganic fertilizer + 25 % N organic(Poultry manure) + PSB + Azotobactor was found non significant to weed control while produced significantly highest yield attributes and total tuber yield.

Sarker *et al.*, (2011) conducted a field experiment during winter of 2005-06 and 2006-07 at Hooghly, West Bengal to investigate the effect of different organic and inorganic sources of nutrients on productivity and profitability of potato (*Solanum tuberosum* L.) cultivars. The treatments consisted 3 varieties, viz. 'Kufri Chipsona-1', 'Kufri Chipsona-2' and 'Kufri Jyoti' in main-plots and 4 nutrient sources, viz. Farmyard manure (FYM) @ 35 t ha^{-1} (N1), FYM @ 30 t ha^{-1} + biofertilizers (N2), FYM @ 25 t ha^{-1} + mustard cake @ 1 t ha^{-1} (N3), recommended dose of NPK i.e. 180:66:125 kg ha^{-1} N, P, K (N4) in sub-plots.

Varieties had significant variations in growth and yield attributes, yield and nutrient uptake. Higher growth attributes were recorded under ‘Kufri Chipsona-1’ except plant height. Hence, ‘Kufri Chipsona-1’ gave maximum number of tubers, total tuber yield (28.18 and 28.39 t ha^{-1}), NPK uptake, net profit and B:C ratio (1.28, 1.22). Among sources of nutrient recommended dose of NPK showed better performance in all respects and registered 4.7 to 9.7% more tuber yield when compared with other nutrient sources. The highest B:C ratio (1.34, 1.29) was also recorded in recommended dose of NPK treatment. Higher dry weight of tubers (718.15, 722.40 g/m^2), number of tubers (680.21, 690.74 thousand ha^{-1}) and tuber yield (29.44, 29.89 t ha^{-1}) were obtained from ‘Kufri Chipsona-1’ potato treated with recommended dose of NPK.

Urkurkar *et al.* (2010)conducted field experiments at Raipur in Inceptisols between 2003-04 and 2007-08 to compare organic, integrated and chemical fertilizer nutrient inputs pakages in scented rice (Oryza sativa L.) – potato (*Solanumtuberosum* L.) a high value cropping system. Seven different nutrient treatments, 5 of them having use of organic inputs and 1 each having integrated (50% through fertilizers and 50% through organic nutrients) and 100%through fertilizers were studied in RBD with 3 replications. Organic transition effect in which decline in yield from 1to 3 years and again increase in yield was noticeable in rice under organic nutrient inputs packages. These treatments followed a steady increase and registered 20 to 50% more yield at the end of study compared to first year yield i.e. 2003-04. However, effect of different organic inputs packages on potato tuber yield was not stable over the years. Total productivity in terms of rice equivalent yield of the system (13.36 ton ha^{-1}) and total net return (Rs92, 634 kg^{-1}) was highest with chemical fertilizer treatment closely followed by integrated inputs use. 100% N (1/3each from cowdung manure, neem cake and composed crop residue) appreciably increased the organic carbon (6.3 g kg^{-1}) over initial value (5.8 g kg^{-1}). However, availability of P and K did not show any perceptible change after completion of five cropping cycles under organic as well as integrated nutrient approaches.

Narayan *et al.* (2014) conducted a field experiment during the rainy (kharif) seasons of 2008 and 2009 at Shalimar, Srinagar in a split plot design having 3 dates in the main plots and 6 sources of nutrients through the combinations of organic and inorganic fertilizers in the sub-plots with 3 replications, to find out their effect on productivity and profitability of potato (*Solanum tuberosum* L.). Among the dates, planting on 25 March recorded significantly higher tuber yield (35.7t ha^{-1}) and benefit: cost ratio (1.89) than that sown on 10 March and 11 April during both the years. Plant height, number of shoots, shoot dry matter, leaf-area index (LAI) and number of tubers $hill^{-1}$ (11.48) were also the highest in 25 March planting as compared to the other planting dates. Application of 75% of full recommended dose of fertilizers (RDF) (120:75:75 $NPKha^{-1}$) + 8 t ha^{-1} vermicompost + pre-sowing tuber treatment with Azotobacter and phosphorus-solubilizing bacteria proved significantly superior in terms of number of tubers hill, harvest index, tuber yield (32.7 t ha^{-1}) and benefit: cost ratio (1.75) of potato over rest of the treatments during both years.

Meena *et al.* (2013)conducted a field experiment during 2008–09 and 2009–10 at New Delhi, to study the effect of organic sources of nutrients on growth, yield and yield attributes of pop porn (Zea mays averta Sturt)-potato (*Solanum tuberosum* L.) cropping system. The experiment consisted of 24 treatment combinations with 8 treatments in pop corn [control, recommended dose of fertilizers (RDF) (N120P25K35 kg ha^{-1}), farmyard manure equivalent to120 kg N ha^{-1} (FYM120), leaf compost equivalent to 120 kg N ha^{-1} (LC120), vermicompost equivalent to 120 kg N ha^{-1} (VC120), farmyard manure equivalent to 90 kg N ha^{-1} (FYM90), leaf compost equivalent to 90 kg N ha^{-1} (LC90) and vermicompost equivalent to 90 kg N ha^{-1} (VC90)] and 3 treatments in potato crop [control, farmyard manure equivalent to 60 kg N ha^{-1} (FYM60) and farmyard manure equivalent to 90 kg N ha^{-1} (FYM90)]. The application of RDF (N120P25K35 kg ha^{-1}) recorded significantly highest plant height, leaf-area index and dry matter with higher values of yield attributes, viz. cob length and girth, cobs ha^{-1} over the control. Application of vermicompost equivalent to 120 kg N ha^{-1} was the best source and remained at par with VC90, FYM120, FYM90 and N120P25K35 kg ha^{-1} for growth and yield attributes of pop corn. Similar trend in respect of grain and stover yield was also found. Due to residual fertility of FYM (equivalent to 120 kg N ha^{-1}) potato recorded the highest plant height, LAI, number of haulms and dry matter in haulms. Both FYM (equivalent to 90 kg ha^{-1}) and vermicompost (equivalent to 120 kg N ha^{-1}) exhibited the effects similar to FYM @ 120 kg N ha^{-1}. The yield and yield attributes of potato, viz. tubers $hill^{-1}$, fresh and dry weight of tubers, tuber yield and haulm yield also exhibited similar trend. Regarding direct effects of FYM, application of FYM equivalent to 90 kg N ha^{-1} in potato recorded the higher plant height, LAI, haulms $hill^{-1}$, dry matter in haulms; and yield and yield attributes compared to FYM equivalent 60 kg N ha^{-1} and control.

Mike *et al.* (2013) conducted a field experiment in North East England over six years (2004–2009) as part of a long-term factorial field trial about the effects of organic versus conventional crop management practices (fertilization, crop protection) and preceding crop on potato tuber yield (total, marketable, tuber size grade distribution) and quality (proportion of diseased, green and damaged tubers, tuber macro-nutrient concentrations) parameters. Inter-year variability (the effects of weather and preceding crop) was observed to have a profound effect on yields and quality parameters, and this variability was greater in organic fertility systems. Total and marketable yields were significantly reduced by the use of both organic crop protection and fertility management. However, the yield gap between organic and conventional fertilization regimes was greater and more variable than that between crop protection practices. This appears to be attributable mainly to lower land less predictable nitrogen supply in organically fertilized crops. Increased incidence of late blight inorganic crop protection systems only occurred when conventional fertilization was applied. In organically fertilized crops yield was significantly higher following grass red^{-1} clover leys than winter wheat, but there was no pre-crop effect in conventionally fertilized crops. The results highlight that nitrogen supply from organic fertilizers rather than inefficient pest and disease control may be the major limiting factor for yields in organic potato production systems.

CHAPTER III

MATERIALS AND METHODS

This chapter presents a brief description about experimental period, site, climatic condition, crop or planting materials, treatments, experimental design and layout, crop growing procedure, intercultural operations, data collection and statistical analysis. The details of experimental materials and methods are described below:

3.1 Experimental period

The experiment was conducted at the Agronomy research field, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from November 12, 2014 to April 30, 2015 in Rabi season.

3.2 Site description

3.2.1 Geographical location

The experimental area was situated at $23^0$77‘N latitude and $90^0$33‘E longitude at an altitude of 8.6 meter above the sea level (Anon., 2004).

3.2.2 Agro-ecological region

The experimental site belongs to the agro-ecological zone of “Modhupur Tract”, 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 is shown in the map of AEZ of Bangladesh in Appendix I.

3.2.3 Climate of the experimental site

Experimental site was located in the sub-tropical monsoon climatic zone, set a parted by winter during the months from November 12, 2014 to April 30, 2015

(Rabi season). Plenty of sunshine and moderately low temperature prevailed during experimental period, which is suitable for potato growing in Bangladesh. The weather data during the study period at the experimental site are shown in Appendix II.

3.2.4 Soil

Top soil was silty clay in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. Soil pH was 5.6 and has organic carbon 0.45%. The experimental area was flat having available irrigation and drainage system and above flood levels. The selected plot was medium high land.

3.3 Details of the experiment

3.3.1 Treatments

The experiment is consisted of two factors, were as follows:

Factor A: Potato varieties (V-4)

V_1:BARI Alu-25 (Asterix)

V_2:BARI Alu-28 (Lady rosetta)

V_3: BARI Alu-29 (Courage)

V_4: Diamant

V_5: BARI TPS-1

Factor B: Organic manure level (O-4)

O_0: 100% recommended fertilizer

O_1: 50% RDF + Cowdung (10 ton ha^{-1})

O_2: 50% RDF + Poultry litter (10 ton ha^{-1})

O_3: 50% RDF + ACI organic manure (10 ton ha^{-1})

Treatment combinations were as: 20

V_1M_1, V_1M_2, V_1M_3, $V_1M_{4,}$$V_2M_1$, V_2M_2, V_2M_3, V_2M_4,V_3M_1, V_3M_2, V_3M_3, $V_3M_{4,}$$V_4M_1$, V_4M_2, V_4M_3,$V_4M_{4,}$ V_5M_1, V_5M_2, V_5M_3 and $V_5M_{4.}$

3.3.2 Planting material

Five varieties of potato were used as planting materials as follows:

1) BARI Alu-25 (Asterix)
2) BARI Alu-28 (Lady Rosetta)
3) BARI Alu-29 (Courage)
4) Diamant
5) BARI TPS-1

3.3.3 Experimental design and layout

Experiment was provoked in a Randomized Complete block design (RCBD) with 3 replications. So, the total number of plots becomes 60. The variety was assigned to main plot and organic manure to sub plot. The size of unit plot was 4m × 2.5m where the tubers were planted at 50 cm × 25 cm spacing. The distances between plot to plot and replication to replication were 1 m and 0.75 m, respectively.

3.4 Crop management

3.4.1 Collection of seed

All variety of seed potato (certified seed) was collected from, Tuber Crops Research Centre (TCRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur and from BARI sub-station. Individual weight of seed potato was 60-70 g.

3.4.2 Preparation of seed

Collected seed tubers were kept in room temperature to facilitate sprouting. Finally sprouted potato tubers were used as planting material.

3.4.3 Land preparation

The land of the experimental site was first opened in the last week of October with power tiller. Later on, the land was ploughed and cross-ploughed four times followed by laddering to obtain the desirable tilth. The corners of the land were spaded and weeds and stubbles were removed from the field. The land was finally prepared on 14 November 2014 three days before planting the seed. In order to avoid water logging due to rainfall during the study period, drainage channels were made around the land. The soil was treated with Furadan 5G @10 kg ha^{-1} when the plot was finally ploughed to protect the young plant from the attack of cut worm.

3.4.4 Manure and fertilizer application

The experimental soil was fertilized with following dose of urea, Triple Super Phosphate (TSP), Muriate of Potash (MoP), gypsum, zinc sulphate and boric acid.

