INFLUENCE OF VERMICOMPOST ON GROWTH, YIELD AND PROCESSING QUALITY OF POTATO VARIETIES

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DEDICATED TO

MY

BELOVED PARENTS

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ABSTRACT

A field experiment was conducted at the Agronomy research field, Sher-e-Bangla Agricultural University, Dhaka from November 01, 2014 to April 30, 2015 to find out the effect of 4 different vermicompost (Vm) levels *viz*., Vm_1 - (control), Vm_2 - (2 t ha^{-1}), Vm_3 – (4 t ha^{-1}) and Vm_4 – (6 t ha^{-1}) on growth, yield and quality of 4 potato varieties *viz*., V_1-BARI TPS-1, V_2- BARI Alu-28 (Lady Rosetta), V_3- BARI Alu-29 (Courage), V_4 - BARI Alu-25 (Asterix). The experiment was conducted in spilt plot Design with 3 replications. The different levels of vermicompost had significant effect on most of the growth, yield and quality contributing parameters of potato irrespective of varieties. All parameters studied in this experiment were increased with the increasing vermicompost levels except water percentage. The variety 'BARI Alu-28' produced maximum yield (28.89 t ha^{-1}) whereas, 'BARI TPS-1' showed minimum yield (22.95 t ha^{-1}) irrespective of vermicompost levels and other growth, yield and processing characters also influenced by the different varieties. The results also revealed that the yield of potato varieties were increased with increasing vermicompost levels. 'BARI Alu-28' cultivated with vermicompost 6 t ha^{-1} performed the best results and the same variety with 4 t ha^{-1} also showed the statistically similar results in terms of growth, most of the yield and quality parameters. Among the 16 treatment combination maximum tuber weight (57.18 g) was produced in V_2Vm_4, and the variety Lady Rosetta produced highest yield (33.86 t ha^{-1}), highest marketable yield (28.78 t ha^{-1}) and also produced maximum seed tuber (25.40 t ha^{-1}) when cultivated with 6 t ha^{-1} vermicompost. Incase of dry matter, reducing sugar and starch content, Lady Rosetta showed the best performance compared to those other varieties when 6 t ha^{-1} vermicompost was applied.

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LIST OF ACCRONYMS AND ABBREVIATIONS

Adv	Advance

AEZ	Agro-Ecological Zone
Agric.	Agriculture
Agril.	Agricultural
Anon.	Anonymous
Appl.	Applied
As	Arsenic
Assoc	Association
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCF	Bio Concentration Factors
cm	Centi-meter
cm^2	Square centi-meter
CV	Coefficient of Variance
DAP	Days After Planting
Dev.	Devlopment
DMRT	Duncan's Multiple Range Test
Eng	Engineeri*ng*
Environ.	Environmental
et al.	And others
Expt.	Experimental
FAO	Food and Agriculture Organization
g	Gram (s)
$hill^{-1}$	Per hill
i.e.	*id est* (L), that is
Intl	International
j.	Journal
kg	Kilogram (s)
M.S	Master of Science
m^2	Meter squares
mg	Milligram
Res.	Research
SAU	Sher-e-Bangla Agricultural University
Sci.	Science
SE	Standard Error

LIST OF ACCRONYMS AND ABBREVIATIONS (Cont'd)

t ha^{-1}	Ton per hectare
TSS	Total Soluble Solids
UNDP	United Nations Development Programme
viz	Namely
WHO	World Health Organization
%	Percentage

Chapter 1

Introduction

CHAPTER I

INTRODUCTION

Potato (*Solanum tuberosum* L.) is herbaceous leading staple food crops of the world and it ranks next to wheat and rice. In Bangladesh, potato is a first leading vegetable crop and commercially grown in almost whole of the country. The probable place of origin is Peru and Bolivia. It was introduced to the Indian sub-continent during the first half of the 17th century. In Bangladesh, the cultivation of potato was started in the late 19 century but still average yield is very low compared to the leading potato growing countries (Hashem, 1990). The major constraints of such low yields viz. lack of quality and available seed tubers, high price of seed tubers, imbalanced fertilizations, no or less use of organic manures and sometimes low market value at the time of harvesting. Both chemical and organic manures fertilizers can play a major role to improve this situation (Asumus and Gorlitz, 1986). Ilin *et al.* (1992) also observed that application vermicompost increased tuber yield by 43 to 45.3 % over control.

There are few foods, which are as versatile as potato. Potato is a favourite food throughout the world, both in its fresh and processed forms. Potato is unique in a sense that it can fit into any meal. In world, Bangladesh ranks 7^{th} in potato production. The major potato growing districts in Bangladesh are; Rajshahi, Rangpur, Dinajpur and Munshigonj, however, the contribution of Munshigonj in potato production is prime (nearly 44%) in the country (Singh and

Lal, 2003).

The use of organic matter such as animal manures, human waste, food wastes, yard wastes, sewage sludge and composts has long been recognized in agriculture as beneficial for plant growth and yield and the maintenance of soil fertility. The new approaches to the use of Vermicompost in farming has proven to be effective means of improving soil structure, enhancing soil fertility and increasing crop yields. Organic matter are excellent source of plant-available nutrients and their addition to soil could maintain high microbial populations and activities with increased values of biomass C, basal respiration, biomass C:total organic C ratio, and metabolic quotient (CO_2). Crop yields have increased with corresponding improvements in soil quality from additions of organic matter. Significant yield increases using mulches from coffee husks (Bwamiki *et al.*, 1998) and increases in productivity using animal manures and hay residues have been reported. Their important roles in the soil and their potentially positive effect on crop yields have made organic amendments a valuable component of farm fertilization and management programs in alternative agriculture. Forms of organic matter used include crop residues as mulches, among others.

Vermicompost can be a good substitute for chemical fertilizers to overcome their adverse effects. Vermicomposts are finely-divided mature peat-like materials which are produced by a non-thermophylic process involving interactions between earthworms and microorganisms (Edwards and Burrows, 1988).

Vermicompost are finely divided peat-like materials with high porosity, aeration, drainage, water-holding capacity (Edwards and Burrows, 1988). They have greatly increased surface areas, providing more microsites for microbial decomposing organisms, and strong adsorption and retention of nutrients (Shi-wei and Fu-zhen, 1991).

The compost prepared through the application of earthworms is called vermicompost and the technology of using local species of earthworms for culture or composting has been called Vermitech (Ismail, 1997). The nutrient content of vermicompost greatly depends on most of the mineral elements, which are in available forms than the parent material (Edwards and Bohlen, 1996).

Vermicompost improves the physical, chemical and biological properties of soil increased microbial activity and enzyme production, (Kale, 1998). There is a good evidence that vermicompost which, in turn, increases the aggregate stability of soil promotes growth of plants (Krishnamoorthy and Vajranabhaiah, 1986) and it has been found that organic matter to have a favourable influence on all yield parameters of has a property of binding mineral particles like calcium, crops potato.

Rational use of fertilizers, ameliorants is one of the most important measures for improving soil fertility and increase of agricultural crops productivity. Special prospects were presented by the innovative eco-friendly bio-organic fertilizer, enabling alternatively to implement the replacement of traditional fertilizers, including a certain amount of pollutants of various natures in its structure a certain. For example, the uncontrolled use of nitrogen fertilizers in large quantities (60 kg of active ingredient per 1 ha) suppresses the natural biological process of nitrogen fixation in the soil, causing the accumulation of nitrates and nitrites in the plants (Zavalin, 2005).

The yield of potato is influenced by plant density, the cultural practices and environmental conditions such as temperature and day length. The goal of yield study is to attain the most profitable yields of quality potatoes in order to obtain such a big goal it seems necessary to study the effect of cumulative yield factors such as the application of vermicompost. Growth, yield and quality of potato depend on nutrient availability in soil, which is directly related to the judicious application of manures and fertilizers. Using of vermicompost is now a global movement for the second green revolution that emphasizes on composting. This mixture is made by earthworm's activities which are necessary for soil improvement and farm production, raw materials and various microorganisms which decompose organic wastes and convert them into suitable nutritional elements particularly NPKS. Use of optimum dose of fertilizers and vermicompost resulted in maximum yield in Potato (Patil, 1995; Saikia *et al*., 1998, Asumus, and Gorlitz, 1986).

Objectives of the Research work:

The main objectives of the field experiment was:

i) To study the varietal difference on growth, yield and quality attributes of potato.

ii) To compare the growth, yield and quality of different potato varieties using different level of vermicompost.

iii) To compare interactional effect of varieties and vermicompost level on growth, yield and quality of potato.

Chapter 2
Review of literature

CHAPTER II
REVIEW OF LITERATURE

Potato is the most important tuber crop in the world as well as in Bangladesh. Numerous experiments have been conducted throughout the world on potato crop but information regarding Vermicompost response in potato varieties and their effects on growth, yield and quality parameters are still inadequate. Brief reviews of available literature pertinent to the present study have been reviewed in this chapter.

Varietal effect

Kassim *et al.* (2014) run an experiment and reported a result that reducing physiological functions of above ground part of potato plant (leaf area and total chlorophyll content), the number and the weight of tuber decreased, so the productivity of the plant decreased.

Rojoni *et al.* (2014) found on an experiment which was conducted at the Horticulture farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, during the period from November 2010 to March 2011. They found BARI TPS-1 produced gross tuber yield 27.67 tha^{-1}.

Mihovilovich *et al*. (2014) found that the potential tuber number that can be successfully produced by a plant varies with the genotype and most cultivars having a consistent number of tubers on each stem.

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) conducted an experiment at three distinct locations in the Amhara region of Ethiopia for evaluation of the specific gravity of 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.

Ranjbar and Mirzakhan (2012) done an experiment with treatments included 11 cultivars of commercial and conventional potato that Ramous, Sante ,Shepody, Marfona, Santana, Maradona, Milova, Boren ,Cosima, Granola, Agria. In this study growth indies such as: days to maturity, plant height, number of stem per plant, number of tuber per plant and mean weight of tubers were assessed. Results showed that all cultivars have Significant different at the 1% probability levels in all of growth traits. Results indicated that Cosima variety with mean weight of tubers (26.2 g) and Ramus variety with mean weight of tubers (14 g) were significantly superior to the other cultivars. The purpose of this study, evaluate the phenology of potato cultivars in green house condition.

Ali *et al.* (2009) conducted an experiment with two varieties of sweet potato *viz.*, i) BARI Sweet Potato-5 and ii) BARI Sweet Potato-7 .The highest sweet potato yield was obtained from BARI SP-7 with (IPNS) basis fertilizer doses (33.9 t ha^{-1}). The lowest sweet potato yield was obtained from BARI SP-7 with control treatment.

Behjati *et al.* (2013) observed 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 plant^{-1}, related to Lady Rosetta and clone No. 397067-2. Lady Rosetta variety had the highest number of tube plant^{-1} and clone No. 397067-2 had 25 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.

Jatav *et al.* (2013) conducted a study at Central Potato Research Station, Jalandhar during 2009-11 to evaluate potato cultivars*viz.* Kufri Jyoti, Kufri Jawahar, Kufri Bahar, Kufri Sutlej, Kufri Pukhraj, Kufri Pushkar, Kufri Surya and Kufri Gaurav. Results revealed that Kufri Gaurav recorded maximum yield, agronomic efficiency and net return at all the levels of nitrogen followed by Kufri Pushkar and Kufri Pukhraj. Kufri Surya yielded minimum with least agronomic efficiency. This variety can be useful for poor farmers as this produces higher yield compared to other released varieties .

Karim *et al.* (2011) run 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.

Hossain (2011) run 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 %).

Güler (2009) conducted an experiment and 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 yield and total yield as well as total yield and tuber number plant^{-1} were highly significant.

Adhikari (2009) A field experiment was carried out to assess the effect of NPK on vegetative growth and yield of potato cultivars; Kufri Sindhuri and Desiree. Plant height, number of stems, fresh weight of stem and leaves were recorded at 15 days interval during crop growth period and tuber yield at maturity stage. Kufri Sindhuri was taller than Desiree at all the stages of plant growth. The yield increase of potato tuber was associated with increase in the plant height, fresh weight of leaves and stems as a result of applied N.P.K.

Mahmud *et al.* (2009) determined the yield of seed size tubers in five standard potato cultivars (Cardinal, Multa, Ailsa, Heera, and Dheera) in relation to dates of dehaulming (65, 70, and 80 days after planting) in a Seed Potato Production Farm, Debijong, Panchagarh. The maximum seed tuber yield was recorded from Cardinal at 80 DAP followed by Heera and

Cardinal at 70 DAP, Dheera and Ailsa at 75 DAP.

Kumar *et al.* (2005) evaluated the result 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).

Anonymous (2009a) conducted an experiment with three potato varieties to observe their performance on yield under different soil moisture levels. The highest plant height (50.75 cm) was found in Cardinal which was similar to Diamant (48.88 cm). The lowest plant height was observed in Granola (38.50 cm). The highest foliage coverage (93.25%) was observed in Diamant followed by Cardinal (92.75%) and the lowest in Granola (90.33%). The highest no. of 26 stems hill^{-1} (6.25) was observed in Cardinal which was similar to Diamant (5.42) and the lowest in Granola (4.75). The highest no. of tubers hill^{-1} (13.83)
was observed in Granola which was similar to Cardinal (13.33) and the lowest in Diamant (11.92).