Fertilizers	**Dose (kg ha^{-1})**
Urea	250
TSP	150
MoP	250
Gypsum	120
Zinc Sulphate	10
Boric Acid	10

(Mondal *et al.*, 2011)

Total amount of triple superphosphate, gypsum, zinc sulphate, magnesium sulphate, boric acid and half of urea was applied at basal doses during final land preparation. The remaining 50% urea was side dressed in two equal splits at 35 and 50 days after planting (DAP) during first and second earthing up.

3.4.5 Planting of seed tuber

The well sprouted healthy and uniform sized potato tubers were planted according to treatment and 8 potatoes were used for 1m^2. Seed potatoes were planted in such a way that potato does not go much under soil or does not remain in shallow. On an average, potatoes were planted at 4-5cm depth in soil on November 17, 2014.

3.4.6 Intercultural operations

3.4.6.1 Irrigation

Just after full emergence the crop was irrigated by flooding so that uniform growth and development of the crop was occurred and also moisture status of soil retain as per requirement of plants. In total four-time irrigation were applied throughout the whole cropping period by four times. Excess water was not given, because it always harmful for potato plant.

3.4.6.2 Weeding and mulching

Weeding and mulching were necessary to keep the plots free from weeds and to conserve soil moisture. The newly emerged weed was uprooted carefully after complete emergence of sprouts and afterwards when necessary. Mulching was done for breaking the surface crust as and when needed.

3.4.6.3 Earthing up

Earthing up process was done in the plot at two times, during crop growing period. First was done at 35 DAP and second was at 50 DAP.

3.4.6.4 Plant protection measures

Dithane M-45 was applied at 30 DAP as a preventive measure for controlling fungal infection. Ridomil (0.25%) was sprayed at 45 DAP to protect the crop from the attack of late blight.

3.4.6.5 Haulm cutting

Haulm cutting was done at February 28, 2015 at 85 DAP, when 40-50% plants showed senescence and the tops started drying. After haulm cutting the tubers were kept under the soil for 10 days for skin hardening. The cut haulm was collected, bagged and tagged separately for further data collection.

3.4.6.6 Harvesting of potatoes

Harvesting of potato was done on March 10, 2015 at 9 days after haulm cutting. The potatoes of each plot were separately harvested, bagged and tagged and brought to the laboratory. The yield of potato plant^{-1} was determined in gram. Harvesting was done manually by hand.

3.5 Recording of data

Experimental data were recorded from 20 DAP and continued until harvest. Dry weights of different plant parts were collected after harvesting. The following data were collected during the experimentation.

a) Yield and yield contributing parameters:

1. Yield (t ha^{-1})
2. Different grading
3. Marketable yield
4. Non-marketable yield
5. Seed potato yield
6. Non-seed potato yield

b) Processing and storage parameter:

1. Weight loss (%) at 20, 40 and 60 days after storing
2. Tuber flesh dry matter content (%)at 0, 20, 40 and 60 days after storing
3. Firmness at 0, 20, 40 and 60 DAS (Done by Force Gauge)
4. Specific gravity at 0, 20, 40 and 60 DAS.
5. Total soluble solid (TSS) at 0, 20, 40 and 60 days after storing
6. Reducing sugar and non-reducing sugarat 0, 20, 40 and 60 days after storing (Done by Somogi-Nelson method)

3.6 Procedure of recording data

3.6.1 Yield of tuber (t ha^{-1})

Tubers of each plot were collected separately from which yield of tuber $hill^{-1}$ was recorded in kilogram and converted to ton $hectare^{-1}$.

3.6.2 Grading of tuber (% by number and % by weight)

Tubers harvested from each plot were graded by number and by weight on the basis of diameter into the >55 mm, 45-55 mm, 28-45 mm and <28 mm and converted to percentages. A special type of frame (potato riddle) was used for grading of tuber.

3.6.3 Marketable tuber and non-marketable tuber

On the basis of weight, the tubers have been graded into marketable tuber (>20g) and non-marketable tuber (<20g).

3.6.4 Dry matter content (%)

The samples of tuber were collected from each treatment. After peel off the tubers the samples were dried in an oven at 72^0C for 72 hours. Dry matter content was calculated as the ratio between dry and fresh weight and expressed as a percentage (Barton, 1989).

3.6.5 Weight loss (%)

At the end of the experiment, remaining good tubers were recorded and their percentage was calculated on the basis of initial weight of tuber. Weight loss was calculated using the following formula:

$$\% \text{ WL} = (\text{IW}-\text{FW})/\text{IW} \times 100$$

Where,

%WL = Percent total weight loss

IW = Initial weight of tubers (kg)

FW = Final weight of tubers (kg)

3.6.6 Specific Gravity (g cm^{-3})

It was measured by using the following formula –

$$\text{Specific gravity} = \frac{\text{Weight of tuber in air}}{\text{Weight of tuber in fresh water at } 4^0\text{C}}$$

3.6.7 Total soluble solids (TSS)

TSS of harvested tubers was determined in a drop of potato juice by using Hand Sugar Refractometer "ERMA" Japan, Range: 0-32% according to (AOAC, 1990) and recorded as % Brix from direct reading of the instrument.

3.6.8 Firmness

The fresh potato tubers were cut into several slices to take the firmness reading by a firmness meter. The reading seems that, how much pressure is taken by the potato tuber slice to make it chips.

3.6.9 Reducing sugar and non-reducing sugar

3.6.10 Extraction of sugar

For the analysis of sugar content like glucose and sucrose potato flesh was extracted. For each extraction, 1.0g fresh sample of chopped potato was taken from uniform tuber samples. Sugar was extracted using 5ml of 80% ethanol heat at 80°c for 30 min using a dry block heat bath and the extracts was centrifuged at 5000 rpm for 10 min and decanted the supernatant. 8mL 80% EtOH, was added and it was repeated 4 and 5 for 3 times in total. All the supernatants were mixed well and the final volume was made up to 25 mL using 80% EtOH. The residue is used for starch analysis.

3.6.10.1 Reducing sugar determination (glucose)

Reducing sugar was estimated by the photometric adaptation of the Somogyi method with some modification. Copper solution and Nelson reagent and standard glucose solution (0.5 mL) were used. 3 mL sample solution was put into a small glass container. Then it was completely dried up on an electric heater, 3 mL distilled water was added, and then mixed well. Then .5ml solution was taken from this, two times and was put in different test tubes. In one test tube, 0.5 mL Copper solution was added and was boiled (100˚C) for 10 min. After boiling, immediately the test tube was cooled in tap water. 0.5 mL Nelson reagent in the test tube was added, and mixed them well. After 20 min, 8 mL distilled water was added and mixed well (Total volume = 9.5 mL).After that the absorbance at 660 nm (Abs1) was measured and the reducing sugar content was calculated.

3.6.10.2 Non-reducing sugar determination (Sucrose)

0.2 mL Invertase solution (1,000 U 0.1 mL^{-1}) was diluted with 50 mL distilled water, and add one drop of Vinegar. 0.5 mL solution, which was left during reducing sugar determination, was put into a test tube. Then 0.5 mL diluted Invertase solution (20 Unit 0.5 mL^{-1}) was added and incubated for 30 min at ambient temperature and then .05ml Copper solution was added and boiled (100˚C) for 10 min. After boiling, immediately the test tubes were cooled in tap water. 0.5 mL Nelson reagent in the test tube was added, and mixed them well. After 20 min, 8 mL distilled water was added and mixed well (Total volume = 9.5 mL). After that the absorbance at 660 nm (Abs2) was measured and the reducing sugar content was calculated.

3.6.10.3Measurement of starch in potato tubers

The residue remained after extraction for sugar, was washed for several times with water to ensure that there was no more soluble sugar in the residues. After that using tap water and mark up to 250 ml beaker. Stir well on a magnetic stirrer. Then 0.5 mL solution was taken from the beaker into 3 test tubes. 0.5 mL was taken during the stirring. Then the test tubes were boiled for 10 min at 100 ˚C. 1 mL Amyloglucosidase solution was added and mix well and heat at 50-60˚C for 2 hrs in hot water. After cooling, a 0.5 mL Copper solution was added and mix well, heat at 100C for 10 min., cool in tap water again added 0.5 mL Nelson solution, mix well and added 7 mL distilled water, mix well (Final volume = 9.5 mL), and measure the absorbance at 660 nm (Abs4). . Calculate starch content using the glucose standard curve.

3.7 Statistical Analysis

The data obtained for different characters were statistically analyzed following the analysis of variance techniques by using MSTAT-C computer package program. The significant differences among the treatment means were compared by Least Significant Difference (LSD) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The present investigation was attempted to evaluate the response of variety and organic manure on different yield and storage characteristics of potato. In this chapter; tables and appendices have been used to present, discuss and compare the findings obtained from the present study. The ANOVA (analysis of variance) of data in aspects of all the quantitative and qualitative characteristics have been presented in Appendix (III-XIV). The revelation and all possible interpretations were given under the following headings:

4.1 Yield parameters

4.1.1 Tuber yield (t ha^{-1})

Tuber yield was significantly influenced by different varieties (Table 4.1.1). Results revealed that the highest tuber yield (42.23 t ha^{-1}) was found from V_4 ("Diamant") which was statistically similar with V_1("Asterix") and V_3("Courage). On the other hand, the lowest tuber yield (34.26 t ha^{-1}) was found from V_5 ("BARI TPS-1") which was also statistically similar with V_2 ("Lady rosetta") and statistically similar with V_1("Asterix") and V_3("Courage"). The results obtained from the present study were similar with the findings of Mahmood *et al.* (2005), Haque (2007), Farzana (2015), Jannatul (2015) and Das (2006).

Significant variation was found for tuber yield influenced by different organic manure treatments (Table 4.1.1). The highest tuber yield (45.97 t ha^{-1}) was found from O_0 (100% RDF) which was significantly different from all other organic manure combination with RDF treatments. On the other hand, the lowest tuber yield (32.46 t ha^{-1}) was found from O_1 (50% RDF + Cowdung) which was statistically similar with O_2 (50% RDF + Poultry litter) followed by 35.37 t ha^{-1}.

Jaipul *et al.* (2011), Raghav *et al.* (2007) observed the similar trend in their results. Mike (2013) has demonstrated that inefficient nutrient supply (especially N) from organic fertilizers contributed more than the limited use of chemo-synthetic crop protection products to the lower yield in organic compared to conventional potato production which supported the result of higher yield from 100% recommended fertilizers than partially organic sources nutrient management of this experiment.

Combined effect of varieties and organic manure applications on tuber yield of potato had significant influence (Table 4.1.2).The highest tuber yield (57.23 t ha^{-1}) was found from V_4O_0 which was statistically similar with V_3O_2 (45.35 t ha^{-1}) and V_5O_0 (45.54 t ha^{-1}). On the other hand, lowest tuber yield (25.42 t ha^{-1}) was found from V_5O_1 which was statistically similar with V_1O_1, V_2O_1, V_2O_2, V_2O_3, V_3O_1, V_4O_2, V_5O_2 and V_5O_3.

4.1.2 Total Number of tuber $hill^{-1}$

Number of Tuber was significantly influenced by different varieties (Table 4.1.1). The highest number of tuber per hill (7.99) was observed from V_2 ("Lady rosetta") which was significantly different from all other varieties. On the other hand, the lowest number of tuber per hill (6.60) was observed from V_5 ("BARI TPS-1") which was statistically similar with V_1, V_3 and V_4. The results obtained from the present study were similar with the findings of Jannatul (2015).

Number of Tuber per hill was significantly influenced by different organic manure with different level of chemical fertilizer applications (Table 4.1.1). The highest number of tuber per hill (7.86) was observed from O_0 (100% RDF) which was statistically similar with O_3 (50% RDF + ACI Organic manure). On the other hand, the lowest number of tuber per hill (6.08) was observed from O_2 (50% RDF + Poultry litter) which were significantly different from all other Organic manure with different level of chemical fertilizer applications.