Anonymous (2009b) conducted an experiment with twenty five varieties were evaluated at six locations. They found that, plant height (cm) in case of Diamant (47.87), Sagitta (56.20), Quincy (95.40); no. of stem hill^{-1} in Diamant (3.66), Sagitta (2.53), Quincy (2.26); Foliage coverage at 60 DAP (%) in Diamant (73.33), Sagitta (93.67), Quincy (92.00); No of tuber hill-1 in Diamant (6.72), Sagitta (3.94), Quincy (9.95); Weight of tuber hill^{-1} (kg) in Diamant (0.30), Sagitta (0.34), Quincy (0.35); dry matter (%) in case of Diamant (19.54), Sagitta (20.10), Quincy (18.70).

Anonymous (2009c) conducted an experiment with twelve varieties were evaluated at six locations in their third generation. They found that, plant height (cm) in case of Diamant (50.93), Granola (69.10), Sagitta (41.33), Quincy (65.87); no. of stem hill^{-1} in Diamant (5.66), Granola (3.20), Sagitta (3.46), Quincy (4.86); Foliage coverage at 60 DAP (%) in Diamant (92.00), Granola (91.00), Sagitta (89.33), Quincy (96.00); no. of tuber hill^{-1} in Diamant (7.24), Granola (6.82), Sagitta (5.23), Quincy (5.76); Weight of tuber hill^{-1} (kg) in Diamant (0.38), Granola (0.26), Sagitta (0.33), Quincy (0.35); dry matter (%) in case of Diamant (20.80), Granola (20.45), Sagitta (19.80), Quincy (18.40).

Anonymous (2009d) conducted an experiment with twenty eight varieties were evaluated at five locations. They found that, plant height at 60 DAP (cm) incase of Diamant (54.13), Sagitta (47.27), Quincy (80.93); no. of stem hill^{-1} in Diamant (4.66), Sagitta (5.40), Quincy (5.80); Foliage coverage at 60 DAP (%) in Diamant (93.67), Sagitta (90.67), Quincy (97.00); no. of tubers hill^{-1} in Diamant (8.11), Sagitta (5.41), Quincy (6.95); Weight of tubers hill^{-1} (kg) in Diamant (0.28), Sagitta (0.37), Quincy (0.45); dry matter (%) in case of Diamant (19.91), Sagitta (20.60), Quincy (18.34).

Anonymous (2009e) conducted an experiment with four exotic potato varieties along with check Diamant, Cardinal and Granola were evaluated at six locations in Regional Yield Trial. They found that plant height (cm) in case of Diamant (51.20), Cardinal (48.27), Meridian (48.33) and Laura (41.00); no. of stem hill^{-1} in Diamant (5.93), 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 Patrone followed by Asterix (37.16%), Granola (36.64%) and Multa (35.39%) among which there was no significant variation. Cardinal (6.20), Meridian (5.67) and Laura (4.73); Foliage coverage (%) in Diamant (88.33), Cardinal (90.33), Meridian (95.67) and Laura (86.67); No. of tuber hill-1 in Diamant (9.48), Cardinal (9.81), Meridian (9.63) and Laura (7.50); Weight of tuber hill-1 (kg) in case of Diamant (0.313), Cardinal (0.377), Meridian (0.490) and Laura (0.430); dry matter (%) in case of Diamant (22.69), Cardinal (21.03), Meridian (19.49) and Laura (20.22).

Anonymous (2009f) conducted an experiment with seven potato varieties were evaluated at MLT site. They found that plant height (cm) in case of Diamant (43.00), Lady Rosetta (37.00), and Courage (44.47); no. of stem plant^{-1} in Diamant (3.57), Lady Rosetta (2.80), and Courage (3.67); No of tuber plant^{-1} in Diamant (8.07), Lady Rosetta (5.67), and Courage (6.70).

Anonymous (2009g) conducted adaptive trails with new potato varieties at eleven districts. The mean yield of varieties over locations arranged in order of descending as BARI TPS-1 (23.87 t ha-1), Granola (23.68 t ha^{-1}), Diamant (23.63 t ha^{-1}), Asterix (20.83 t ha^{-1}) and Raja (18.28 t ha^{-1}).

Rabbani and Rahman (1995) studied the performance of 16 Dutch potato varieties in their third generation. They reported that the height of the plants significantly varied among the varieties. The highest foliage coverage at maximum vegetative growth stage was found in the variety Cardinal (93.3%) followed by Diamant. The highest yield of tubers per hectare was obtained from Cardinal (35.19 t ha^{-1}) followed by Romano (30.09 t ha^{-1}) and the lowest from Stroma (11.11 t ha^{-1}).

Haque (2007) run 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), Quincy (18.5).

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.

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), Granola (13.47); 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).

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 (32.5 t ha^{-1}) from BARI TPS-1.

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

Pandey *et al*. (2002) reported that the variety BARI TPS-1' attained higher yield due to its hybrid vigor in its first clonal generation.

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 30 was (416.67), BARI TPS-1 (491.33); dry matter of tuber (%) of Diamant was (19.71), BARI TPS-1 (18.18).

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.

Vermicompost effect

Akbasova *et al.* (2015) conducted an experiment and reported that the increase of root crops yield 1.2-1.5 times in making 8 t ha^{-1} vermicompost in gray soils was established. It was shown that the use vermicompost as a fertilizer was more expedient, as it contains more nutrients (N.P.K) and organic humic acids compared to conventional compost. Vermicompost has a direct physiological effect on plants; it stimulates the development of root systems and reduces the harmful effects of pollutants.

Shirzadi (2015) was done the study in order to evaluate the use of organic fertilizers (Vermicompost and Chicken manure) on the plant's height and number and weight of micro tuber Marfona cultivator potato (diameter of 25 to 35mm) with 2 factors of vermicompost in 4 levels (0,3,6 and 9 t ha^{-1}) and chicken manure in 4 levels (0,10,12 and 14 t ha^{-1}). The result showed that with increasing Vermicompost fertilizer, plant's height was reduced. Also highest number and weight of tubers with a diameter of 25-35mm belonged to 12 tons Chicken manure treatment without Vermicompost.

Mojtaba *et al.* (2013) conducted an experiment on which experimental factors included nitrogen fertilizer with three levels (50, 100 and 150 kg ha^{-1} as urea) and vermicompost with 4 levels 0 (control), 4.5, 9, and 12 t ha^{-1}). Results illustrated that the highest amount of plant height, leaf and stem dry weight, Leaf Area Index (LAI), fresh and dry weight of tuber , total tuber weight, total number of tuber, tuber diameter ,nitrogen percent of tuber, potassium percent of tuber and phosphorous percent of tuber were found from application of 150 kg N ha^{-1}. Data also demonstrated that vermicompost application at the rate of 12 t ha^{-1}promoted all above traits except plant height in compared to control treatment. Furthermore, the interaction effects between different nitrogen rates and vermicompost application significantly improved growth parameters, yield and N.P.K content of tuber compared with nitrogen and/or vermicompost alone treatments. To gain highest yield and avoidance of environments pollution use of 150 kg N ha^{-1} nitrogen fertilizer and vermicompost application of 12 t ha^{-1} are suggested.

Ramamurthy *et al*. (2015) was conducted an experiment to show the Influence of different percentages of vermicompost (25%, 50%, 75% and 100%) on the tuber length, width, circumference and weight of the radish plant (*Raphanus sativus* L.) was carried out at different period of exposures (30, 60 and 90 days). The maximum tuber length (20.67, 23.67 and 27.55cm) and weight (189.31, 215.31 and 244.64gm) were noticed in 75% of vermicompost concentration at 30, 60 and 90 days respectively except tuber width and circumference. During 60 and 90 days of exposure the maximum width and circumference were noticed in 50% of vermicompost and thereafter both width and circumference decreased in commensurate with increasing vermicompost concentration. The study reveals the 75% concentration of the vermicompost influence the tuber yield status of Radish plant.

Panwar and Wani (2014) a field experiment was done in the sweet potato filed with Nitrogen, Potash, and Phosphorus was applied in form of organic manure Farm yard Manure, Vermicompost, and Neemcake. (Vermicompost) recorded highest survival percent , length of vine, number of branches/vine, shoot fresh weight, shoot dry weight, tuber yield plot^{-1}, number of tuber plot^{-1} under poplar trees. The maximum Gross return was noticed in with Rs. 99204.00. The maximum Benefit cost ratio was noticed in with 1:1.37.

Ansari (2008) study the effect of vermicompost application in reclaimed sodic soils on the productivity of potato (*Solanum tuberosum*), spinach (*Spinacia oleracea*) and turnip (*Brassica campestris*). The soil quality was monitored during the experiment followed by productivity. The treatments were 4, 5 and 6 t ha^{-1} of vermicompost as soil application in plots already reclaimed by Vermitechnology. Among the different dosages of vermicompost applied there has been a significant improvement in the soil quality of plots amended with vermicompost @ 6 t ha^{-1}. The overall productivity of vegetable crops during the two years of the trial was significantly greater in plots treated with vermicompost @ 6 t ha^{-1}. The present investigation showed that the requirement of vermicompost for leafy crops like spinach was lower (4 t ha^{-1}), whereas that for tuber crops like potato and turnip was higher (6 t ha^{-1}).

Alam *et al.* (2007) An experiment was conducted to study the effect of vermicompost and NPKS fertilizers on growth and yield of potato (cv. Cardinal) in Level Barind Tract (AEZ-25) soils of Bangladesh. The organic matter of the experimental field soil was very low and in case of N, P, K and S also low. 1 The land was medium fertile and PH was 5.4. There were 12 treatments *viz*. control , vermicompost 2 3 4 5 (VC) 2.5 t ha^{-1} , VC 5.0 t ha^{-1} , VC 10.0 t ha^{-1} , VC 2.5 t ha^{-1}+50% NPKS . VC 5 t ha^{-1}+50% 6 7 8 9 NPKS , VC 10 t ha^{-1}+50% NPKS , VC 2.5 t ha^{-1}+100% NPKS , VC 5 t ha^{-1}+100% NPKS , 10 11 12 VC 10 t ha^{-1}+100% NPKS 50% NPKS and 100% NPKS. The experiment was laid out in RCBD with three replications. The doses of N-P-K-S were 90-40-100-18 kg ha^{-1} for potato. Application of 10 vermicompost and NPKS significantly influenced the growth and yield of potato. The treatment produced the highest (25.56 t ha^{-1}) tuber yield of potato. The lowest yield and yield contributing parameters recorded in control. Application of various amounts of vermicompost (2.5, 5, 10 t ha^{-1}) with NPKS fertilizers (50% and 100%) increased the vegetative growth and yield potato. Vermicompost at 2.5 5 and 10 t ha^{-1} with 50% of NPKS increased tuber yield over control by 78.3, 96.9 and 119.5 t ha^{-1} respectively. And vermicompost at 2.5, 5 and 10 t ha^{-1} with 100% of NPKS increased tuber yield by 146.8, 163.1 and 197.9 %, respectively. The results indicated that vermicompost (10 t ha^{-1}) with NPKS (100%) produced the highest growth and yield of potato.

Shweta and Sharma (2011) was conducted an experiment with Application of organic manures along with chemical fertilizers had a significant effect on the tuber and haulm yield. Highest tuber (30.46 t ha^{-1}) and haulm yield (9.04 t ha^{-1}) was recorded with application of 100 % NPK + 25 t ha^{-1} vermicompost and was significantly higher over sole use of chemical fertilizers. Tuber yield of potato recorded under 100% of recommended dose of NPK without organics (21.39 t ha^{-1}) was at par with 25 t FYM/ha or 12.5 t VC/ha applied along with 75% of recommended dose of NPK thereby, indicating a saving of 25% in NPK.

Sood and Sharma (2001) was doing a field experiments during 2000 at Shimla for assessing the utility of growth promoting bacteria, *Azotobacter* & Vermicompost for potato production indicated 'that *Bacillus cerus* (A) and *Bacillus subtilis* (B) separately increased the tuber yield of potato from 115 to 268 q ha^{-1} par with 100% NPK treatment. Vermicompost @ 5 t ha^{-1} increased the tuber yield by 34 to 65 *q* ha^{-1}. The increase in yield was more when optimum NPK dose of fertilizer was applied. Inoculation of seed tubers with *Azotobacter* in the absence of N increased the tuber yield by 68 $q\ ha^{-1}$ and the effect of *Azotobacter* decreased gradually as the dose of N was increased.