Combined effect of varieties and organic manure applications on number of tuber per hill of potato had significant influence (Table 4.1.2).The highest number of tuber per hill (9.73) was found from V_2O_0 which was statistically similar with

V_2O_3 followed by number of tuber per hill of 8.39. On the other hand, the lowest number of tuber per hill (5.33) was found from V_4O_2 which was significantly similar with V_1O_1, V_2O_2, V_3O_1, V_3O_2, V_4O_1, V_5O_1, V_5O_2 and V_5O_3.

4.1.3 Number of marketable tuber

Number of marketable tuber was significantly influenced by different varieties (Table 4.1.1). The highest number of marketable tuber (6.57) was found from V_2 (Lady rosetta) which was significantly different from all other varieties. On the other hand, the lowest number of marketable tuber (4.53) was found from V_5 (BARI TPS-1) which was significantly different from all other varieties. Bejhati *et al.* (2013) and Farzana (2015) showed similar trend of change in yield attributes of potato.

Number of marketable tuber was significantly influenced by different organic manure applications (Table 4.1.1). The highest number of marketable tuber (6.46) was found from O_0 (100% RDF) which was statistically similar with O_3 (50% RDF + ACI organic manure). On the other hand, the lowest number of marketable tuber (5.04) was found from O_2 (50% RDF + Poultry litter) which were statistically similar with O_1 (50% RDF + Cowdung) followed by the number of marketable yield of 5.23. Jannatul (2015) found the similar trend of results.

Combined effect of varieties and organic manure applications on number of marketable tuber had significant influence (Table 4.1.2). The highest number of marketable tuber (8.13) was found from V_2O_0 which was statistically similar with V_2O_3 and V_4O_0. On the other hand, the lowest number of marketable tuber (3.73) was found from V_5O_1 which was statistically similar with V_1O_1, V_2O_2, V_3O_1, V_4O_2, V_5O_2 and V_5O_3.

4.1.4 Weight of marketable tuber (t ha^{-1})

Weight of marketable tuber was significantly influenced by different varieties (Table 4.1.1). The highest weight of marketable tuber (41.82 t ha^{-1}) was found from V_4 (Diamant) which was statistically similar with V_1 (Asterix) and V_3

(Courage). On the other hand, the lowest weight of marketable tuber (33.65 t ha^{-1}) was found from V_5 (BARI TPS-1) which was statistically identical with V_2 (Lady rosetta) and statistically similar with V_1 and V_3. Farzana (2015) showed similar trend of change in yield attributes of potato.

Weight of marketable tuber was significantly influenced by different organic manure applications (Table 4.1.1). The highest weight of marketable tuber (45.49 t ha^{-1}) was found from O_0 (100% RDF) which was significantly different from all other organic manure applications. On the other hand, the lowest weight of marketable tuber (31.92 t ha^{-1}) was found from O_1 (50% RDF + Cowdung) which was statistically similar with O_2 (50% RDF + Poultry litter).

Combined effect of varieties and organic manure applications on weight of marketable tuber had significant influence (Table 4.1.2).The highest weight of marketable tuber (56.80) was found from V_4O_0 which was statistically similar with V_3O_2 and V_5O_0.). On the other hand, the lowest weight of marketable tuber (24.61) was found from V_5O_1 which was statistically similar with V_1O_1, V_2O_1, V_2O_2, V_2O_3, V_3O_1, V_4O_2, V_5O_2 and V_5O_3.

4.1.5 Number of non-marketable tuber

Number of non-marketable tuber was significantly influenced by different varieties (Table 4.1.1). The highest number of nonmarketable tuber (2.06) was found from V_5 (BARI TPS-1) which was significantly different from all other varieties. On the other hand, the lowest number of nonmarketable tuber (0.90) was found from V_3 (Courage) which was statistically similar with V_4 (Diamant). Farzana (2015) showed similar trend of change in yield attributes of potato.

Number of nonmarketable tuber was significantly influenced by different organic manure applications (Table 4.1.1). The highest number of nonmarketable tuber (1.57) was found from O_1 (50% RDF + Cowdung) which is statistically similar with O_2 (50% RDF + Poutry litter) and O_0 (100% RDF). On the other hand, the lowest number of nonmarketable tuber (1.04) was found from O_3 (50% RDF +

ACI organic manure) which were statistically dissimilar from all other organic manure with different proportion of chemical fertilizer applications.

Combined effect of varieties and organic manure applications on number of nonmarketable tuber had significant influence (Table 4.1.2).The highest number of nonmarketable tuber (2.62) was found from V_5O_1 which was statistically similar with V_5O_2 and V_5O_0 followed by number of nonmarketable tuber 2.28 and 2.10. On the other hand, the lowest number of nonmarketable tuber (0.68) was found from V_3O_3 which was significantly similar with V_1O_0, V_2O_3, V_3O_0, V_3O_1, V_3O_1, V_3O_2, V_4O_0, V_4O_1, V_4O_2, V_4O_3 and V_5O_3.

4.1.6 Weight of non-marketable tuber (t ha^{-1})

Weight of nonmarketable tuber was significantly influenced by different varieties (Table 4.1.1). The highest weight of on nonmarketable tuber (0.61 t ha^{-1}) was found from V_5 (BARI TPS-1) which was significantly similar with V_2 (Lady rosetta) and significantly similar with V_1 (Asterix) and V_4 (Diamant). On the other hand, the lowest weight of nonmarketable tuber (0.34 t ha^{-1}) was found from V_3 (Courage) which was statistically similar with V_1 (Asterix) and V_4 (Diamant).Farzana (2015) and Jannatul (2015) showed similar trend of change in yield attributes of potato.
Weight of nonmarketable tuber was significantly influenced by different organic manure applications (Table 4.1.1). The highest weight of nonmarketable tuber (0.61 t ha^{-1}) was found from O_3 (50% RDF + ACI organic manure) which was statistically similar with O_1 (50% RDF + Cowdung) and statistically similar with O_0 (100% RDF). On the other hand, the lowest weight of nonmarketable tuber (0.34 t ha^{-1}) was found from O_2 (50% RDF + Poultry manure) which were statistically similar with O_0 (100% RDF).

Combined effect of varieties and organic manure applications on weight of nonmarketable tuber had significant influence (Table 4.1.2).The highest weight of nonmarketable tuber (0.95 t ha^{-1}) was found from V_2O_3 which was statistically similar with V_1O_1, V_1O_3, V_2O_0, V_5O_0, V_5O_1, V_5O_3. On the other hand, the lowest weight of nonmarketable tuber (0.23 t ha^{-1}) was found from V_3O_2 which was significantly similar with V_10_1, V_1O_2, V_1O_3, V_2O_0, V_2O_1, V_2O_2 V_2O_4, V_3O_1, V_3O_3, V_4O_0, V_4O_1, V_4O_2, V_4O_3, V_5O_0 and V_5O_2.

Table 4.1.1: Single effect of variety and organic manure on yield and yield attributes of potato

Variety	Yield (t ha^{-1})	Total no. of tuber $hill^{-1}$	No. of marketable tuber	Weight of marketable tuber (t ha^{-1})	No. of non-marketable tuber	Weight of non-marketable tuber (t ha^{-1})
V_1	40.27 ab	7.10 b	5.63 b	39.76 ab	1.47 b	0.51 ab
V_2	35.69 b	7.99 a	6.57 a	35.10 b	1.43 b	0.59 a
V_3	39.26 ab	6.65 b	5.75 b	38.91 ab	0.90 c	0.34 b
V_4	42.23 a	6.77 b	5.70 b	41.82 a	1.07 c	0.41 ab
V_5	34.26 b	6.60 b	4.53 c	33.65 b	2.06 a	0.61 a
$LSD_{(0.05)}$	6.188	0.787	0.803	6.209	0.330	0.208
Organic manure						
O_0	45.97 a	7.86 a	6.46 a	45.49 a	1.40 a	0.48 ab
O_1	32.46 c	6.80 b	5.23 bc	31.92 c	1.57 a	0.54 a
O_2	35.37 bc	6.08 c	5.04 c	35.01 bc	1.54 a	0.34 b
O_3	39.57 b	7.35 ab	5.80 ab	38.96 b	1.04 b	0.61 a
$LSD_{(0.05)}$	5.534	0.704	0.718	5.553	0.295	0.186
CV (%)	19.53	13.57	17.24	19.85	28.81	51.19

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1; O_0 = 100% RDF,
O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

Table 4.1.2: Combined effect of variety on yield and yield contributing characters of potato

Variety × Organic manure	Yield (t ha^{-1})	Total no. of tuber hill^{-1}	No. of marketable tuber	Weight of marketable tuber (t ha^{-1})	No. of non-marketable tuber	Weight of non-marketable tuber (t ha^{-1})
V_1O_0	43.56 b-d	6.95 b-f	5.83 b-f	43.18 b-d	1.13 d-i	0.38 cd
V_1O_1	35.07 b-g	6.81 c-g	5.18 c-g	34.41 b-h	1.63 b-e	0.66 a-c
V_1O_2	40.52 b-e	7.07 b-f	5.68 b-f	40.09 b-f	1.74 b-d	0.43 b-d
V_1O_3	41.94 b-e	7.57 b-d	5.83 b-f	41.35 b-f	1.39 d-h	0.59 a-d
V_2O_0	43.39 b-d	9.73 a	8.13 a	42.85 b-e	1.60 c-g	0.54 a-d
V_2O_1	31.37 d-g	8.07 bc	6.48 b-d	30.84 d-h	1.58 c-g	0.53 b-d
V_2O_2	32.92 c-g	5.78 e-g	4.89 d-g	32.59 c-h	1.63 b-f	0.33 cd
V_2O_3	35.07 b-g	8.39 ab	6.77 a-c	34.12 b-h	0.89 hi	0.95 a
V_3O_0	40.14 b-e	7.21 b-e	6.08 b-e	39.68 b-f	1.13 d-i	0.46 b-d
V_3O_1	31.01 e-g	5.91 e-g	5.07 d-g	30.71 e-h	0.84 hi	0.30 cd
V_3O_2	45.35 ab	6.58 c-g	5.91 b-f	45.05 ab	0.97 f-i	0.23 d
V_3O_3	40.54 b-e	6.90 b-f	5.93 b-f	40.20 b-f	0.68 i	0.35 cd
V_4O_0	57.23 a	7.87 b-d	6.81 ab	56.80 a	1.06 e-i	0.43 b-d
V_4O_1	39.45 b-f	6.85 b-g	5.69 b-f	39.05 b-g	1.16 d-i	0.40 b-d
V_4O_2	27.47 fg	5.33 g	4.38 fg	27.09 gh	1.11 d-i	0.38 cd
V_4O_3	44.79 bc	7.03 b-f	5.93 b-f	44.33 bc	0.95 g-i	0.46 b-d
V_5O_0	45.54 ab	7.57 b-d	5.47 b-f	44.94 a-c	2.10 a-c	0.60 a-d
V_5O_1	25.42 g	6.35 d-g	3.73 g	24.61 h	2.62 a	0.81 ab
V_5O_2	30.59 e-g	5.63 fg	4.37 fg	30.24 f-h	2.28 ab	0.36 cd
V_5O_3	35.50 b-g	6.84 b-g	4.57 e-g	34.82 b-h	1.27 d-i	0.69 a-c
$LSD_{(0.05)}$	12.375	1.575	1.605	12.417	0.660	0.417
CV (%)	19.53	13.57	17.24	19.85	28.81	51.19

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;O_0 = 100% RDF,
O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

4.2 Grading parameters of potato

4.2.1 Number of total seed tuber

Number of total seed tuber was significantly influenced by different varieties (Table 4.2.1). The highest number of total seed tuber (6.85) was found from V_2 (Lady rosetta) which was significantly different from all other varieties. On the other hand, the lowest number of total seed tuber (4.85) was found from V_5 (BARI TPS-1) which was significantly different from all other varieties.Similar results were also observed by Hossain (2011) and Guler (2009).

Number of total seed tuber was significantly influenced by different organic manure applications (Table 4.2.1). The highest number of total seed tuber (6.56) was found from O_0 (100% RDF) which was significantly similar with O_2 (50% RDF + Poultry litter) followed by number of total seed tuber of 5.93. On the other hand, the lowest number of total seed tuber (5.32) was found from O_3 (50% RDF + ACI organic manure) which were statistically similar with O_1 (50% RDF + Cowdung) and significantly similar with O_2 (50% RDF + Poultry litter). Jannatul (2015) also observed the similar results.