Mária *et al.* (2013) conducted an experiment with maize grown for grain were 4 treatments established – a control treatment and three treatments with dose increasing of granulated vermicompost (4.6; 9.2; 11.6 t ha^{-1}, respectively), which supplied 57, 114 and 142 kg.ha-1 total nitrogen to the soil, respectively. The experiment was not irrigated. The experiment with potatoes included 7 treatments of fertilization. The first treatment was a control treatment, i.e., without the appliance of dry granulated vermicompost. In treatment 2 to 6 increasing doses of vermicompost (3.3; 6.6; 9.9; 13.2 and 19.8, respectively) were applied. Through the following doses of granulated vermicompost were applied to the soil 40, 80, 120, 160, 240 kg ha^{-1} N. Not only was the granular vermicompost applied in treatment 7, but also the industrial NPK fertilizer (150 kg urea + 200 kg ha^{-1} NPK 15-15-15. The grain yield was increased with the dose increasing of vermicompost. A thousand kernel weight, starch content and magnesium content parameters with the increasing dose of vermicompost were reduced. A dose of 4.6 t ha^{-1} vermicompost seems like the most appropriate for the parameters of a thousand kernel weight, starch and magnesium content. The increasing doses of vermicompost significantly increased the yield of potato tubers, starch content and dry matter content in tubers. The application of granulated vermicompost reduced vitamin C content in potato tubers. The use of fertilizers resulted to increasing the nitrate content in potato tubers however the application of granulated vermicompost has increased the contents of nitrates to a lesser extent than the joint application of NPK fertilizer and granulated vermicompost.

Singh and Chauhan (2014) conducted an experiment and the results revealed that plant per meter row length, height of main shoot, dry matter(g) and number of leaves/plant higher in treatment (1/3 N-FYM+1/3N-Vermicompost + 1/3N-Neem cake plus agronomic practices). On an average treatment (1/3 N-FYM+1/3N-Vermicompost + 1/3N-Neem cake plus agronomic practices for weed and pest control (without chemical) significantly maximum tuber yield and A grade B grade and C grade tuber of potato.

Kumar *et al*. (2012) conducted a field experiments with farm yard manure (FYM), poultry manure (PM), vermicompost (VC) and solubilizing bacteria (PSB) and *Azotobacter* + PSB) in sub plots. The results showed that 50 % of the recommended dose of NPK through inorganic + 50% recommended dose of nitrogen (RDN) through organic manures (FYM, PM or VC) or 100% recommended dose of NPK through inorganic fertilizers alone favorably influenced the tuber yield, nutrient uptake, soil fertility and paid higher returns compared to other treatments. Seed treatment with *Azotobacter* + PSB proved better in tuber yield, nutrient uptake and recorded higher returns as compared to sole treatment of either *Azotobacter* or PSB. Three years pooled result revealed that integrated application of 50 % of recommended NPK through inorganic and 50 % RDN through PM recorded significantly highest tuber yield (22.73 t ha^{-1}) closely followed by 100 % recommended NPK through inorganic (22.20 t ha^{-1}) which were 228 % and 223 % respectively, higher than control. Integrated application of inorganic and organic fertilizers and seed treatment with *Azotobacter* + PSB biofertilizers improved tuber yield, nutrient uptake, and gave higher return as compared to other treatment combinations. Total organic carbon (TOC), soil microbial biomass carbon (SMBC), available N, P, and K status of the soil after 3 years were maximum when 50 % recommended dose of NPK were applied through inorganic and remaining 50 % RDN through PM.

Raja and Veerakumari (2013) conducted an experiment and find the impact of vermicomposts *viz.* Cowdung vermicompost, leaf ash vermicompost and poultry feather vermicompost on the yield and alkaloid content of medicinal plant, *Withania somnifera* were assessed and compared with the plants cultivated in the soil amended with chemical fertilizer and the plants cultivated without any fertilizer (control). The plant growth parameters such as shoot length, root length, shoot dry weight, root dry weight, shoot wet weight, root wet weight, shoot: root ratio and the alkaloid withaferin A and withanolide D were significantly increased in the plants cultivated in the soil amended with poultry feather vermicompost.

Kashem *et al.* (2015) conducted a study attempted to compare the effect of cow manure vermicompost and inorganic fertilizers on the vegetative growth and fruits of tomato plant (*Solanum lycopersicum* L.). An air dried sandy loam soil was mixed with five rates of vermicompost equivalent to 0 (control), 5, 10, 15 and 20 t ha^{-1} and three rates of NPK fertilizer equivalent to 50% (N-P-K = 69-16-35 kg t ha^{-1}), 100% (N-P-K = 137-32-70 kg ha^{-1}) and 200% (N-P-K = 274-64-140 kg ha^{-1}).The data revealed that shoot length, number of leaves, dry matter weight of shoots and roots, fruit number and fruit weight were influenced significantly ($P < 0.05$) by the application of vermicompost and NPK fertilizer in the growth media. The highest dose of vermicompost of 20 t ha-1 increased dry weight of shoot of 52 folds and root of 115 folds, number of fruit(s)/plant of 6 folds and mean fruit weight of 29 folds while the highest rate of NPK fertilizer of 200% increased dry weight of shoot of 35 folds and root of 80 folds, number of fruit(s)/plant of 4 folds and mean fruit weight of 18 folds over the control treatment. The growth performance of tomato was better in the vermicompost amended soil pots than the plants grown in the inorganic fertilizer amended soil pots.

Meenakumari and Shekhar (2012) conducted an experiment to determine the effect of vermicompost and other fertilizers on growth, yield and fruit quality of tomato in the field condition. The field trails were conducted using different fertilizers having equal concentration of nutrients to determine their impact on different growth parameters of tomato plants. Six types of experimental plots were prepared where was kept as control and five others were treated by different category of fertilizers Chemical fertilizers, Farm Yard Manure (FYM), Vermicompost, and FYM supplemented with chemical fertilizers and vermicompost supplemented with chemical fertilizer respectively).The treatment plots showed 73% better yield of fruits than control, Besides, vermicompost supplemented with N.P.K treated plots displayed better results with regard to fresh weight of leaves, dry weight of leaves, dry weight of fruits, number of branches and number of fruits per plant from other fertilizers treated plants.

Goutam *et al.* (2011) was Field trials were conducted using different fertilizers having equal concentration of nutrients to determine their impact on different growth parameters of tomato plants. Six types of experimental plots were prepared where was kept as control and five others were treated by different category of fertilizers Chemical fertilizers, Farm Yard Manure (FYM), Vermicompost, and FYM supplemented with chemical fertilizers and vermicompost supplemented with chemical fertilizer respectively).The treatment plots showed 73% better yield of fruits than control, Besides, vermicompost supplemented with N.P.K treated plots displayed better results with regard to fresh weight of leaves, dry weight of leaves, dry weight of fruits, number of branches and number of fruits per plant from other fertilizers treated plants.

Singh *et al. (*2014) done a field experiment was conducted for two years to investigate the effect of vermicompost, organic mulching and irrigation level on growth, yield and quality attributes of tomato (*Solanum lycopersicum* L.). The vermicompost together with organic mulching increased plant height (106.5 cm), leaf area (40.6 cm2), leaf weight (1301 mg/ leaf), fruit weight (92.9 g), fruit yield (4.013 kg plant^{-1}), fruit density (0.972 g cc^{-1}), post-harvest shelf-life (15.0 days) and TSS (5.2º Brix) of tomato significantly. Application of vermicompost alone too increased the shelf-life of fruits by 25-106 % and TSS beyond 4.5 %, both of which are traits highly desirable for production of summer tomato and the related processing industry. The application of vermicompost @ 5 t ha^{-1}, 5 cm thick mulching with dried crop residues, two-thirds dose of NPK fertilizer (80:40:40 kg ha^{-1}) and 30 % irrigation is optimum for obtaining better quality and productivity of field grown tomatoes during dry period of mild-tropical climate.

Zandonadi and Busato (2012) reported that vermicomposting and its products represents a crucial ecofriendly technology capable of recycling organic wastes to be used as fertilizers. Through its hormone-like substances, vermicompost, liquid humus or worm bed leachate stimulates plant growth. Additionally, manipulation of microbial population present in vermicompost and its products may increase both nutrient content and availability.

Chapter 3

Materials and Methods

CHAPTER III
MATERIALS AND METHODS

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

3.1 Experimental period

The experiment was conducted during the period from November 01, 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 was 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 aparted by winter during the months from November, 01, 2014 to April 30, 2015 (Rabi season). Plenty of sunshine and moderately low temperature prevails 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.

3.3 Details of the Experiment

3.3.1 Experimental treatments

The experiment consisted of two factors such as variety and vermicompost level. The treatments were as follows:

Factor A: Variety (4)

V_1 – BARI TPS-1

V_2 – BARI Alu-28 (Lady Rosetta)

V_3 – BARI Alu-29 (Courage)

V_4 – BARI Alu-25 (Asterix)

Factor B: Vermicompost level (4)

Vm_1 – 0 t ha^{-1}

Vm_2 – 2 t ha^{-1}

Vm_3 – 4 t ha^{-1}

Vm_4 – 6 t ha^{-1}

Treatment combinations are as:

V_1Vm_1, V_1Vm_2, V_1Vm_3, V_1Vm_4,
V_2Vm_1, V_2Vm_2, V_2Vm_3, V_2Vm_4,
V_3Vm_1, V_3Vm_2, V_3Vm_3, V_3Vm_4,
V_4Vm_1, V_4Vm_2, V_4Vm_3, V_4Vm_4

3.3.2 Experimental design

The experiment was laid out in a split plot Design with3 replications. Distance between row to row was 50 cm and plant to plant distance was 25 cm. Distance between plot to plot was 40 cm.

3.4 Planting material

The planting materials comprised the certified seed tubers of four potato varieties. The varieties were BARI TPS-1 (V_1), Lady Rosetta (V_2), Asterix (V_3), Courage (V_4)

3.5 Crop management

3.5.1 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.

3.5.2 Preparation of seed

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

3.5.3 Soil preparation

Research field was selected at the research farm of Sher-e-Bangla Agricultural University. The soil was sandy loam. The soil was plough 4-5 times by cross section and level the soil by laddering. Weeds and stubbles were completely removed from soil.

3.5.4 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

Source: Mondal *et al.,* 2011

The total amount of vermicompost was applied at 7 days before planting as per treatment.The entire amounts of triple superphosphate, muriate of potash, gypsum, zinc sulphate, boric acid and one third of urea were applied as basal dose at 7 days before potato planting. Rest of the urea was applied in two equal installments i.e., first was done at 30 days after planting (DAP) followed by first pouring the soil for complete the earthing up in the field and second was at 50 DAP followed by pouring the soil.

3.5.5 Planting of seed tuber

The well sprouted healthy and uniform sized potato tubers were planted according to treatment. 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 4-5 cm depth in soil on November 27, 2014.

3.5.6 Intercultural operations

3.5.6.1 Weeding

Weeding was necessary to keep the plant free from weeds. The newly emerged weeds were uprooted carefully from the field after complete emergence of sprouts and afterwards when necessary.

3.5.6.2 Watering

Two times irrigation was done in the field to keep upon moisture status of soil retained as requirement of plants. Excess water was not given, because it always harmful for potato plant.

3.5.6.3 Earthing up

Earthing up process was done by pouring the soil in the base of the plant at two times, during crop growing period. First pouring was done at 45 days after planting and second was at 60 DAP.

3.5.6.4 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.

3.5.6.5 Haulm cutting

Haulm cutting was done at Feb 22, 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 7 days for skin hardening. The cut haulm was collected, bagged and tagged separately for further data collection.

3.5.6.6 Harvesting of potatoes

Harvesting of potato was done at March 01, 2015 at 7 days after haulm cutting. The potatoes of each plot were separately harvested, bagged and tagged and brought to the laboratory. The yield of potato $plot^{-1}$ was determined in kg. Harvesting was done manually by hand.

3.5.7 Recording of data

Experimental data were recorded from 40 DAP and continued until harvest. Dry weights of different plant parts were collected after harvesting. The following data were collected during the experimentation.

A. Crop growth characters

   i. Days to first emergence
   i. Day to final emergence
   ii. Plant height at 40, 55, 70, and 85 DAP
   iii. Number of leaves plant^{-1} at 40, 55, 70, and 85 DAP
   iv. Number of stems hill^{-1} at 40, 55, 70, and 85 DAP
   v. Total chlorophyll content of leaves at 40, 55, 70, and 85 DAP

B. Yield and yield components

   vi. Yield of tubers plot^{-1}
   vii. Average weight of tuber
   viii. Marketable yield
   ix. Non- marketable yield
   x. Seed yield

C. Quality characters

   xi. Tuber flesh dry matter content (%)
   xii. Specific gravity
   xiii. Total soluble solids (TSS)
   xiv. Water percentage
   xv. Dry matter (%)
   xvi. Flesh color
   xvii. Skin color
   xviii. Firmness
   xix. Specific gravity

3.5.8 Experimental measurements

A brief outline of the data recording procedure followed during the study is given below:

A. Crop growth characters

i. Days to first emergence

After planting the potato tuber keenly observed the first emergence in each plot twice in a day (morning and afternoon).

ii. Days to final emergence

The plot was keenly observed the final emergence to conform 100% emergence.

iii. Plant height (cm)

Plant height refers to the length of the plant from ground level to the tip of the tallest stem. It was measured at an interval of 15 days starting from 40 DAP till 85 DAP. The height of each plant of each plot was measured in cm with the help of a meter scale and mean was calculated.

iv. Number of leaves plant^{-1}

Number of leaves plant^{-1} was counted at an interval of 15 days starting from 40 DAP till 85 DAP. Leaves number plant^{-1} were recorded by counting all leaves from each plant of each plot and mean was calculated.

v. Number of stems hill^{-1}

Number of stems hill^{-1} was counted at an interval of 15 days starting from 40 DAP till 85 DAP. Stem numbers hill^{-1} was recorded by counting all stem from each plot.

vi. Chlorophyll content of leaves (SPAD value)

Chlorophyll content of leaves was measured at an interval of 15 days starting from 40 DAP till 85 DAP. Mature leaf (fourth leaves from top) were measured all time. Three mature plant of each pot were measured by using portable Chlorophyll Meter (SPAD-502, Minolta, Japan) and then calculated an average SPAD value for each pot at each sampling time. The chlorophyll meter Soil Plant Analysis Development (SPAD-502) is a simple and portable diagnostic tool that measures the greenness or the relative chlorophyll concentration of leaves (Kariya *et al.,* 1982; Torres-netto *et al.*, 2005). It provides instantaneous and non-destructive readings on plants based on the quantification of the intensity of absorbed light by the tissue sample using a red LED (wavelength peak is ~650 nm) as a source. An infrared LED, with a central wavelength emission of approximately 940 nm, acts simultaneously with the red LED to compensate for the leaf thickness (Minolta camera Co. Ltd., 1989).

B. Yield and yield components

i. Yield of tuber plot^{-1}

Tubers of each plot were collected separately from which yield of tuber per plot was recorded in kg.

ii. Average weight of tuber (g)

Average weight of tuber was measured by using the following formula-

$$\text{Average weight of tuber} = \frac{\text{Yield of tuber/plot}}{\text{Number of tubers/plot}}$$

iii. 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).

iv. Seed yield

On the basis of the size of the tuber (28-55mm) the seed type potato tuber were graded.

C. Quality characters

i. Tuber flesh dry matter content (%)

The samples of tuber were collected from each treatment. After peel off the tubers the samples were dried in oven at 72^0C for 72 hours. From which the weights of tuber flesh dry matter content % were recorded.

ii. Specific Gravity (gcm^{-3})

It was measured by using the following formula (Gould, 1995)-

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

iii. Total soluble solids (TSS)

TSS of harvested tubers was determined in a drop of potato juice by using Hand Sugar Refrectometer "ERMA" Japan, Range: 0-32% according to (AOAC, 1990) and expressed as °BRIX value.

iv. Color measurements

Color was measured with a color spectrophotometer NF333 (Nippon Denshoku, Japan) using the CIE Lab L*, a* and b* color scale. The 'L*'value is the lightness parameter indicating degree of lightness of the sample; it varies from 0 = black (dark) to 100 = white (light). The 'a*' which is the chromatic redness parameter, whose value means tending to red color when positive (+) and green color when negative (–). The 'b*' is yellowness chromatic parameter corresponding to yellow color when it is positive (+) and blue color when it is negative (–). Each sample consisted of 10 slices, each of which was measured thrice.

3.5.9 Statistical Analysis

The data obtained for different characters were statistically analyzed following the analysis of variance techniques by using MSTAT-C computer package programme. The significant differences among the treatment means were compared by Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

Chapter 4

Results and Discussion

CHAPTER

RESULTS AND DISCUSSION

The experiment was conducted to find out the effect of Vermicompost on different potato varieties. The results obtained from the study have been presented, discussed and compared in this chapter through table(s), figures and appendices. The analysis of variance of data in respect of all the parameters have been shown in Appendix III-XII. The results have been presented and discussed with the help of table and graphs and possible interpretations given under the following headings.

4.1 Crop growth characters

4.1.1 Days to first emergence (visual observation)

4.1.1.1 Effect of varieties

Days to first emergence was significantly influenced by the different potato varieties (Fig.1). Results revealed that the variety 'BARI TPS-1' took the maximum days (17 days) for first emergence whereas, the minimum (15.25 days) was taken by 'BARI Alu -28 (Lady Rosetta)'.This result showed that 'BARI Alu-28' was the early to first emergence variety whereas, 'BARI TPS-1' was the late one. This might be due to varietal characters.

4.1.1.2 Effect of vermicompost levels

Significant variation of days to first emergence was found due to different vermicompost levels (Fig.2). Figure 2 showed that duration of first emergence decreased with increasing vermicompost levels. The minimum days to first emergence (14.66 days) was required in Vm_4 (6 t ha^{-1}) treatment and the maximum (17.08 days) was recorded in Vm_1 (0 t ha^{-1}).

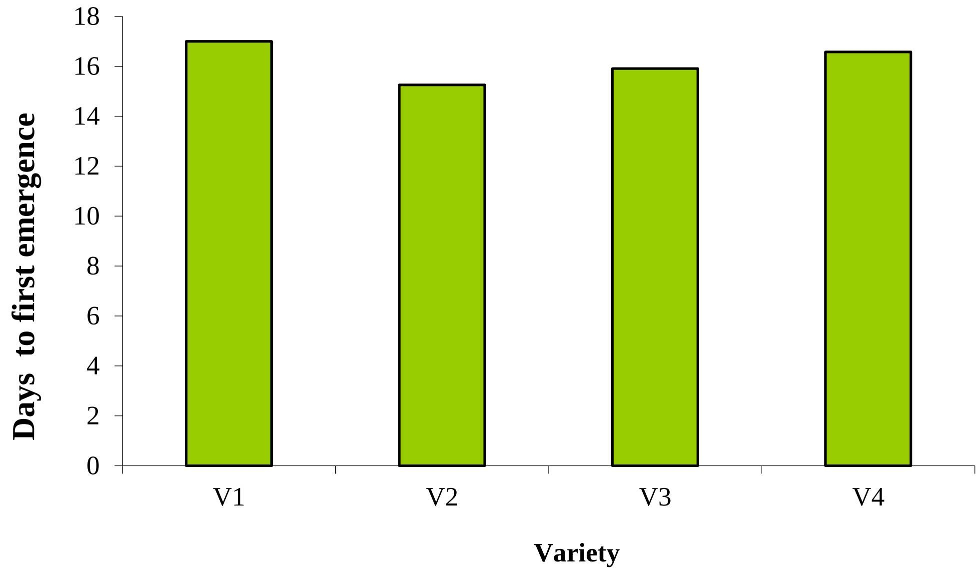

Figure 1. Effect of varieties on days to first emergence of potato (SE value = 0.07)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

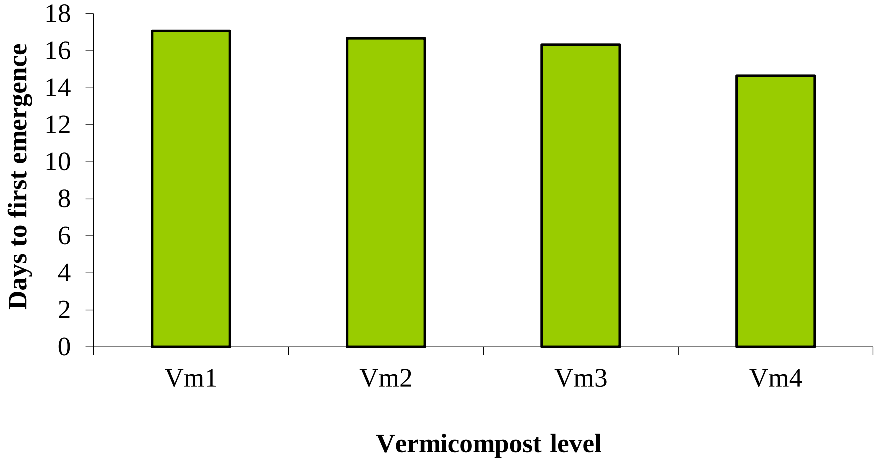

Figure 2. Effect of vermicompost levels on days to first emergence of potato variety (SE value = 0.07)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.1.1.3 Interaction effect of varieties and vermicompost levels

Interaction effect of varieties and vermicompost levels significantly influenced the days taken to first emergence of potato tubers (Table 1). The minimum duration for first emergence (14 days) was recorded from the combination of 'BARI Alu-2' and vermicompost levels 6 t ha^{-1} treatment which was statistically similar with V_3Vm_4 (14.33 days), whereas, the maximum duration (18 days) was recorded from the combination of 'BARI TPS-1' and control (0 t ha^{-1}).

4.1.2 Days to final emergence (visual observation)

4.1.2.1 Effect of varieties

Days to final emergence was significantly influenced by the different potato varieties (Fig.3). Results revealed that the variety 'BARI TPS-1' took the maximum days (22.75 days) for final emergence whereas, the minimum days (18 days) was taken by 'BARI Alu -28 (Lady Rosetta)'.This result showed that 'BARI Alu-28' was the early to final emergence variety whereas, ‘BARI TPS-1’ was the late one. This might be due to varietal characters.

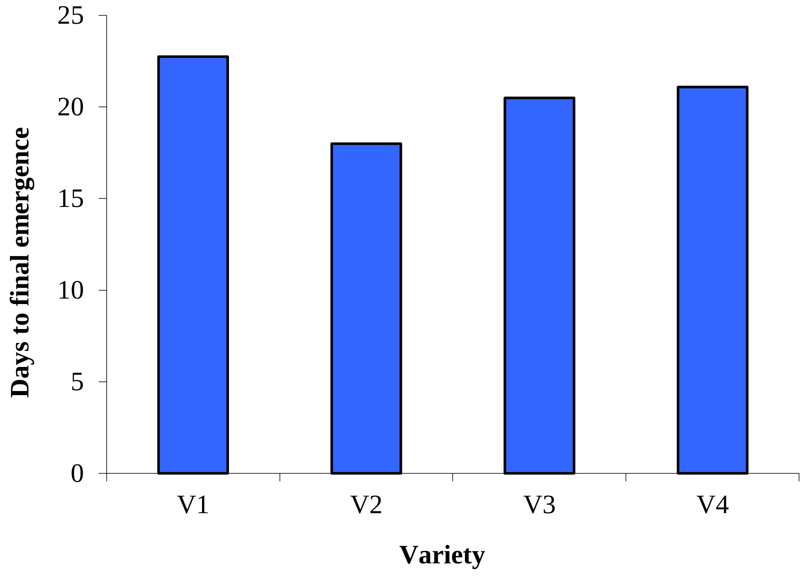

Figure 3. Effect of varieties on days to final emergence of potato (SE value = 0.19)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.1.2.2 Effect of vermicompost levels

Significant variation of days to final emergence was found due to different vermicompost levels (Fig.4). Figure 4 showed that duration of final emergence decreased with increasing vermicompost levels. The minimum days to final emergence (20.25 days) was required in Vm_4 (6 t ha^{-1}) treatment and the maximum (22.17 days) was recorded in Vm_1 (0 t ha^{-1}).

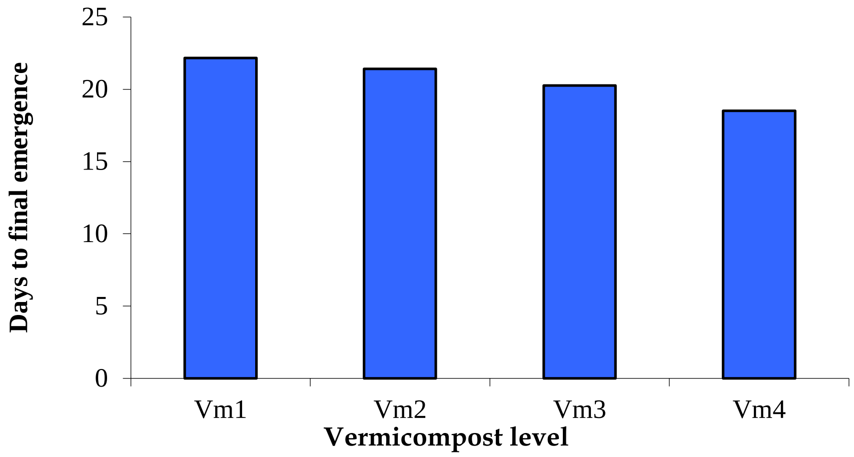

Figure 4. Effect of vermicompost levels on days to final emergence of potato variety (SE value = 0.20)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.1.2.3 Interaction effect of varieties and vermicompost levels

Interaction effect of varieties and Vermicompost levels significantly influenced the days taken to final emergence of potato tubers (Table 1.). The minimum duration for final emergence (16.17 days) was recorded from the combination of 'BARI Alu-2' and Vermicompost levels 6 t ha^{-1} treatment. The maximum duration (24.33 days) was recorded from the combination of 'BARI TPS-1' and control (0 t ha^{-1}) which was statistically similar with V_1Vm_2 (24.33 days).