Combined effect of varieties and organic manure applications on number of total seed tuber had significant influence (Table 4.2.2).The highest number of total seed tuber (8.32) was found from V_2O_0 which was statistically similar with V_2O_2. On the other hand, the lowest number of total seed tuber (4.23) was found from V_5O_1 which was statistically similar with V_1O_0, V_1O_1, V_2O_3, V_3O_1, V_4O_3, V_5O_2 and V_5O_3.

4.2.2 Weight of total seed tuber (t ha^{-1})

Weight of total seed tuber was significantly influenced by different varieties (Table 4.2.1). The highest weight of total seed tuber (13.14 t ha^{-1}) was found from V_4 (Diamant) which was statistically similar with V_1 (Asterix), V_3 (Courage) and statistically similar with V_2 (Lady rosetta). On the other hand, the lowest weight of total seed tuber (9.97 t ha^{-1}) was found from V_5 (BARI TPS-1) which was statistically similar with V_2 (Lady rosetta). Similar results were also observed by Hossain (2011) and Guler (2009).

Weight of total seed tuber was significantly influenced by different organic manures applications (Table 4.2.1). The highest weight of total seed tuber (13.88 t ha^{-1}) was found from O_0 (100% RDF) which was significantly different from all other organic manure applications. On the other hand, the lowest weight of total seed tuber (10.40 t ha^{-1}) was found from O_1 (50% RDF + Cowdung) which was statistically similar with O_3 (50% RDF + ACI organic manure).

Combined effect of varieties and organic manure applications on weight of total seed tuber had significant influence (Table 4.2.2).The highest weight of total seed tuber (16.15 t ha^{-1}) was found from V_4O_0 which was statistically similar with V_1O_2, V_1O_3, V_2O_0, V_3O_0, V_3O_3, V_4O_2 and V_5O_0. On the other hand, the lowest weight of total seed tuber (7.91) was found from V_5O_1 which was statistically similar with V_1O_1, V_2O_1, V_2O_3, V_3O_1, V_4O_3, V_5O_2 and V_5O_3.

4.2.3 Number of total non-seed tuber

Number of total non-seed tuber was significantly influenced by different varieties (Table 4.2.1). The highest number of total non-seed tuber (1.74) was found from V_5 (BARI TPS-1) which was significantly different from each other varieties. On the other hand, the lowest number of total non-seed tuber (1.14) was found from V_3 (Courage) which was statistically similar with V_4 (Diamant). Farzana (2015) and Jannatul (2015) showed similar result.

Number of total non-seed tuber was significantly influenced by different organic manure applications (Table 4.2.1). The highest number of total non-seed tuber (1.42) was found from O_2 (50% RDF + Poultry litter) which was statistically similar with O_0 (100% RDF) and O_1 (50% RDF + Cowdung). On the other hand, the lowest number of total non-seed tuber (0.76) was found from O_3 (50% RDF + ACI organic manure) which were significantly different from all other organic manure applications.

Combined effect of varieties and organic manure applications on number of total non-seed tuber had significant influence (Table 4.2.2). The highest number of total non-seed (2.13) was found from V_5O_1 which was statistically identical with V_5O_2 and statistically similar with V_1O_2 and $V_5O_{0.}$ On the other hand, the lowest number of total non-seed tuber (0.62) was found from V_4O_3 which was statistically similar with V_2O_3 and statistically similar with V_3O_0, V_3O_1, V_3O_2, V_3O_3, V_4O_1, V_4O_2 and $V_5O_{3.}$

4.2.4 Weight of total non-seed tuber

Weight of total non-seed tuber was significantly influenced by different varieties (Table 4.2.1). The highest weight of total non-seed tuber (1.60) was found from V_5 (BARI TPS-1) which was significantly similar with V_1 (Asterix) V_3 (Courage) and V_4 (Diamant). On the other hand, the lowest weight of total non-seed tuber (0.46) was found from V_2 (Lady rosetta) which was statistically similar with V_1 (Asterix) V_3 (Courage) and V_4 (Diamant).Farzana (2015) and Jannatul (2015) showed similar result.

Weight of total non-seed tuber was significantly influenced by different organic manure applications (Table 4.2.1). The highest weight of total non-seed tuber (1.61) was found from O_0 (100% RDF) which was statistically similar with O_2 (50% RDF + Poultry litter). On the other hand, the lowest weight of non-seed tuber (0.56) was found from O_1 (50% RDF + Cowdung) which was statistically similar with O_3 (50% RDF + ACI organic manure) and statistically similar with O_2 (50% RDF + Poultry litter).

Combined effect of varieties and organic manure applications on weight of total non-seed tuber had significant influence (Table 4.2.2). The highest weight of total non-seed tuber (3.06) was found from V_4O_0 which was statistically similar with V_3O_3, V_5O_0 and V_5O_2. On the other hand, the lowest weight of total non-seed tuber (0.36) was found from V_2O_1 which was statistically similar with V_4O_2 and statistically with all other combined treatments except V_4O_0, V_5O_0 and V_5O_2.

Table 4.2.1: Single effect of variety and organic manure on number and weight of seed and non-seed tuber of potato

Variety	No. of total seed tuber	Weight of total seed tuber	No. of total non-seed tuber	Weight of total non-seed tuber
V_1	5.71 b	12.66 a	1.39 b	0.93 ab
V_2	6.85 a	11.58 ab	1.14 c	0.46 b
V_3	5.89 b	12.32 a	0.76 d	0.97 ab
V_4	5.86 b	13.14 a	0.91 cd	1.09 ab
V_5	4.85 c	9.97 b	1.74 a	1.60 a
$LSD_{(0.05)}$	0.741	1.653	0.227	0.853
Organic manure				
O_0	6.56 a	13.88 a	1.30 a	1.61 a
O_1	5.52 b	10.40 c	1.28 a	0.56 b
O_2	5.93 ab	12.29 b	1.42 a	1.07 ab
O_3	5.32 b	11.17 bc	0.76 b	0.80 b
$LSD_{(0.05)}$	0.663	1.478	0.203	0.763
CV (%)	15.38	16.75	23.13	102.31

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

Table 4.2.2: Combined effect of variety and organic manure on number and weight of seed and non-seed tuber of potato

Variety × Organic manure	No. of total seed tuber	Weight of total seed tuber	No. of total non-seed tuber	Weight of total non-seed tuber
V_1O_0	5.65 b-g	12.75 b-f	1.30 d-f	1.95 a-d
V_1O_1	5.43 c-g	11.10 c-i	1.38 c-e	0.74 cd
V_1O_2	5.76 b-f	13.47 a-e	1.81 a-c	0.68 cd
V_1O_3	5.99 b-f	13.33 a-f	1.08 d-h	0.35 d
V_2O_0	8.32 a	14.18 a-c	1.41 b-d	0.47 cd
V_2O_1	6.79 bc	10.23 e-i	1.28 d-f	0.36 d
V_2O_2	7.03 ab	11.39 c-h	1.36 c-f	0.44 cd
V_2O_3	5.28 d-g	10.53 d-i	0.51 i	0.58 cd
V_3O_0	6.41 b-e	13.09 a-f	0.80 g-i	0.46 cd
V_3O_1	5.25 e-g	10.04 f-i	0.66 hi	0.43 cd
V_3O_2	5.98 b-f	12.43 b-g	0.92 f-i	1.25 b-d
V_3O_3	5.93 b-f	13.73 a-d	0.66 hi	1.75 a-d
V_4O_0	6.73 b-d	16.15 a	1.13 d-g	3.06 a
V_4O_1	5.91 b-f	12.72 b-f	0.94 e-i	0.59 cd
V_4O_2	6.08 b-f	14.84 ab	0.96 d-i	0.27 d
V_4O_3	4.71 fg	8.84 hi	0.62 i	0.43 cd
V_5O_0	5.71 b-f	13.25 a-f	1.86 ab	2.12 a-c
V_5O_1	4.23 g	7.91 i	2.13 a	0.67 cd
V_5O_2	4.78 fg	9.31 g-i	2.07 a	2.67 ab
V_5O_3	4.71 fg	9.41 g-i	0.93 e-i	0.92 cd
$LSD_{(0.05)}$	1.483	3.305	0.454	1.707
CV (%)	15.38	16.75	23.13	102.31

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

4.3 Dry matter content (%)

Percent (%) dry matter content was significantly influenced by different test varieties at different days after harvest (DAS) (Table 4.3.1). Results signified that the highest % dry matter content (26.65, 25.65, 24.15 and 21.51 at 0, 20, 40 and 60 DAS, respectively) was observed from V_2 (Lady rosetta) which was significantly different from all other varietal performance where the lowest % dry matter content (22.37, 21.53, 20.27 and 18.04 at 0, 20, 40 and 60 DAS, respectively) was found from V_4 (Diamant) which was significantly different from all other varieties. Rainys and Rudokus (2005), observed similar result in their experiment in Lithuania.

Percent (%) dry matter content was significantly influenced by different organic manure applications at different days after harvest (DAS) (Table 4.3.1). Results signified that the highest % dry matter content (25.34, 24.40, 22.98 and 20.47 at 0, 20, 40 and 60 DAS, respectively) was observed from O_3 (50% RDF + ACI organic manure) which was significantly similar with O_0 (100% RDF) and O_2 (50% RDF + Poultry litter) where the lowest % dry matter content (24.10, 23.19, 21.81 and 19.39 at 0, 20, 40 and 60 DAS, respectively) was found from O_1 (50% RDF + Cowdung), which was significantly similar with O_0 (100% RDF) and O_2 (50% RDF + Poultry litter). Jaipaul *et al.*, (2011) and Sarkar *et al.*, (2007) observed the similar results.

Combined effect of variety and organic manure applications on percent dry matter content of potato had also significant influence at different DAS (Table 4.3.2). Results revealed that the highest % dry matter content 28.36, 27.29, 25.67 and 22.82 at 0, 20, 40 and 60 DAS, respectively) was found from V_2O_1 which was statistically similar with V_2O_0, V_2O_3, V_3O_0, V_4O_2 and V_5O_3. On the other hand, the lowest % dry matter content (21.80 and 20.99 at 0 and 20 DAS) was found from V_1O_3 which was statistically similar with V_4O_1 and V_5O_0 at 0 and 20 DAS but statistically similar with V_1O_0, V_1O_1, V_1O_2, V_3O_1 V_3O_2 and V_5O_1.