Table 1. Interaction effect of varieties and vermicompost levels on days to first emergence and days to final emergence of potato

Variety x Vermicompost level	Days to first emergence	Days to final emergence
V_1Vm_1	18.00 a	24.33 a
V_1Vm_2	17.33 b	24.33 a
V_1Vm_3	17.33 b	22.67 bc
V_1Vm_4	15.33 gh	19.67 fg
V_2Vm_1	16.00 ef	19.00 gh
V_2Vm_2	15.67 fg	18.33 h
V_2Vm_3	15.33 gh	18.00 h
V_2Vm_4	14.00 i	16.6 i
V_3Vm_1	17.00 bc	22.33 b-d
V_3Vm_2	16.33 de	21.33 de
V_3Vm_3	16.00 ef	19.67 fg
V_3Vm_4	14.33 i	18.67 gh
V_4Vm_1	17.33 b	23.00 b
V_4Vm_2	17.33 b	21.67 c-e
V_4Vm_3	16.67 cd	20.67 ef
V_4Vm_4	15.00 h	19.00 gh
SE value	0.13	0.39
Level of significance	*	*
CV (%)	1.36	3.30

* = Significant at 5% level of probability

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)
Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.1.3 Plant height

4.1.3.1 Effect of varieties

The plant height of potato varieties were measured at 40, 55, 70 and 85

DAP. It was evident from Figure 5 and Appendix 2 that the height of plant was no significantly influenced by variety at all the sampling dates. Figure 5 showed that plant height numerically increased with advancing growing period irrespective of varieties, the potato height increased rapidly at the early stages of growth and rate of progression in height was slow at the later stages. At 40 DAP numerically longest plant height (36.25 cm) was measured from BARI Alu-28 (Lady Rosetta) variety and shortest one (29.23 cm) from BARI TPS-1.At 55 DAP numerically longer plant height (55.04 cm) was recorded from BARI Alu-29 (Courage) and shortest height (50.13 cm) from BARI Alu-28 (Lady Rosetta). At 70 DAP the tallest plant height (70.67 cm) was recorded from BARI TPS-1 and the shortest plant height (53.08 cm) from BARI Alu-28 (Lady Rosetta). And finally at 85 DAP the tallest plant height (73.83 cm) was recorded from BARI TPS-1 and the shortest plant height (58.33 cm) from BARI Alu-28 (Lady Rosetta). The numerical different of plant height of a crop depends on the plant vigor, cultural practices, growing environment and the varietal characters. In the present experiment since all the varieties were grown in the same environment and were given same cultural practices, the variation in the plant height among the varieties might be due to the varietal character.

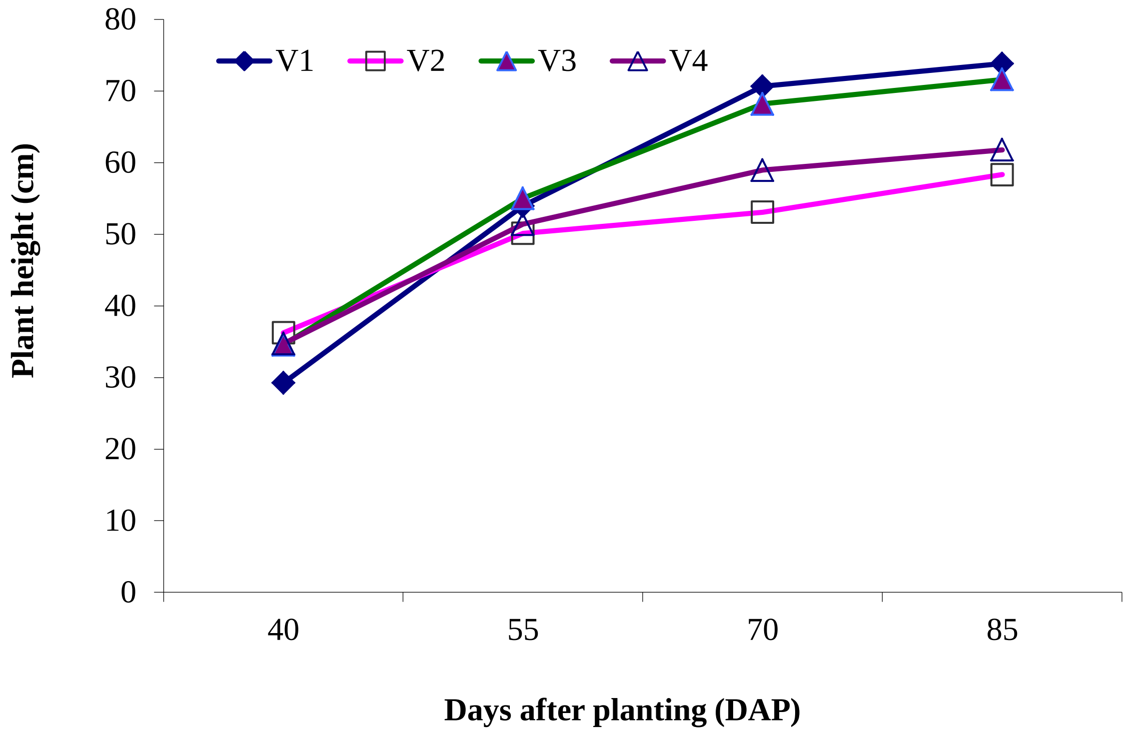

Figure 5. Effect of varieties on plant height (cm) of potato at different growth stages (SE value at 40, 55, 70 and 85 DAP are 1.84, 2.22, 3.64 and 2.96 respectively)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.1.3.2 Effect of vermicompost levels

No significant variation of plant height was found due to different vermicompost levels in all the studied durations (Appendix IV and Figure 6).Only numerically difference was observed among the vermicompost levels. At 40 DAP numerically longest plant height (34.39 cm) was measured from 6 t ha^{-1} vermicompost dose and shortest one (32.14 cm) from 4 t ha^{-1}. At 55 DAP numerically longer plant height (54.08 cm) was recorded from 6 t ha^{-1} and shortest height (51.42 cm) from 2 t ha^{-1}. At 70 DAP the tallest plant height (63.29 cm) was recorded from 6 t ha^{-1} and the shortest plant height (61.92 cm) from 2 t ha^{-1}. And finally at 85 DAP the tallest plant height (67.88 cm) was recorded from 4 t ha^{-1} and the shortest plant height (65.42 cm) from 2 t ha^{-1}.

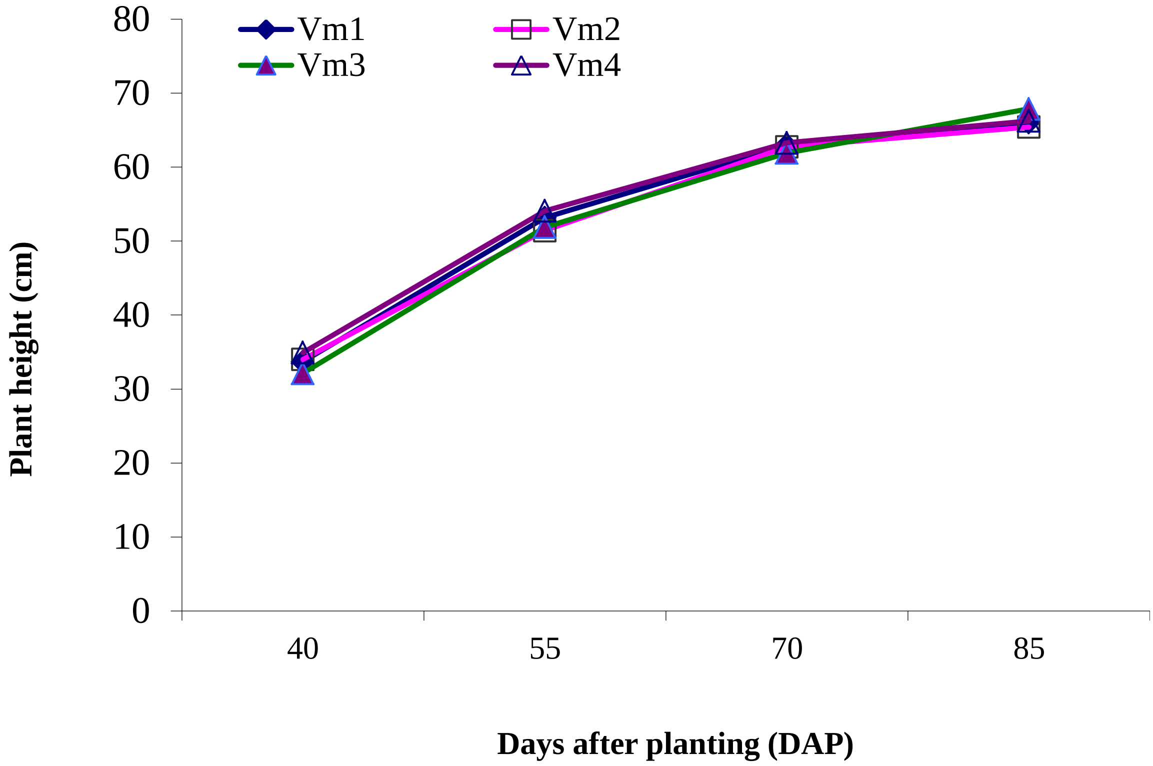

Figure 6. Effect of vermicompost levels on plant height (cm) of potato at different growth stages (SE value at 40, 55, 70 and 85 DAP are 1.38, 1.79, 2.62 and 2.57 respectively)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.1.3.3 Interaction effect of varieties and Vermicompost levels

No significant variation of plant height was found due to interactional effect of varieties and Vermicompost levels in all the studied durations (Appendix IV and table 2).Only numerically difference was observed among the interaction between varieties and vermicompost levels. At 40 DAP numerically longest plant height (38.98 cm) was measured from V_2Vm_1 combination and shortest one (25.62 cm) from V_1Vm_3. At 55 DAP numerically longer plant height (61.00 cm) was recorded from V_1Vm_4 and shortest height (45.00 cm) from V_2Vm_3. At 70 DAP the tallest plant height (78.67 cm) was recorded from V_1Vm_4 and the shortest plant height (50.00 cm) from V_2Vm_2. And finally at 85 DAP the tallest plant height (79.17 cm) was recorded from V_1Vm_4 and the shortest plant height (65.42 cm) from V_2Vm_2.

Table 2. Interaction effect of varieties and vermicompost levels on plant height of potato at different DAP

Variety x Vermicompost level	Plant height (cm) at DAP			
	40	**55**	**70**	**85**
V_1Vm_1	27.30	52.83	67.50	71.17
V_1Vm_2	28.24	52.83	70.33	70.50
V_1Vm_3	25.62	49.17	66.17	74.50
V_1Vm_4	35.73	61.00	78.67	79.17
V_2Vm_1	38.98	53.50	57.50	59.33

V_2Vm_2	38.79	50.33	50.00	54.67
V_2Vm_3	32.30	45.00	52.33	60.17
V_2Vm_4	34.94	51.67	52.50	59.17
V_3Vm_1	35.59	58.00	71.33	76.00
V_3Vm_2	36.24	57.33	73.17	75.17
V_3Vm_3	32.51	55.00	63.67	67.33
V_3Vm_4	33.96	49.83	64.67	68.00
V_4Vm_1	32.90	48.33	55.50	57.67
V_4Vm_2	32.78	45.17	57.50	61.33
V_4Vm_3	38.13	58.33	65.50	69.50
V_4Vm_4	35.10	53.83	57.33	58.67
SE value	-	-	-	-
Level of significance	NS	NS	NS	NS
CV (%)	14.23	11.78	14.51	13.43

NS = Not significant

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.1.4 Number of stems $hill^{-1}$

4.1.4.1 Effect of Varieties

The number of stems $hill^{-1}$ was significantly varied among the varieties at 40, 55, 70 and 85 DAP (Appendix V and Figure 7). Number of stems $hill^{-1}$ increased with advancing growing period up to 40 DAP irrespective of varieties and thereafter remained constant (Figure 7). At 40 DAP, the maximum stem numbers $hill^{-1}$ (5.58) was obtained from the variety 'BARI Alu-29' which statistically similar with the variety BARI Alu-28

(Lady Rosetta) (5.00) and the minimum (2.58) was obtained from the 'BARI TPS-1' which was statistically similar with 'BARI Alu-25' (2.83). At 55 DAP, the maximum stem numbers hill^{-1} (5.50) was obtained from the variety 'BARI Alu-29' which statistically similar with the variety BARI Alu-28 (Lady Rosetta) (4.42) and the minimum (2.58) was obtained from the 'BARI Alu-25' which was statistically similar with 'BARI TPS-1' (2.67). At 70 DAP, the maximum stem numbers hill^{-1} (5.42) was obtained from the variety 'BARI Alu-29' which statistically similar with the variety BARI Alu-28 (Lady Rosetta) (4.50) and the minimum (2.58) was obtained from the 'BARI Alu-25' which was statistically similar with 'BARI TPS-1' (2.67). And finally at 85 DAP, the maximum stem numbers hill^{-1} (5.584.67) was obtained from the variety 'BARI Alu-29' which statistically similar with the variety BARI Alu-28 (Lady Rosetta) (4.58) and the minimum (2.41) was obtained from the 'BARI Alu-25' which was statistically similar with 'BARI TPS-1' (2.58). This might be due to varietal characters.