Table 4.3.1: Single effect of variety and organic manure on dry matter content (%) of potato

Variety	Dry matter content (%)			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1	22.37 c	21.53 c	20.27 c	18.04 c
V_2	26.65 a	25.65 a	24.15 a	21.51 a
V_3	25.17 b	24.23 b	22.81 b	20.30 b
V_4	24.55 b	23.63 b	22.24 b	19.80 b
V_5	24.29 b	23.38 b	22.01 b	19.59 b
$LSD_{(0.05)}$	1.245	1.209	1.155	1.050
Organic manure				
O_0	24.47 ab	23.55 ab	22.17 ab	19.73 ab
O_1	24.10 b	23.19 b	21.81 b	19.39 b
O_2	24.51 ab	23.60 ab	22.23 ab	19.80 ab
O_3	25.34 a	24.40 a	22.98 a	20.47 a
$LSD_{(0.05)}$	1.114	1.081	1.033	0.939
CV (%)	6.12	6.18	6.27	6.40

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

Table 4.3.2: Combined effect of variety and organic manure on dry matter content (%) of potato

Variety × Organic manure	Dry matter content (%)			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1O_0	22.10 ij	21.24 ij	19.96 i	17.69 i
V_1O_1	23.28 f-j	22.40 f-j	21.09 g-i	18.76 g-i
V_1O_2	22.32 h-j	21.49 h-j	20.26 hi	18.07 hi
V_1O_3	21.80 j	20.99 j	19.78 i	17.64 i
V_2O_0	26.22 a-e	25.25 a-e	23.81 a-f	21.24 a-f
V_2O_1	28.36 a	27.29 a	25.67 a	22.82 a
V_2O_2	24.79 c-h	23.85 c-h	22.44 d-h	19.96 d-h
V_2O_3	27.22 a-c	26.21 a-c	24.70 a-d	22.02 a-d
V_3O_0	27.56 ab	26.53 ab	24.98 ab	22.24 ab
V_3O_1	24.06 e-j	23.16 e-j	21.80 f-i	19.40 f-i
V_3O_2	23.48 f-j	22.59 f-j	21.27 g-i	18.93 g-i
V_3O_3	25.58 b-f	24.62 b-f	23.18 b-g	20.62 b-g
V_4O_0	24.53 e-i	23.64 e-i	22.29 f-h	19.91 e-h
V_4O_1	21.84 j	20.98 j	19.69 i	17.41 i
V_4O_2	27.13 a-d	26.12 a-d	24.61 a-e	21.94 a-e
V_4O_3	24.68 d-h	23.76 d-h	22.37 e-h	19.93 d-h
V_5O_0	21.93 j	21.08 j	19.81 i	17.57 i
V_5O_1	22.96 g-j	22.11 g-j	20.84 hi	18.59 g-i
V_5O_2	24.85 c-g	23.93 c-g	22.55 c-h	20.10 c-h
V_5O_3	27.43 ab	26.40 ab	24.85 a-c	22.12 a-c
$LSD_{(0.05)}$	2.490	2.418	2.311	2.10
CV (%)	6.12	6.18	6.27	6.40

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

4.4 Total soluble solids (TSS)

TSS was significantly influenced by different test varieties of potato at different days after storing (DAS) (Table 4.4.1). The highest TSS (6.450, 6.663,6.0 and 6.19 at 0, 20, 40 and 60 DAS, respectively) was observed from V_3 (Courage) which was closely followed by V_1 (Asterix) at 0 DAS and V_5 (BARI TPS-1) at 60 DAS. On the other hand, the lowest TSS (5.088, 5.125, 4.750 and 5.700 at 0, 20, 40 and 60 DAS, respectively) was observed from V_4 (Diamant) which was significantly different from all other varietal performance at 0, 20, 40 and 60 DAS. Vaezzadeh and Naderidarbaghshahi (2012), observed similar trend in experimentation of five varieties.

Performance on different organic manure with different level of chemical fertilizers applications for the present study had also significant variation on TSS of potato at different days after harvest (Table 4.4.1). The highest TSS (6.29, 5.83, 5.35 and 6.10 at 0, 20, 40 and 60 DAS, respectively) was observed from O_0 (100% RDF) which was closely followed by O_1 (50% RDF + Cowdung) at 60 DAS. On the other hand, the lowest TSS (5.790, 5.510, 5.130 and 5.890) was found O_3 (50% RDF + ACI organic manure) which were significantly different from all other treatments.

Combined effect of variety and organic manure applications on TSS had also significant influence at different DAS (Table 4.4.2). The highest TSS (6.95 and 6.20 at 20 and 40 DAS, respectively) was observed from V_3O_1 which was closely followed by V_3O_0 at 20, 40 and 60 DAS, respectively. On the other hand, the lowest TSS (4.80 and 4.20) was found from V_4O_1 at 0 and 40 DAS, respectively which was closely followed by V_4O_2 and V_4O_0 at 20 and 60 DAS, respectively.

Table 4.4.1: Single effect of variety and organic manure on total soluble solids (TSS) of potato

Variety	TSS			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1	6.400 ab	5.313 c	5.238 b	5.925 c
V_2	6.363 b	6.000 b	5.113 c	6.100 b
V_3	6.450 a	6.663 a	6.000 a	6.188 a
V_4	5.088 d	5.125 d	4.750 e	5.700 d
V_5	5.538 c	5.363 c	4.975 d	6.150 ab
$LSD_{(0.05)}$	0.075	0.075	0.074	0.064
Organic manure				
O_0	6.290 a	5.830 a	5.350 a	6.100 a
O_1	5.810 c	5.720 b	5.200 b	6.050 ab
O_2	5.980 b	5.710 b	5.180 bc	6.010 b
O_3	5.790 c	5.510 c	5.130 c	5.890 c
$LSD_{(0.05)}$	0.067	0.067	0.066	0.057
CV (%)	1.51	1.58	1.72	1.28

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

Table 4.4.2: Combined effect of variety and organic manure on total soluble solids (TSS) of potato

Variety × Organic manure	TSS			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1O_0	7.15 a	5.35 h	5.45 c	5.90 fg
V_1O_1	6.00 h	5.10 ij	5.50 c	6.05 c-e
V_1O_2	6.20 fg	5.30 h	5.00 fg	5.95 ef
V_1O_3	6.25 f	5.50 fg	5.00 fg	5.80 g
V_2O_0	6.80 c	6.15 c	5.30 d	6.30 b
V_2O_1	6.05 h	6.00 d	5.15 e	6.05 c-e
V_2O_2	6.60 d	6.05 cd	5.05 ef	5.95 ef
V_2O_3	6.00 h	5.80 e	4.95 f-h	6.10 cd
V_3O_0	6.00 h	6.95 a	6.10 a	6.45 a
V_3O_1	7.00 b	6.95 a	6.20 a	6.15 c
V_3O_2	6.40 e	6.65 b	5.85 b	6.10 cd
V_3O_3	6.40 e	6.10 cd	5.85 b	6.05 c-e
V_4O_0	5.40 j	5.30 h	4.90 gh	5.45 h
V_4O_1	4.80 n	5.15 i	4.20 I	5.95 ef
V_4O_2	5.15 l	5.00 j	5.05 ef	6.05 c-e
V_4O_3	5.00 m	5.05 ij	4.85 h	5.35 h
V_5O_0	6.10 gh	5.40 gh	5.00 fg	6.40 ab
V_5O_1	5.20 kl	5.40 gh	4.95 f-h	6.05 c-e
V_5O_2	5.55 i	5.55 f	4.95 f-h	6.00 d-f
V_5O_3	5.30 jk	5.10 ij	5.00 fg	6.15 c
$LSD_{(0.05)}$	0.149	0.149	0.148	0.127
CV (%)	1.51	1.58	1.72	1.28

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

4.5 Firmness

Firmness was significantly influenced by different test varieties of potato at different days after storing (DAS) (Table 4.5.1). The highest firmness (48.311, 45.840, 43.268 and 38.24 at 0, 20, 40 and 60 DAS, respectively) was found from V_4 (Diamant) which was closely followed by V_1 (Asterix) at 0, 20 and 60 DAS. Again, the lowest firmness (45.197, 40.514 and 37.359 at 0, 20 and 40 DAS, respectively) was found from V_5 (BARI TPS-1) which was closely followed by V_3 (Courage) at 0 and 60 DAS. Ismail (1988), observed this kind of physical properties in potato varieties.

Firmnessat different organic manure applications was not significantly influenced at different days after harvest (DAS) (Table 4.5.1).But results indicated that numerically the highest firmness (43.634, 40.160 and 37.39 at 20, 40 and 60 DAS, respectively) was observed from O_1 (50% RDF + Cowdung) and the lowest firmness (41.936 and 36.23 at 20 and 60 DAS, respectively) was found from O_2 (50% RDF + Poultry litter). On the other hand, significant result has been observed at 0 DAS, the highest firmness (47.251) and the lowest firmness (45.231) was found from O_1 (50% RDF + Cowdung) and O_2 (50% RDF + Poultry litter) respectively.

Combined effect of variety and organic manure applications on firmness had also significant influence at different DAS (Table 4.5.2). The highest firmness has been observed from V_4O_0 at 0 and 20 DAS but at 40 and 60 DAS, the highest firmness has been observed from V_4O_1 and V_1O_1 respectively. The lowest firmness has been observed from V_5O_0 at 40 and 60 DAS but at 0 and 20 DAS the lowest firmness has been observed from V_5O_2 and V_3O_2 respectively.

Table 4.5.1: Single effect of variety and organic manure on firmness of potato

Variety	Firmness			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1	47.945 a	43.308 ab	39.489 b	36.22 ab
V_2	44.932 b	42.793 bc	39.420 b	37.72 ab
V_3	45.981 b	42.074 bc	37.837 b	35.20 b
V_4	48.311 a	45.840 a	43.268 a	38.24 a
V_5	45.197 b	40.514 c	37.359 b	35.43 ab
$LSD_{(0.05)}$	1.907	2.632	2.632	2.940
Organic manure				
O_0	46.743 ab	43.349	39.532	36.32
O_1	47.251 a	43.634	40.160	37.39
O_2	45.231 b	41.936	38.907	36.23
O_3	46.667 ab	42.703	39.299	36.30
$LSD_{(0.05)}$	1.706	ns	ns	ns
CV (%)	4.97	7.42	8.07	9.73

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

Table 4.5.2: Combined effect of variety and organic manure on firmness of potato

Variety × Organic manure	Firmness			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1O_0	47.42 b-e	43.68 a-d	38.02 c-f	35.73 a-d
V_1O_1	50.05 ab	43.46 a-d	41.34 a-e	39.21 a
V_1O_2	48.80 a-c	44.67 a-c	39.59 a-f	37.13 ab
V_1O_3	45.51 c-g	41.42 b-d	39.02 b-f	32.81 b-d
V_2O_0	43.98 e-g	42.10 b-d	39.83 a-f	37.14 ab
V_2O_1	45.90 c-f	44.11 a-d	41.10 a-e	37.81 ab
V_2O_2	44.73 d-g	40.16 cd	38.87 b-f	36.52 a-c
V_2O_3	45.12 c-g	44.81 a-c	37.89 c-f	39.42 a
V_3O_0	46.89 b-f	42.75 a-d	40.73 a-e	31.12 cd
V_3O_1	46.45 b-f	45.28 a-c	36.88 d-f	35.81 a-d
V_3O_2	45.07 c-g	39.04 d	37.21 d-f	38.89 a
V_3O_3	45.52 c-g	41.23 b-d	36.54 ef	35.00 a-d
V_4O_0	51.95 a	47.68 a	43.77 ab	37.36 ab
V_4O_1	45.51 c-g	44.67 a-c	44.70 a	39.26 a
V_4O_2	45.74 c-f	45.34 a-c	41.98 a-d	38.51 ab
V_4O_3	50.06 ab	45.68 ab	42.63 a-c	37.84 ab
V_5O_0	43.49 fg	40.54 b-d	35.33 f	30.11 d
V_5O_1	48.35 a-d	40.66 b-d	36.79 d-f	40.27 a
V_5O_2	41.83 g	40.48 b-d	36.89 d-f	34.89 a-d
V_5O_3	47.13 b-f	40.39 cd	40.44 a-f	36.44 a-c
$LSD_{(0.05)}$	3.814	5.263	5.264	5.881
CV (%)	4.97	7.42	8.07	9.73

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

4.6 Weight loss percentage (%)

Percent (%) weight loss was significantly influenced by different varieties at different days after harvest (DAS) (Table 4.6.1). Results revealed that the highest % weight loss (0.952, 2.610 and 5.969 at 20, 40 and 60 DAS, respectively) was observed from V_1 (Asterix) which was closely followed by V_4 (Diamant). On the other hand, the lowest % weight loss (0.506, 1.388 and 3.176) was found from V_2 (Lady rosetta) which was significantly different from all other varieties. Rasul *et al.* (1997) and Hossain *et al.* (1992) observed, similar pattern of weight loss in ambient storage.

Percent (%) weight loss at different organic manure applications were significantly influenced at different days after storing (DAS) (Table 4.6.1). The highest percent weight loss (0.821, 2.253 and 5.164 at 20, 40 and 60 DAS, respectively) has been observed from O_3 (50% RDF + ACI organic manure) which was closely followed by O_1 (50% RDF + Cowdung) and O_2 (50% RDF + Poultry litter). On the other hand, the lowest percent weight loss (0.698, 1.911 and 4.369 at 20, 40 and 60 DAS, respectively) was found from O_0 (100% RDF) which was significantly different from all other treatments.