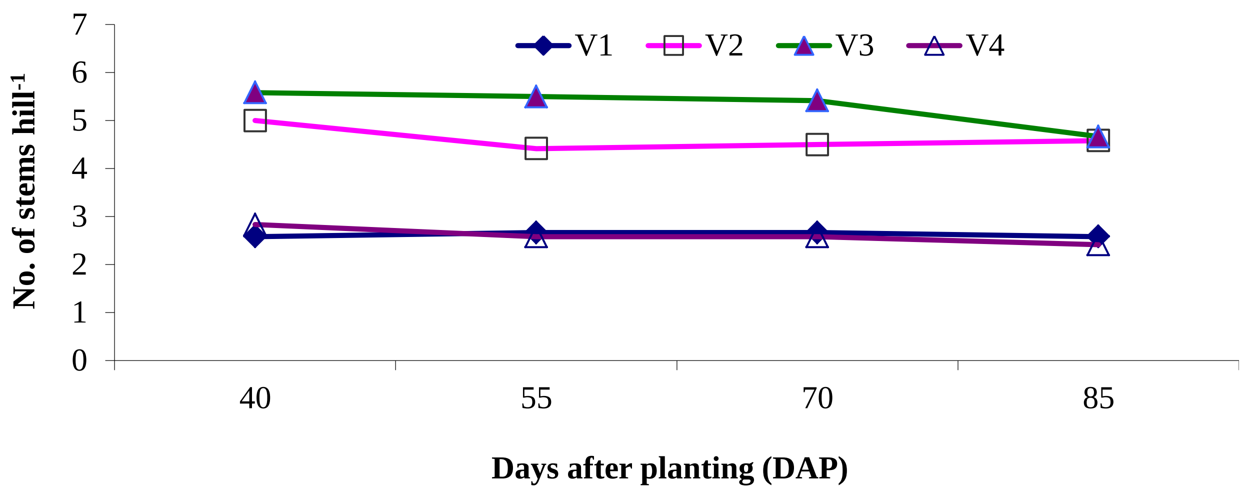

Figure 7. Effect of varieties on number of stems hill^{-1} of potato at different growth stages (SE value at 40, 55, 70 and 85 DAP are 0.45, 0.33, 0.37 and 0.25 respectively)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.1.4.2 Effect of vermicompost levels

No significant variation of number of stems hill^{-1} was found due to different vermicompost levels in all the studied durations (Appendix V and Figure 8). Only numerically difference was observed among the vermicompost levels. At 40 DAP numerically maximum number of stems hill^{-1} (4.25) was measured from 0 t ha^{-1} (control) vermicompost dose and minimum one (3.50) from 6 t ha^{-1}. At 55 DAP numerically maximum number of stems hill^{-1} (4.08) was recorded from 0 t ha^{-1} (control) and minimum number of stems hill^{-1} (3.33) from 4 t ha^{-1}. At 70 DAP maximum numer of stem hill^{-1} (4.00) was recorded from 2 t ha^{-1} and the minimum (3.42) from 6 t ha^{-1}. And finally at 85 DAP the maximum number of stem hill^{-1} (3.83) was recorded from 0 t ha^{-1} (control) and the minimum was (3.33) from 4 t ha^{-1}.

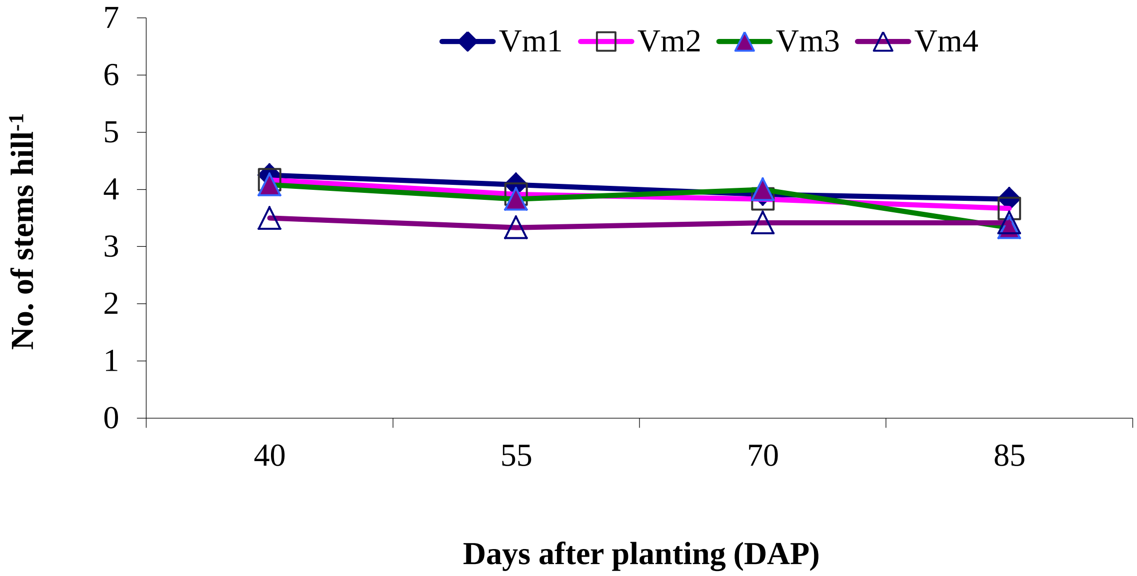

Figure 8. Effect of vermicompost levels on number of stem hill^{-1} of potato at different growth stages (SE value at 40, 55, 70 and 85 DAP are 0.28, 0.31, 0.33 and 0.32 respectively)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.1.4.3 Interaction effect of varieties and vermicompost levels

No significant variation of number of stems hill^{-1} was found due to interactional effect of varieties and vermicompost levels in all the studied durations (Appendix V and table 3). Only numerically difference was observed among the interaction between varieties and vermicompost levels. At 40 DAP numerically maximum number of stems hill^{-1} (6.33) was measured from V_3Vm_2 combination and minimum one (2.00) from V_4Vm_4. At 55 DAP numerically maximum number of stems hill^{-1} (6.00) was recorded from V_3Vm_2 and minimum one (2.00) from V_4Vm_4. At 70 DAP numerically maximum number of stems hill^{-1} (6.00) was measured from V_3Vm_2 combination and minimum one (1.66) from V_4Vm_4. At 85 DAP numerically maximum number of stems hill^{-1} (5.66) was measured from V_3Vm_2 combination and minimum one (1.66) from V_4Vm_4.

Table 3. Interaction effect of varieties and vermicompost levels on number stems hill^{-1} of potato at different DAP

Variety x Vermicompost level	Number of stem hill^{-1} at different DAP			
	40	**55**	**70**	**85**
V_1Vm_1	3.00	3.00	3.00	2.66
V_1Vm_2	2.33	2.33	2.33	2.00
V_1Vm_3	2.66	2.66	2.66	2.66
V_1Vm_4	3.00	3.00	3.00	3.00
V_2Vm_1	5.33	5.33	5.33	5.33
V_2Vm_2	5.00	4.33	4.33	4.33
V_2Vm_3	5.00	5.00	4.33	4.00
V_2Vm_4	4.66	4.66	4.66	4.66
V_3Vm_1	5.66	6.00	5.33	4.66
V_3Vm_2	6.33	6.00	6.00	5.66
V_3Vm_3	5.33	5.33	5.00	4.00
V_3Vm_4	5.00	4.33	4.33	4.33

V_4Vm_1	3.00	3.00	3.00	2.66
V_4Vm_2	3.00	3.00	3.00	2.66
V_4Vm_3	3.33	3.33	3.33	2.66
V_4Vm_4	2.00	2.66	1.66	1.66
SE value	-	-	-	-
Level of significance	NS	NS	NS	NS
CV (%)	23.66	28.15	30.21	30.77

NS = Not significant.

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)
Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.1.5 Number of leaves plant^{-1}

4.1.5.1 Effect of varieties

Different varieties exhibited significant variation in respect of number of leaves plant^{-1} of potato at 40, 55 and 85 DAP expect 70 DAP (Appendix VI and Figure 9). Number of leaves plant^{-1} increased with advancing growing period up to 70 DAP irrespective of varieties and thereafter decreased due to senescence of leaves (Figure 9). At 40 DAP, the maximum number of leaves plant^{-1} (63.33) was observed from the variety 'BARI Alu-29' which is statistically similar with the variety BARI Alu-28 (60.50) and the minimum number (27.08) was observed from 'BARI TPS-1' which statistically similar with the variety BARI Alu-25 (30.42). At 55 DAP, the maximum number of leaves plant^{-1} (92.75) was obtained from the 'BARI Alu-29' whereas, the minimum (44.50) was from 'BARI Alu-25' which was statistically similar (59.33) with 'BARI TPS-1'. At 70 DAP no significant difference observed on variety only numerical difference observed among the varieties. The numerically maximum number of leaves (155.7) was observed from the variety BARI Alu-29 and minimum from the variety BARI Alu-25 (77.25). At 85, the maximum number of leaves (58.58) was counted from 'BARI TPS-1 which is statistically similar with the variety BARI Alu-29' whereas, the minimum (29.25) was counted from the variety 'BARI Alu-25'.

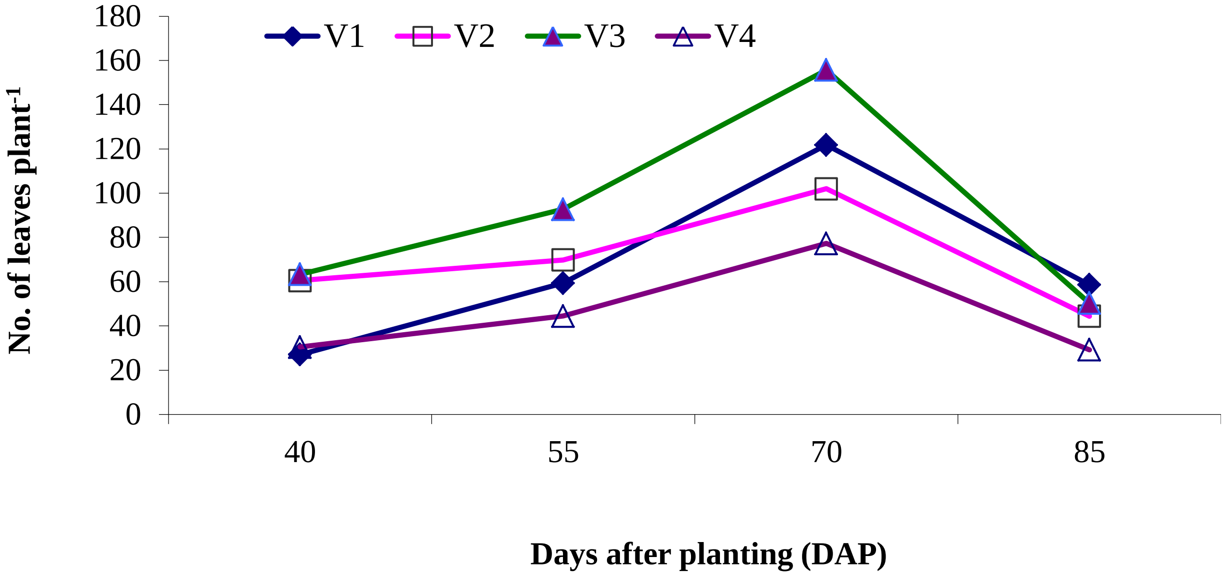

Figure 9. Effect of varieties on number of leaves plant^{-1} of potato at different growth stages (SE value at 40, 55, 70 and 85 DAP are 3.97, 6.12, 15.65 and 2.98 respectively)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.1.5.2 Effect of vermicompost levels

No significant variation of number of leaves plant^{-1} was found due to different vermicompost levels in all the studied durations (Appendix VI and Figure 10). Only numerically difference was observed among the vermicompost levels. At 40 DAP numerically maximum number of leaves plant^{-1} (71.08) was measured from 0 t ha^{-1} (control) vermicompost dose and minimum one (60.83) from 6 t ha^{-1}. At 55 DAP numerically maximum number of leaves plant^{-1} (71.08) was recorded from 0 t ha^{-1} (control) and minimum number of leaves plant^{-1} (60.83) from 6 t ha^{-1}. At 70 DAP maximum number of leaves plant^{-1} (123.2) was recorded from 6 t ha^{-1} and the minimum (104.8) from 4 t ha^{-1}. And finally at 85 DAP the maximum number of leaves plant^{-1} (49.83) was recorded from 2 t ha^{-1} and the minimum was (43.50) from 6 t ha^{-1}.