Combined effect of variety and organic manure applications on percent weight loss had also significant influence at different DAS (Table 4.6.2).The highest percent (%) weight loss has been observed from V_1O_2 at 0, 20, 40 and 60 DAS, respectively which was closely followed by V_3O_2 and V_4O_1 at 0, 20, 40 and 60 DAS, respectively. On the other hand, the lowest percent (%) weight loss has been observed from V_5O_0 at 40 and 60 DAS which was closely followed by V_2O_1 at 20, 40 and 60 DAS.

Table 4.6.1: Single effect of variety and organic manure on weight loss (%) of potato

Variety	Weight loss (%)		
	20 DAS	40 DAS	60 DAS
V_1	0.952 a	2.610 a	5.969 a
V_2	0.506 d	1.388 c	3.176 c
V_3	0.777 b	2.129 b	4.911 b
V_4	0.935 a	2.563 a	5.864 a
V_5	0.717 c	1.962 b	4.486 b
$LSD_{(0.05)}$	0.059	0.208	0.504
Organic manure			
O_0	0.698 b	1.911 b	4.369 b
O_1	0.776 a	2.127 a	4.892 a
O_2	0.815 a	2.230 a	5.099 a
O_3	0.821 a	2.253 a	5.164 a
$LSD_{(0.05)}$	0.053	0.186	0.451
CV (%)	9.15	11.81	12.49

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

Table 4.6.2: Combined effect of variety and organic manure on weight loss % of potato

Variety × Organic manure	Weight loss %		
	20 DAS	40 DAS	60 DAS
V_1O_0	0.833 e	2.284 de	5.222 de
V_1O_1	0.896 de	2.457 cd	5.622 cd
V_1O_2	1.122 a	3.075 a	7.030 a
V_1O_3	0.958 b-d	2.624 b-d	5.999 b-d
V_2O_0	0.539 g	1.476 f-h	3.377 f-h
V_2O_1	0.420 h	1.157 h	2.651 h
V_2O_2	0.526 gh	1.442 gh	3.300 gh
V_2O_3	0.538 g	1.475 f-h	3.374 f-h
V_3O_0	0.688 f	1.879 ef	4.293 e-g
V_3O_1	0.666 f	1.818 fg	4.289 e-g
V_3O_2	1.074 ab	2.942 ab	6.726 ab
V_3O_3	0.682 f	1.877 ef	4.335 ef
V_4O_0	0.934 c-e	2.560 b-d	5.855 b-d
V_4O_1	1.014 a-c	2.780 a-c	6.359 a-c
V_4O_2	0.825 e	2.259 de	5.167 de
V_4O_3	0.967 b-d	2.652 b-d	6.075 a-d
V_5O_0	0.494 gh	1.355 h	3.099 h
V_5O_1	0.883 de	2.422 cd	5.540 cd
V_5O_2	0.529 gh	1.432 gh	3.270 h
V_5O_3	0.962 b-d	2.638 b-d	6.036 a-d
$LSD_{(0.05)}$	0.118	0.416	1.008
CV (%)	9.15	11.81	12.49

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

4.7 Specific gravity (g cm^{-3})

Specific gravity of different potato varieties was significantly influenced at different days after harvest (DAS) (Table 4.7.1). The highest specific gravity (1.05, 1.05, 1.07 and 1.22g cm^{-3} at 0, 20, 40 and 60 DAS, respectively) was observed from V_2 (Lady rosetta) which was closely followed by V_3 (Courage) at 0 and 60 DAS. On the other hand, the lowest specific gravity (1.04, 1.05, 1.06 and 1.08 at 0, 20, 40 and 60 DAS, respectively) was found from V_5 (BARI TPS-1). Jannatul (2015) showed the similar trend.

Specific gravity at different organic manure with different proportion of chemical fertilizers applications was significantly influenced at different days after storing (DAS) (Table 4.7.1). The highest specific gravity (1.05, 1.06, 1.07 and 1.17 at 0, 20, 40 and 60 DAS, respectively) has been observed from O_3 (50% RDF + ACI organic manure) which were closely followed by O_0 (100% RDF) at 0 and 60 DAS. These results have close proximity with those reported by Verma *et al.* (1975) and Pervez *et al*. (2000).

Combined effect of variety and organic manure applications on specific gravity had also significant influence at different DAS (Table 4.7.2). The highest specific gravity has been observed from V_2O_3 at 0 and 20 DAS but at 40 and 60 DAS V_1O_3 and V_2O_1 shows the highest specific gravity which was closely followed by V_3O_3 at 0, 20 and 60 DAS. On the other hand, the lowest specific gravity has been observed from V_5O_2 at 0, 40 and 60 DAS which was closely followed by V_3O_2 at 0, 20, 40 and 60 DAS.

Table 4.7.1: Single effect of variety and organic manure on specific gravity of potato

Variety	Specific gravity (g cm^{-3})			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1	1.0492 ab	1.0525 b	1.0700 a	1.0834 b
V_2	1.0508 a	1.0550 a	1.0700 a	1.2157 a
V_3	1.0458 ab	1.0524 b	1.0625 c	1.1836 ab
V_4	1.0425 b	1.0525 b	1.0674 b	1.0825 b
V_5	1.0425 b	1.0500 c	1.0637 c	1.0858 b
$LSD_{(0.05)}$	0.0071	0.0024	0.0021	0.120
Organic manure				
O_0	1.0493 a	1.0530 b	1.0659 b	1.0817 ab
O_1	1.0420 b	1.0510 b	1.0650 bc	1.1877 a
O_2	1.0420 b	1.0440 c	1.0640 c	1.0789 b
O_3	1.0513 a	1.0619 a	1.0720 a	1.1726 ab
$LSD_{(0.05)}$	0.0063	0.0021	0.0019	0.107
CV (%)	0.82	0.27	0.24	12.84

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

Table 4.7.2: Combined effect of variety and organic manure on specific gravity of potato

Variety × Organic manure	Specific gravity (g cm^{-3})			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1O_0	1.0600 ab	1.0600 b	1.0600 f	1.0800 b
V_1O_1	1.0400 d-f	1.0600 b	1.0700 d	1.0850 b
V_1O_2	1.0533 a-d	1.0400 f	1.0650 e	1.0795 b
V_1O_3	1.0433 c-f	1.0500 d	1.0850 a	1.0892 b
V_2O_0	1.0500 b-e	1.0500 d	1.0700 d	1.0850 b
V_2O_1	1.0400 d-f	1.0450 e	1.0700 d	1.6133 a
V_2O_2	1.0467 b-f	1.0500 d	1.0800 b	1.0850 b
V_2O_3	1.0667 a	1.0750 a	1.0600 f	1.0795 b
V_3O_0	1.0400 d-f	1.0450 e	1.0550 g	1.0745 b
V_3O_1	1.0467 b-f	1.0500 d	1.0600 f	1.0750 b
V_3O_2	1.0367 ef	1.0400 f	1.0550 g	1.0700 b
V_3O_3	1.0600 ab	1.0745 a	1.0800 b	1.5150 a
V_4O_0	1.0400 d-f	1.0500 d	1.0695 d	1.0750 b
V_4O_1	1.0433 c-f	1.0550 c	1.0650 e	1.0850 b
V_4O_2	1.0400 d-f	1.0450 e	1.0650 e	1.0800 b
V_4O_3	1.0467 b-f	1.0600 b	1.0700 d	1.0900 b
V_5O_0	1.0567 a-c	1.0600 b	1.0750 c	1.0938 b
V_5O_1	1.0400 d-f	1.0450 e	1.0600 f	1.0800 b
V_5O_2	1.0333 f	1.0450 e	1.0550 g	1.0800 b
V_5O_3	1.0400 d-f	1.0500 d	1.0650 e	1.0892 b
$LSD_{(0.05)}$	0.014	0.0047	0.0042	0.240
CV (%)	0.82	0.27	0.24	12.84

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

4.8 Reducing sugar (mg/g FW)

Reducing sugar was significantly influenced by different test varieties at different days after harvest (DAS) (Table 4.8.1).The highest reducing sugar (0.567, 0.624, 1.793 and 1.336 mg/g FW at 0, 20, 40 and 60 DAS, respectively) was observed from V_2 (Lady rosetta) which was statistically similar with V_5 (BARI TPS-1) at 0 and 20 DAS but statistically similar with V_5 (BARI TPS-1) at 40 and 60 DAS. On the other hand, the lowest reducing sugar has been observed from V_1 (Asterix) which was statistically different from all other varieties. Similar result was also observed by Kassim *et al.* (2014) and Shock *et al.* (1993).

Reducing sugar was significantly influenced by different organic manure with RDF applications at different days after harvest (DAS) (Table 4.8.1).The highest reducing sugar (0.525, 0.577, 1.731 and 1.274 mg/g FW at 0, 20, 40 and 60 DAS, respectively) was found from O_3 (50% RDF + ACI organic manure) which was statistically similar with O_0 (100% RDF) at 0 and 20 DAS but statistically similar with O_0 (50% RDF + Cowdung) at 40 and 60 DAS. On the other hand, the lowest reducing sugar (0.453, 0.498, 1.528 and 1.072 mg/g FW at 0, 20, 40 and 60 DAS, respectively) was found from O_2 (50% RDF + Poultry litter) which was closely followed by O_1 (50% RDF + Cowdung) at 0, 20, 40 and 60 DAS. Similar results have been observed by Jaipaul *et al.*(2011).

Combined effect of variety and organic manure applications on reducing sugar had also significant influence at different DAS (Table 4.8.2). The highest reducing sugar (0.647, 0.712, 1.983 and 1.527 mg/g FW) was found from V_2O_0 at 0 and 20 DAS ; V_5O_2 at 40 and 60 DAS, respectively and both treatments are closely similar with each other at different days after harvest. On the other hand, the lowest reducing sugar (0.242, 0.266, 1.065 and 0.608 mg/g Fw at 0, 20, 40 and 60 DAS, respectively) was found from V_1O_2 which was significantly different at 0and 20 DAS from all other treatments but at 40 and 60 DAS this treatment was closely followed by V_3O_1.

Table 4.8.1: Single effect of variety and organic manure on reducing sugar content of potato

Variety	Glucose content (mg/g FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1	0.381 c	0.419 c	1.324 c	0.867 c
V_2	0.567 a	0.624 a	1.793 a	1.336 a
V_3	0.504 b	0.554 b	1.663 ab	1.206 ab
V_4	0.489 b	0.538 b	1.615 b	1.158 b
V_5	0.551 ab	0.606 ab	1.776 a	1.320 a
$LSD_{(0.05)}$	0.062	0.068	0.161	0.161
Organic manure				
O_0	0.513 a	0.564 a	1.656 ab	1.199 ab
O_1	0.503 ab	0.554 ab	1.621 ab	1.165 ab
O_2	0.453 b	0.498 b	1.528 b	1.072 b
O_3	0.525 a	0.577 a	1.731 a	1.274 a
$LSD_{(0.05)}$	0.055	0.061	0.144	0.144
CV (%)	15.02	15.02	11.91	16.53

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

Table 4.8.2: Combined effect of variety and organic manure on reducing sugar content of potato

Variety × Organic manure	Glucose content (mg/g FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1O_0	0.451 c-g	0.496 c-g	1.489 c-f	1.032 c-f
V_1O_1	0.401 g	0.441 g	1.323 e-g	0.866 e-g
V_1O_2	0.242 h	0.266 h	1.065 g	0.608 g
V_1O_3	0.430 e-g	0.473 e-g	1.418 ef	0.961 ef
V_2O_0	0.647 a	0.712 a	1.955 a	1.498 a
V_2O_1	0.594 ab	0.654 ab	1.827 ab	1.371 ab
V_2O_2	0.488 b-g	0.537 b-g	1.610 b-e	1.154 b-e
V_2O_3	0.539 a-e	0.593 a-e	1.779 a-d	1.323 a-d
V_3O_0	0.571 a-c	0.628 a-c	1.885 ab	1.428 ab
V_3O_1	0.390 g	0.429 g	1.286 fg	0.829 fg
V_3O_2	0.491 b-g	0.540 b-g	1.620 b-e	1.164 b-e
V_3O_3	0.563 a-d	0.620 a-d	1.859 ab	1.403 ab
V_4O_0	0.445 d-g	0.490 d-g	1.470 d-f	1.013 d-f
V_4O_1	0.545 a-e	0.600 a-e	1.800 a-c	1.343 a-c
V_4O_2	0.413 fg	0.454 fg	1.363 e-g	0.907 e-g
V_4O_3	0.554 a-d	0.609 a-d	1.827 ab	1.370 ab
V_5O_0	0.449 c-g	0.493 c-g	1.480 c-f	1.024 c-f
V_5O_1	0.587 ab	0.646 ab	1.870 ab	1.414 ab
V_5O_2	0.630 a	0.693 a	1.983 a	1.527 a
V_5O_3	0.537 a-f	0.590 a-f	1.771 a-d	1.314 a-d
$LSD_{(0.05)}$	0.124	0.136	0.322	0.322
CV (%)	15.02	15.02	11.91	16.53

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

4.9 Sucrose content (mg/g FW)

Sucrose content was significant influenced by different test varieties at different days after harvest (DAS) (Table 4.9.1). The highest sucrose content (3.137, 6.144, 7.388 and 7.092 mg/g FW at 0, 20, 40 and 60 DAS, respectively) was found from V_2 (Lady rosetta) which was significantly different from all other varieties. On the other hand, the lowest sucrose content (2.244, 4.343, 5.402 and 5.098 mg/g FW at 0, 20, 40 and 60 DAS, respectively) was found from V_2 (Lady rosetta) which was significantly different from all other varieties. Similar result was also observed by Kassim *et al.*(2014) and Sieczka and Maatta (1986).

Sucrose content was significant influenced by different organic manure applications at different days after harvest (DAS) (Table 4.9.1). The highest sucrose content (2.786, 5.427, 6.594 and 6.301 mg/g FW at 0, 20, 40 and 60 DAS, respectively) was found from O_3 (50% RDF + ACI organic manure) which was significantly different from all other varieties. On the other hand, the lowest sucrose content (2.637, 5.128, 6.263 and 5.950 mg/g FW at 0, 20, 40 and 60 DAS, respectively) was found from O_0 (100% RDF) which was significantly different from all organic manure treatments.

Combined effect of variety and organic manure applications on sucrose content had also significant influence at different DAS (Table 4.9.2). The highest sucrose content (3.340, 6.536, 7.766 and 7.520 mg/g FW at 0, 20, 40 and 60 DAS, respectively) was found from V_2O_2 which was significantly different from all other treatments. On the other hand, the lowest sucrose content (2.149, 4.147, 5.160 and 4.847 mg/g FW at 0, 20, 40 and 60 DAS, respectively) was found from V_1O_0 which was significantly different from all other treatments.

Table 4.9.1: Single effect of variety and organic manure on sucrose content of potato

Variety	Sucrose content (mg/g FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1	2.244 e	4.343 e	5.402 e	5.098 e
V_2	3.137 a	6.144 a	7.388 a	7.092 a
V_3	2.775 c	5.364 c	6.547 c	6.225 c
V_4	2.426 d	4.693 d	5.793 d	5.497 d
V_5	3.016 b	5.883 b	7.109 b	6.813 b
$LSD_{(0.05)}$	0.0197	0.015	0.035	0.011
Organic manure				
O_0	2.637 d	5.128 d	6.263 d	5.950 d
O_1	2.705 c	5.232 c	6.406 c	6.099 c
O_2	2.750 b	5.356 b	6.529 b	6.229 b
O_3	2.786 a	5.427 a	6.594 a	6.301 a
$LSD_{(0.05)}$	0.0176	0.013	0.031	0.0095
CV (%)	0.87	0.34	0.66	0.21

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1; O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

Table 4.9.2: Combined effect of variety and organic manure on sucrose content of potato

Variety × Organic manure	Sucrose content (mg/g FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1O_0	2.149 m	4.147 p	5.160 n	4.847 r
V_1O_1	2.260 k	4.366 n	5.437 l	5.157 p
V_1O_2	2.357 j	4.596 l	5.690 j	5.377 n
V_1O_3	2.211 l	4.263 o	5.323 m	5.010 q
V_2O_0	2.997 d	5.863 e	7.097 d	6.783 f
V_2O_1	3.107 c	6.060 d	7.313 c	7.000 d
V_2O_2	3.340 a	6.536 a	7.766 a	7.520 a
V_2O_3	3.103 c	6.116 c	7.377 c	7.063 c
V_3O_0	2.680 g	5.210 i	6.377 h	6.030 k
V_3O_1	2.824 f	5.430 h	6.620 g	6.307 i
V_3O_2	2.700 g	5.206 i	6.373 h	6.060 j
V_3O_3	2.896 e	5.610 f	6.817 e	6.503 g
V_4O_0	2.350 j	4.553 m	5.590 k	5.310 o
V_4O_1	2.470 i	4.757 k	5.913 i	5.600 m
V_4O_2	2.370 j	4.586 l	5.693 j	5.380 n
V_4O_3	2.514 h	4.876 j	5.977 i	5.697 l
V_5O_0	3.007 d	5.863 e	7.093 d	6.780 f
V_5O_1	2.867 e	5.546 g	6.747 f	6.433 h
V_5O_2	2.983 d	5.853 e	7.120 d	6.807 e
V_5O_3	3.206 b	6.270 b	7.476 b	7.230 b
$LSD_{(0.05)}$	0.039	0.029	0.070	0.0213
CV (%)	0.87	0.34	0.66	0.21

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

4.10 Starch content (mg/g FW)

Starch content was significantly influenced by different test varieties at different days after harvest (DAS) (Table 4.10.1). The highest starch content (26.462, 26.462, 22.631 and 11.563 at 0, 20, 40 and 60 DAS, respectively) was found from V_2 (Lady rosetta) which was closely followed by V_4 (Diamant) at 0, 20 and 40 DAS but significantly different from all other varieties at 60 DAS. On the other hand, the lowest starch content (18.902, 18.902, 16.637 at 0, 20 and 40 DAS, respectively) was found from V_5 (BARI TPS-1) which was closely followed by V_1 (Asterix) but the lowest starch content (6.566 mg/g FW)at 60 DAS was found from V_1 (Asterix) which was significantly different than all other varieties. Jannatul (2015) showed the similar result.

Starch content was significantly influenced by different organic manure applications at 40 and 60 days after harvest (DAS) (Table 4.10.1). The highest starch content (22.649 and 10.393 mg/g FW at 40 and 60 DAS) was found from O_3 (50% RDF + ACI organic manure) which was significantly different from all other organic manure treatments. On the other hand, the lowest starch content (18.634 and 8.476 mg/g FW at 40 and 60 DAS) was found from O_1 (50% RDF + Cowdung) which was closely followed by O_2 (50% RDF + Poultry litter). Jaipaul (2011) and Jannatul (2015) observed similar results.

Combined effect of variety and organic manure applications on starch content had also significant influence at different DAS (Table 4.10.2). The highest starch content (30.826 mg/g FW) was found from V_4O_3at 0 and 40 DAS which was closely followed by V_2O_0. O the other hand, the lowest starch content (14.521 mg/g FW) was found from V_5O_0 at 0 and 20 DAS which was closely followed by V_1O_1.

Table 4.10.1: Single effect of variety and organic manure on starch content of potato

Variety	Starch content (mg/g FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1	19.733 b	19.733 b	19.565 ab	6.566 d
V_2	26.462 a	26.462 a	22.631 a	11.563 a
V_3	24.260 a	24.260 a	19.089 ab	8.832 c
V_4	26.060 a	26.060 a	19.228 ab	9.597 bc
V_5	18.902 b	18.902 b	16.637 b	10.330 b
$LSD_{(0.05)}$	3.355	3.355	4.166	0.878
Organic manure				
O_0	21.781	21.781	19.443 ab	9.493 b
O_1	23.501	23.501	18.634 b	8.476 c
O_2	22.755	22.755	16.994 b	9.148 bc
O_3	24.296	24.296	22.649 a	10.393 a
$LSD_{(0.05)}$	ns	ns	3.726	0.785
CV (%)	26.88	17.58	25.94	11.33

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

Table 4.10.2: Combined effect of variety and organic manure on starch content of potato

Variety × Organic manure	Starch content (mg/g FW)			
	0 DAS	20 DAS	40 DAS	60 DAS
V_1O_0	20.256 d-g	20.256 d-g	13.843 e-g	6.400 l-n
V_1O_1	18.045 e-g	18.045 e-g	15.861 d-g	4.842 n
V_1O_2	17.463 fg	17.463 fg	17.958 d-f	6.033 mn
V_1O_3	23.167 b-f	23.167 b-f	30.599 ab	8.989 f-j
V_2O_0	27.135 a-c	27.135 a-c	31.600 a	9.922 d-h
V_2O_1	25.310 a-d	25.310 a-d	22.749 b-d	11.001 c-e
V_2O_2	30.578 a	30.578 a	18.343 d-f	11.674 b-d
V_2O_3	22.825 b-f	22.825 b-f	17.833 d-f	13.653 a
V_3O_0	24.118 a-f	24.118 a-f	18.152 d-f	7.193 k-m
V_3O_1	25.415 a-d	25.415 a-d	22.833 b-d	8.871 g-k
V_3O_2	24.596 a-e	24.596 a-e	8.640 g	10.274 d-g
V_3O_3	22.908 b-f	22.908 b-f	26.732 a-c	8.989 f-j
V_4O_0	22.876 b-f	22.876 b-f	18.177 d-f	10.685 c-f
V_4O_1	29.021 ab	29.021 ab	19.043 c-f	8.084 i-l
V_4O_2	21.519 c-f	21.519 c-f	21.416 c-e	7.532 j-m
V_4O_3	30.826 a	30.826 a	18.274 d-f	12.088 a-c
V_5O_0	14.521 g	14.521 g	15.445 d-g	13.266 ab
V_5O_1	19.711 d-g	19.711 d-g	12.684 fg	9.582 e-i
V_5O_2	19.621 d-g	19.621 d-g	18.614 c-f	10.227 d-g
V_5O_3	21.754 c-f	21.754 c-f	19.806 c-f	8.246 h-k
$LSD_{(0.05)}$	6.709	6.709	8.332	1.756
CV (%)	26.88	17.58	25.94	11.33

In a column means having similar letter (s) are statistically similar at 5% level of significance and those having dissimilar letter (s) differ significantly

V_1 = Asterix, V_2= Lady rosetta , V_3=Courage, V_4=Diamant, V_5= BARI TPS-1;
O_0 = 100% RDF, O_1 = 50% RDF + Cowdung, O_2 = 50% RDF + Poultry litter, O_3 = 50% RDF + ACI Organic manure

CHAPTER V

SUMMARY AND CONCLUSION

An experiment was conducted at the Agricultural farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November, 2014 to April, 2015 to study the yield and quality of potato (*Solanum tuberosum* L.) as influenced by different organic manures and their performance in ambient condition. The experiment comprised of two factors namely 1) five different potato varieties (Asterix, Lady rosetta, Courage, Diamant and BARI TPS-1) and 2) four organic manure applications (100% recommended fertilizer, 50% RDF + Cowdung, 50% RDF + Poultry litter and 50% RDF + ACI organic manure). The experiment consisting of 20 treatment combinations was laid out in the Randomized Complete Block Design (RCBD) with three replications. Sprouted seed tubers were planted in the field on 27 November 2014. Observations were made on yield and quality of storage. The collected data were analyzed using MSTAT-C computerized program and the mean differences among the treatments were compared by Least Significant Differences (LSD) test and 5% level of significance.