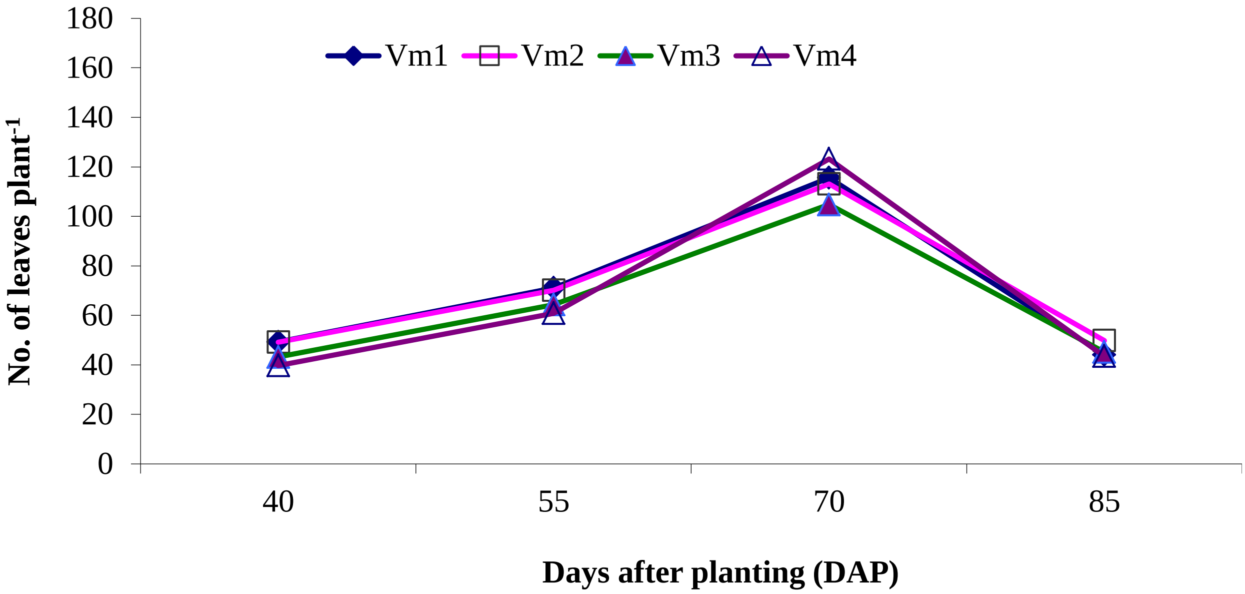

Figure 10. Effect of vermicompost levels on number of leaves plant^{-1} of potato at different growth stages (SE value at 40, 55, 70 and 85 DAP are 3.44, 5.29, 12.68 and 5.respectively)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.1.5.3 Interaction effect of varieties and Vermicompost levels

No significant variation of number of leaves plant^{-1} was found due to interactional effect of varieties and vermicompost levels in all the studied durations (Appendix VI and table 4). Only numerically difference was observed among the interaction between varieties and vermicompost levels. At 40 DAP numerically maximum number of leaves plant^{-1} (78.33) was measured from V_3Vm_2 combination and minimum one

(20.67) from V_4Vm_4. At 55 DAP numerically maximum number of leaves plant^{-1} (97.67) was recorded from V_3Vm_2 and minimum one (30.33) from V_4Vm_4. At 70 DAP numerically maximum number of leaves plant^{-1} (163.8) was measured from V_3Vm_1 combination and minimum one (47.67) from V_4Vm_4. At 85 DAP numerically maximum number of leaves plant^{-1} (62.00) was measured from V_3Vm_2 combination and minimum one (15.67) from V_4Vm_4.

Table 4. Interaction effect of varieties and vermicompost levels on number of leaves plant^{-1} of potato at different DAP

Variety x Vermicompost level	Number of leaves plant^{-1} at different DAP			
	40	**55**	**70**	**85**
V_1Vm_1	29.33	55.33	96.00	44.67
V_1Vm_2	24.33	59.33	118.0	53.67
V_1Vm_3	25.67	53.00	85.00	61.67
V_1Vm_4	29.00	69.67	188.2	74.33
V_2Vm_1	71.33	84.33	128.0	52.67
V_2Vm_2	62.67	68.00	80.83	48.00
V_2Vm_3	56.00	64.67	85.83	31.00
V_2Vm_4	52.00	62.33	113.3	46.00
V_3Vm_1	62.67	95.67	163.8	53.33
V_3Vm_2	78.33	97.67	162.5	62.00
V_3Vm_3	55.00	96.67	152.8	48.00
V_3Vm_4	57.33	81.00	143.7	38.00
V_4Vm_1	33.67	49.00	74.67	25.67
V_4Vm_2	31.33	55.67	91.17	35.67
V_4Vm_3	36.00	43.00	95.67	40.00

V_4Vm_4	20.67	30.33	47.67	15.67
SE value	-	-	-	-
Level of significance	NS	NS	NS	NS
CV (%)	26.33	27.53	38.47	42.61

NS = Not significant. In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix), Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.1.6 Chlorophyll content of leaves (SPAD value)

4.1.6.1 Effect of varieties

Chlorophyll content (SPAD value) of potato leaves were significantly affected by the varieties at 40, 55 and 85 DAP expect 70 DAP (Appendix VII and Figure 11). Chlorophyll content (SPAD value) increased with the advancement of plant age i.e., up to 55 DAP irrespective of varieties and thereafter decreased due to yellowing of leaves (Figure 11). At 40 DAP, the maximum chlorophyll content (SPAD value) (51.92) was recorded from 'BARI Alu-29' which was statistically similar with 'BARI Alu-25', (51.11) 'BARI Alu-28', (49.99) and the minimum (46.01) was recorded from the variety 'BARI TPS-1. At 55 DAP, the highest chlorophyll content (SPAD value) (45.50) was recorded from 'BARI Alu-25' which was statistically similar with 'BARI Alu-29 (45.38), and 'BARI Alu-28' (44.45) and the lowest (41.04) was recorded from 'BARI TPS-1'. At 70 DAP no significant difference observed on variety only numerical difference observed among the varieties. The numerically maximum no of chlorophyll content (SPAD value) (50.98) was observed from the variety BARI Alu-25 and minimum from the variety BARI Alu-28 (47.10). At 85, the maximum chlorophyll content (SPAD value) (46.04) was counted from 'BARI TPS-1 whereas, the minimum (36.35) was counted from the variety 'BARI Alu-28'. Potato varieties used in the study differed in chlorophyll content reading like observed by many other workers (Bavec and Bavec, 2001; Güler *et al.* 2006).

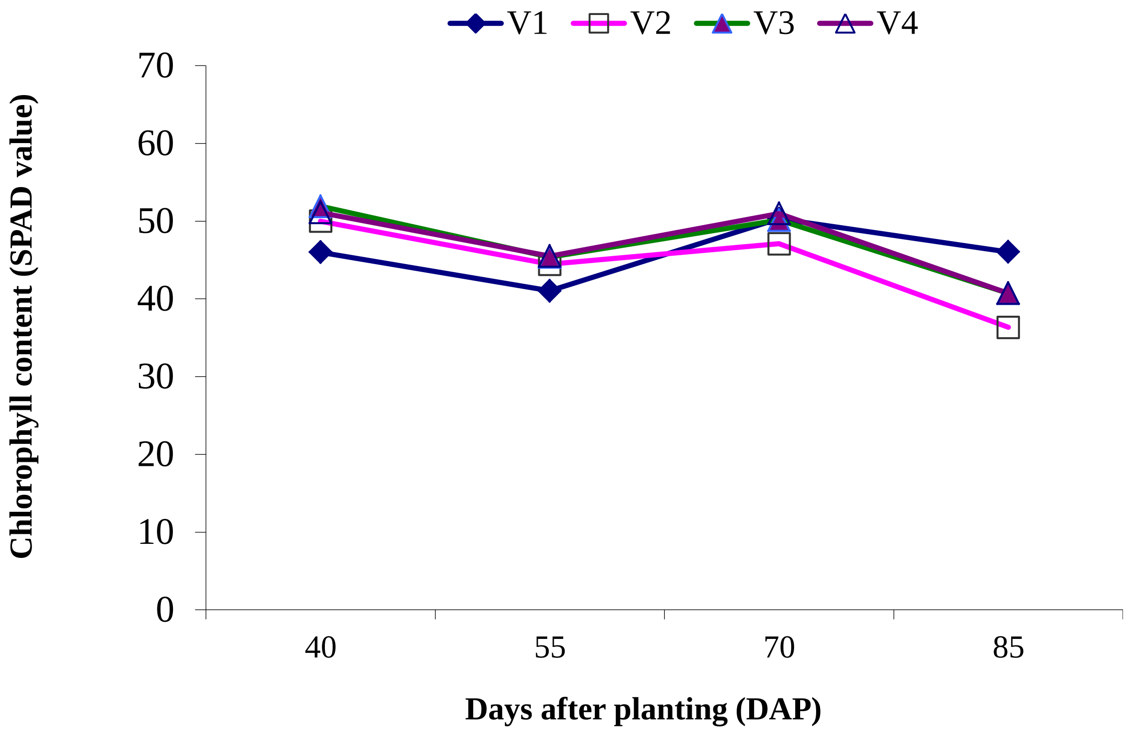

Figure 11.Effect of varieties on chlorophyll content of potato leaves (SPAD value) at different growth stages (SE value at 40, 55, 70 and 85 DAP are 0.96, 0.63, 0.93 and 1.05 respectively)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.1.6.2 Effect of vermicompost levels

No significant variation of chlorophyll content (SPAD value) was found due to different vermicompost levels in all the studied durations (Appendix VII and Figure 12).Only numerically difference was observed among the vermicompost levels. At 40 DAP numerically maximum chlorophyll content (SPAD value) (51.22) was measured from 4 t ha^{-1} vermicompost dose and minimum one (48.92) from 2 t ha^{-1}. At 55 DAP numerically maximum chlorophyll content (SPAD value) (45.67) was recorded from 4 t ha^{-1} and minimum chlorophyll content (SPAD value) (42.56) from 2 t ha^{-1}. At 70 DAP maximum chlorophyll content (SPAD value) (50.28) was recorded from 2 t ha^{-1} and the minimum (48.70) from

0 t ha^{-1}. And finally at 85 DAP the maximum chlorophyll content (SPAD value) (42.43) was recorded from 0 t ha^{-1} and the minimum was (39.78) from 6 t ha^{-1}.

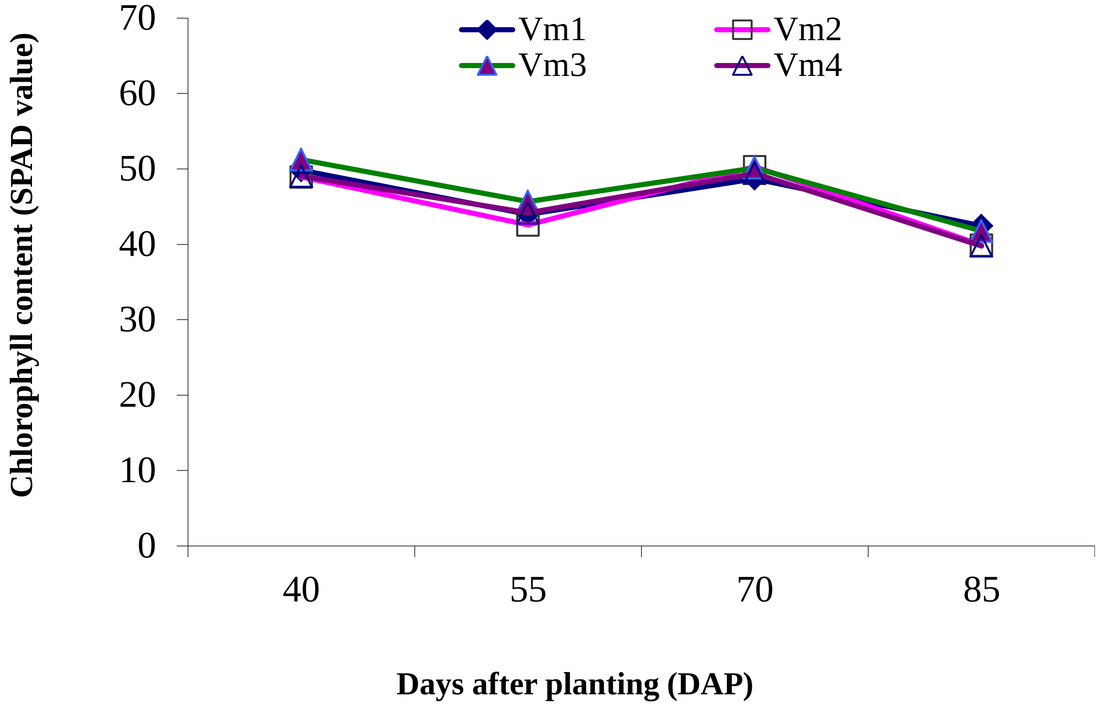

Figure 12. Effect of vermicompost levels on chlorophyll content of potato leaves (SPAD value) at different growth stages (SE value at 40, 55, 70 and 85 DAP are 0.82, 1.05, 1.14 and 1.14 respectively)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.1.6.3 Interaction effect of varieties and vermicompost levels

No significant variation of chlorophyll content (SPAD value) was found due to interactionl effect of varieties and vermicompost levels in all the studied durations (Appendix 5 and Figure 13). Only numerically difference was observed among the interaction between varieties and vermicompost levels. At 40 DAP numerically maximum chlorophyll content (SPAD value) (55.52) was measured from V_3Vm_3 combination and minimum one (43.83) from V_1Vm_4. At 55 DAP numerically maximum chlorophyll content (SPAD value) (49.53) was recorded from V_3Vm_3 and minimum one (38.52) from V_1Vm_2. At 70 DAP numerically maximum chlorophyll content (SPAD value) (53.93) was measured from V_1Vm_2 combination and minimum one (44.52) from V_2Vm_4. At 85 DAP numerically maximum chlorophyll content (SPAD value) (49.37) was measured from V_1Vm_1 combination and minimum one (32.15) from V_2Vm_2.