Different varietal treatments played important role on the yield and storage quality of potato. Variety V_4 (Diamant) showed highest tuber yield (t/ha), highest weight of marketable tuber (t/ha), highest firmness; the variety V_5 (BARI TPS-1) showed the highest nonmarketable yield (t/ha), the highest nonseed tuber (t/ha) with lowest yield (t/ha), weight of marketable tuber, dry matter, specific gravity and starch content. But V_2 (Lady rosetta) showed the highest dry matter, specific gravity, glucose and sucrose content with lowest firmness and percent weight loss.

In terms of organic manure applications, different organic manure practices showed different results. The O_0 (100% recommended fertilizer) showed the highest tuber yield (t/ha), highest weight of marketable tuber (t/ha), highest number of total seed, total soluble solids (TSS) with lowest sucrose content and weight loss percentage. The organic manure practices O_3 (50% RDF + ACI organic manure) showed highest dry matter content, highest specific gravity, highest reducing sugar content, highest sucrose and highest starch content. But O_1 (50% RDF + Cowdung) showed the lowest tuber yield (t/ha), lowest number of total seed, lowest dry matter content, lowest specific gravity, lowest starch content with highest firmness.

In case of combined effect variety and organic manure applications; different treatment combination gave different responses. The treatment combination of V_4O_0(Diamant x 100% RDF) showed the highest tuber yield (t/ha), where V_2O_3(Lady rosetta x 50% RDF + ACI organic manure) showed the highest dry matter content, highest specific gravity, highest reducing sugar content and highest starch content.

The following conclusions could be drawn from the results of the present experiment:

1. Considering yield of potato, variety V_4 (Diamant) gave the best performance and the variety V_2 (Lady rosetta) gave satisfactory results for quality.
2. In case of organic manure applications, O_3 (50% RDF + ACI organic manure) showed the best performance for the maximum parameters and O_0 (100% recommended fertilizer) also gave satisfactory results.
3. In terms of combined effect of variety and organic manure applications; V_4O_0 (Diamant x 100% RDF) showed best results in respect of tuber yield but V_2O_3 (Lady rosetta x 50% RDF + ACI organic manure) was good for quality of potato.

From this experiment, it can be concluded that adequate measures regarding these factors can improve potato yield with good quality at great extent. More research should be undertaken for further improvement of this crop.

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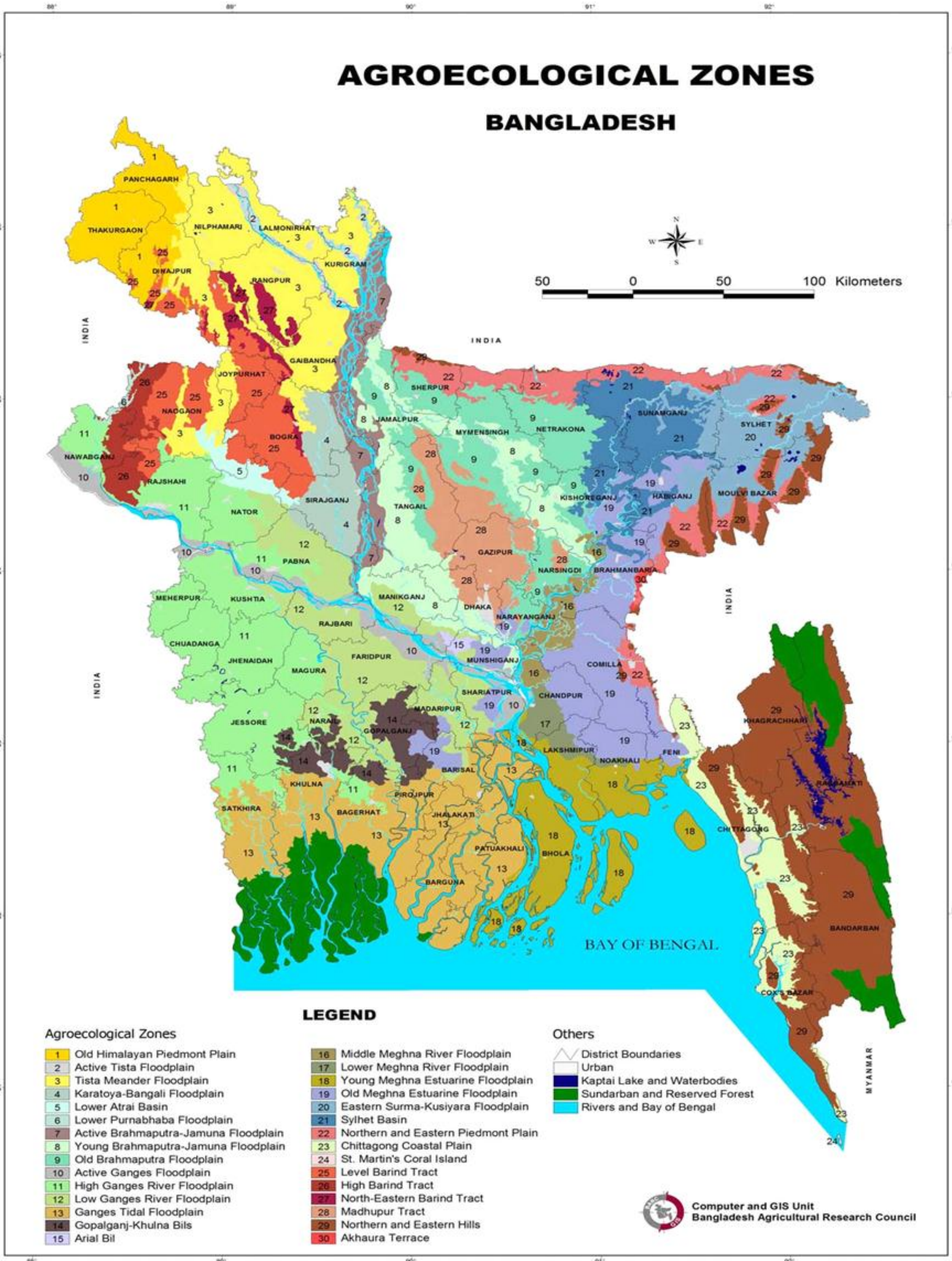
APPENDICES

Appendix I: Map showing the site used for present study



Appendix II. Monthly meteorological information during the period from November, 2014 to April, 2015

Year	Month	Air temperature (^{0}C)		Relative humidity (%)	Total rainfall (mm)	Total sunshine per day(hrs)
		Maximum	Minimum			
2014-2015	November	28.10	15.83	58.18	47	5.5
	December	25.00	15.46	69.53	0	6
	January	23.98	11.47	73.86	0	5
	February	26.45	31.83	75.38	37	4
	March	30.45	23.36	69.44	59	3.9
	April	35.93	42.35	73.92	103	4.1

Source: Bangladesh Meteorological Department (Climate & weather division), Agargoan, Dhaka – 1212

Appendix III. Mean square values for yield and yield contributing characters of potato

Sources of variation	Degrees of freedom	Mean Square					
		Yield (t ha^{-1})	Total no. of tuber	No. of marketable tuber	Weight of marketable tuber (t ha^{-1})	No. of non-marketable tuber	Weight of non-marketable tuber (t ha^{-1})
Replication	2	318.035	0.96337	1.57264	310.118	0.53695	0.18210
Variety	4	130.160*	3.98514**	6.29483**	137.149*	2.40707**	0.16532*
Organic manure	3	515.546**	8.77265**	6.11526**	513.913**	0.90445**	0.18750**
Variety × Organic manure	12	99.092*	1.47139*	1.16415*	99.834*	0.20623*	0.05227*
Error	38	56.056	0.90761	0.94305	56.433	0.15965	0.06354

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

Appendix IV. Mean square values for number and weight of seed and non-seed tuber of potato

Sources of variation	Degrees of freedom	Mean Square			
		No. of total seed tuber	Weight of total seed tuber	No. of total non-seed tuber	Weight of total non-seed tuber
Replication	2	1.24482	23.3541	0.03345	1.53114
Variety	4	6.06126**	18.3625**	1.83767**	1.97485*
Organic manure	3	4.50120**	34.3312**	1.30381**	3.05583**
Variety × Organic manure	12	1.07700*	8.2736**	0.15869**	1.91457*
Error	38	0.80456	3.9978	0.07555	1.06625

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

Appendix V. Mean square values for dry matter and TSS content of potato

Sources of variation	Degrees of freedom	Mean Square							
		Dry matter content (%)				Total soluble solids (TSS)			
		0 DAS	20 DAS	40 DAS	60 DAS	0 DAS	20 DAS	40 DAS	60 DAS
Replication	2	31.3423	14.6862	3.9078	35.6703	0.02813	0.02813	0.01250	0.00013
Variety	4	28.7265**	26.6593**	23.7017**	18.8822**	4.60556**	4.83244**	2.70319**	0.48750**
Organic manure	3	4.1355*	3.9067*	3.5848*	3.0355*	0.80237**	0.26638**	0.13450**	0.12038**
Variety × Organic manure	12	11.3697**	10.6044**	9.5160**	7.7290**	0.41206**	0.13044**	0.17044**	0.13475**
Error	38	2.2698	2.1393	1.9540	1.6135	0.00813	0.00812	0.00803	0.00591

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

Appendix VI. Mean square values for firmnessand weight loss %of potato at different DAS

Sources of variation	Degrees of freedom	Mean Square						
		Firmness				Weight loss %		
		0 DAS	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
Replication	2	5.1761	1.3629	2.0838	8.9750	0.08752	4.59038	40.6321
Variety	4	29.3775**	45.5938**	64.6386**	22.2425*	0.39785**	2.99145**	15.6427**
Organic manure	3	11.2887*	8.5417 ^{ns}	4.1304 ^{ns}	4..6340 ^{ns}	0.04850**	0.36610**	1.9463**
Variety × Organic manure	12	15.6874**	8.9798*	9.3071*	26.8864**	0.07938**	0.59985**	3.0797**
Error	38	5.3244	10.1392	10.1402	12.6569	0.00506	0.06331	0.3715

**: Significant at 0.01 level of probability *: Significant at 0.05 level of probability ns: non-significant

Appendix VII. Mean square values for specific gravity and glucose content of potato at different DAS

Sources of variation	Degrees of freedom	Mean Square							
		Specific gravity (g cm^{-3})				Glucose content (mg/g FW)			
		0 DAS	20 DAS	40 DAS	60 DAS	0 DAS	20 DAS	40 DAS	60 DAS
Replication	2	0.0001517	0.00004504	0.0001013	0.00356	0.00757	0.00916	0.06510	0.29294
Variety	4	0.0001733*	0.00003754**	0.0001457**	0.04982*	0.06410**	0.07756**	0.42887**	0.42887**
Organic manure	3	0.0003572*	0.0008155**	0.0001945**	0.05042*	0.01491*	0.01805*	0.10567*	0.10567*
Variety × Organic manure	12	0.0002322**	0.0002468**	0.0002555**	0.07679**	0.02023**	0.02447**	0.14826**	0.14826**
Error	38	0.00007272	0.000008195	0.000006551	0.02105	0.00560	0.00678	0.03788	0.03788

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

Appendix VIII. Mean square values for sucrose and starch content of potato at different DAS

Sources of variation	Degrees of freedom	Mean Square							
		Sucrose content (mg/g FW)				Starch content (mg/g FW)			
		0 DAS	20 DAS	40 DAS	60 DAS	0 DAS	20 DAS	40 DAS	60 DAS
Replication	2	10.6634	30.6529	14.5807	14.1832	276.949	163.083	4.843	46.6207
Variety	4	1.7313**	7.0178**	8.5595**	8.5943**	228.161**	151.127**	54.669*	41.8016**
Organic manure	3	0.0624**	0.2643**	0.3183**	0.3568**	38.3394 ^{ns}	17.240 ^{ns}	84.644**	9.5508**
Variety × Organic manure	12	0.0334**	0.1331**	0.1419**	0.1628**	0.00001678**	32.208*	107.087**	9.8145 **
Error	38	0.0006	0.0003	0.0018	0.0002	1961.42	16.475	25.408	1.1289

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