Table5. Interaction effect of varieties and vermicompost levels on chlorophyll content of potato at different DAP

Variety x Vermicompost level	Chlorophyll content at DAP			
	40	**55**	**70**	**85**
V_1Vm_1	48.88	42.67	48.57	49.37

V_1Vm_2	44.98	38.52	53.93	45.37
V_1Vm_3	46.35	42.35	47.63	45.68
V_1Vm_4	43.83	40.63	51.10	43.73
V_2Vm_1	49.63	43.40	46.80	38.43
V_2Vm_2	50.15	43.05	45.15	32.15
V_2Vm_3	52.45	45.75	52.02	38.90
V_2Vm_4	47.72	45.60	44.45	35.93
V_3Vm_1	49.67	44.42	49.07	40.97
V_3Vm_2	49.00	42.72	50.22	35.92
V_3Vm_3	55.52	49.53	51.22	44.07
V_3Vm_4	53.50	44.87	50.08	41.92
V_4Vm_1	51.12	45.37	50.35	40.95
V_4Vm_2	51.53	45.97	51.82	46.08
V_4Vm_3	50.58	45.05	49.73	38.37
V_4Vm_4	51.20	45.63	52.02	37.52
SE value	-	-	-	-
Level of significance	NS	NS	NS	NS
CV (%)	5.74	8.26	7.96	12.16

NS = Not significant

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)
Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.2 Yield and yield components

4.2.1 Yield t ha^{-1}

4.2.1.1 Effect of varieties

Variety had significant effect on the yield of tuber t/ha (Appendix VIII and Figure 13). The highest tuber yield (28.89 t ha^{-1}) was obtained from the variety ‘BARI Alu-28 while the minimum (25.19 t ha^{-1}) was found from the ‘BARI Alu-28’. The yields of different cultivars of potato were significantly different from each other reported by Kundu *et al.* (2012). Similar trend of yield performance was also reported by Hossain (2011), Dhar *et al.* (2009) and Das (2006). The probable reason for variation in yield due to the heredity of the variety, difference in agro-ecological condition and soils of the experimental site.

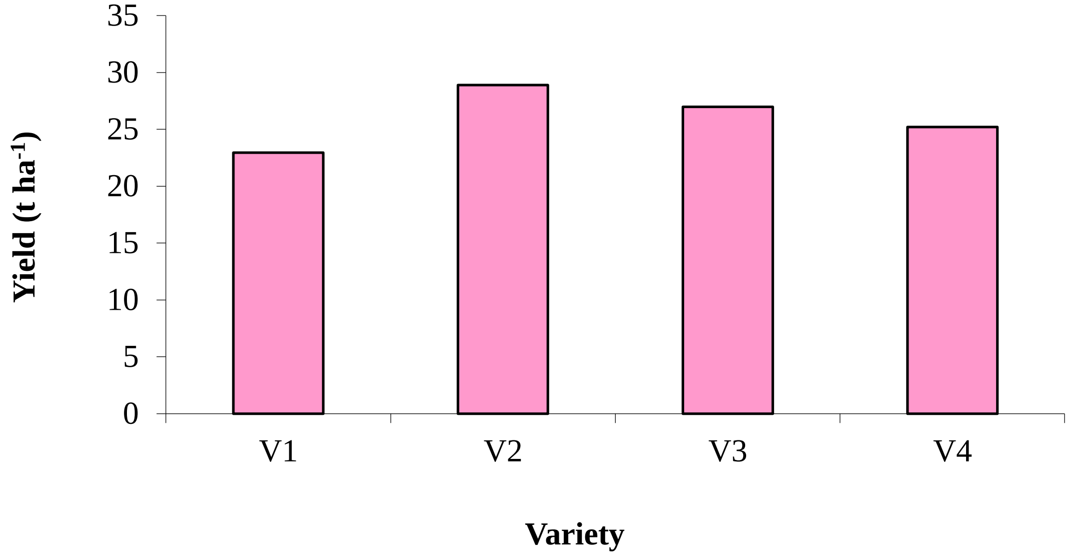

Figure 13.Effect of varieties on yield of tuber (SE value = 0.25)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.2.1.2 Effect of vermicompost levels

Tuber yield t ha^{-1} has significantly influenced by the vermicompost level (Appendix VIII and Figure 14). The highest tuber yield (32.53 t ha^{-1}) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (19.64 t ha^{-1}) was found from the 'Vermicompost 0 t ha^{-1}'. This variation might be due to change the yield contributing character under different vermicompost level.

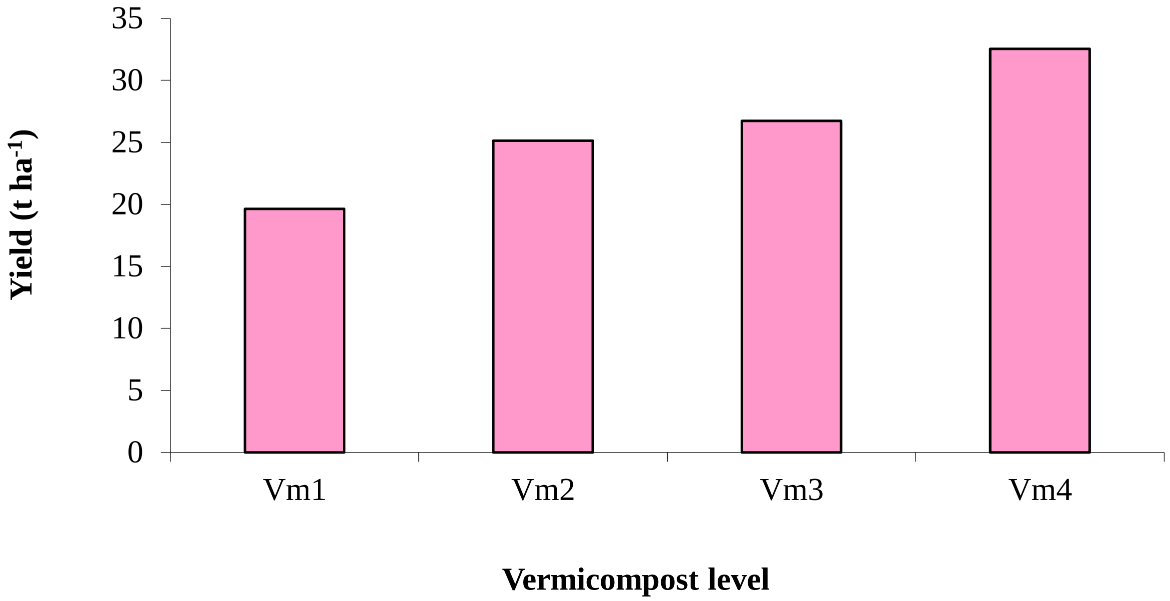

Figure 14. Effect of vermicompost levels on yield of tuber (SE value =0.30)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.2.1.3 Interaction effect of varieties and vermicompost level

Interaction of varieties and vermicompost levels had significant effect on tuber yield t/ha (Appendix VIII and Table 6). The maximum tuber yield (33.86 t ha^{-1}) was recorded in V_2Vm_4 which statistically similar with the V_4Vm_4 (32.65 t ha^{-1}) and V_3Vm_4 (33.71 t ha^{-1}).The minimum tuber yield (15.93 t ha^{-1}) was observed in V_1Vm_1.

4.2.2 Average tuber weight (g)

4.2.2.1 Effect of varieties

The average tuber weight varied significantly due to different varieties (Appendix 6 and Figure 15). The maximum average tuber weight (50.44 g) was recorded from the ‘BARI Alu-28’ variety whereas, the minimum (34.44 g) was obtained from the ‘BARI TPS-1’ variety.

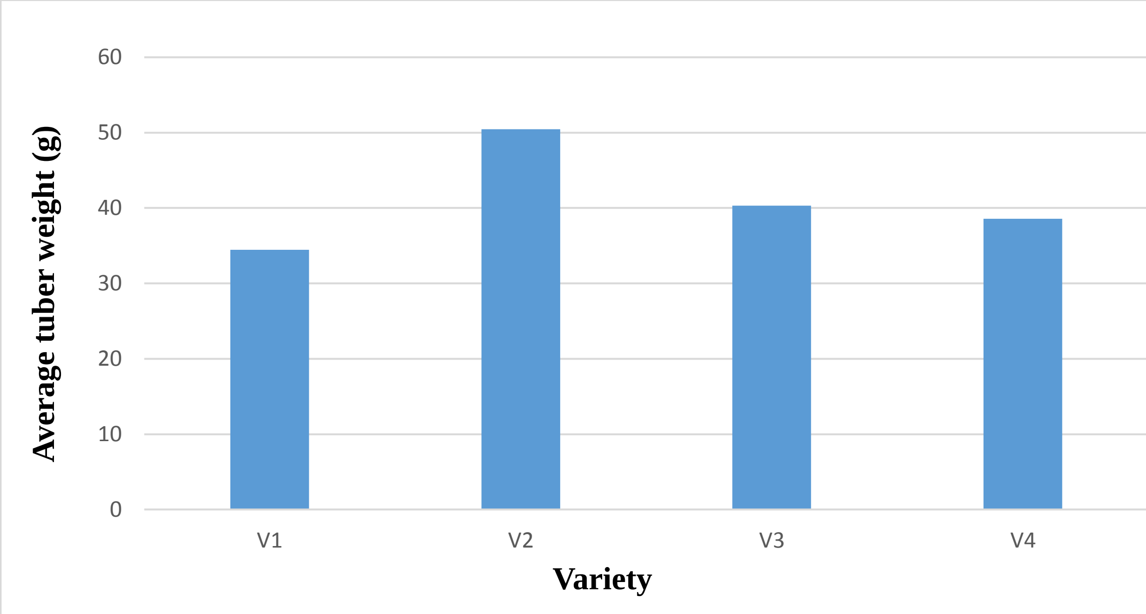

Figure 15. Effect of varieties on average tuber of potato (SE value = 0.37)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.2.2.2 Effect of vermicompost levels

Average tuber weight (g) of potato has significantly influenced vermicompost level (Appendix VIII and Figure 16). The highest Average tuber weight (46.58 g) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (33.75 g) was found from the 'Vermicompost 0 t ha^{-1}'

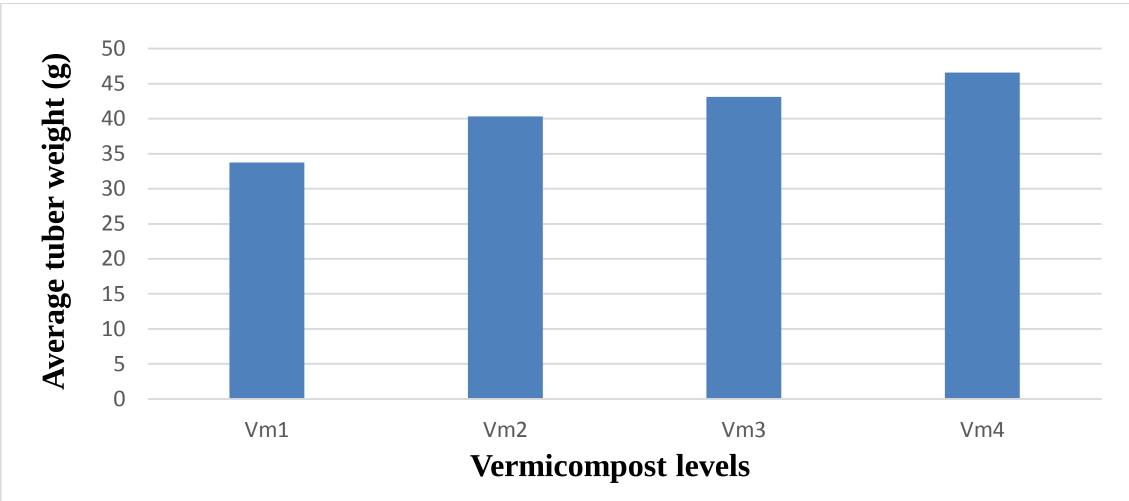

Figure 16. Effect of vermicompost levels on average tuber weight of tuber (SE value = 0.36)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.2.2.3 Interaction effect of varieties and vermicompost level

Interaction of varieties and vermicompost levels had significant effect on average tuber weight (Appendix VIII and Table 6). The maximum Average tuber weight (57.74 g) was recorded in V_2Vm_4 which statistically similar with the V_2Vm_3 (55.74 g) and V_3Vm_4. The minimum Average tuber weight (29.59 g) was observed in V_1Vm_1.

4.2.3 Weight of marketable yield (t ha^{-1})

4.2.3.1 Effect of varieties

Weight of marketable yield (t ha^{-1}) has significantly influenced by the potato varieties (Appendix VIII and Figure 27). The highest marketable yield (24.55 t ha^{-1}) was recorded from the 'BARI Alu-28' and the minimum result (21.41 t ha^{-1}) was found from the 'BARI TPS-1. This variation might be due to different tuber size of potato varieties.

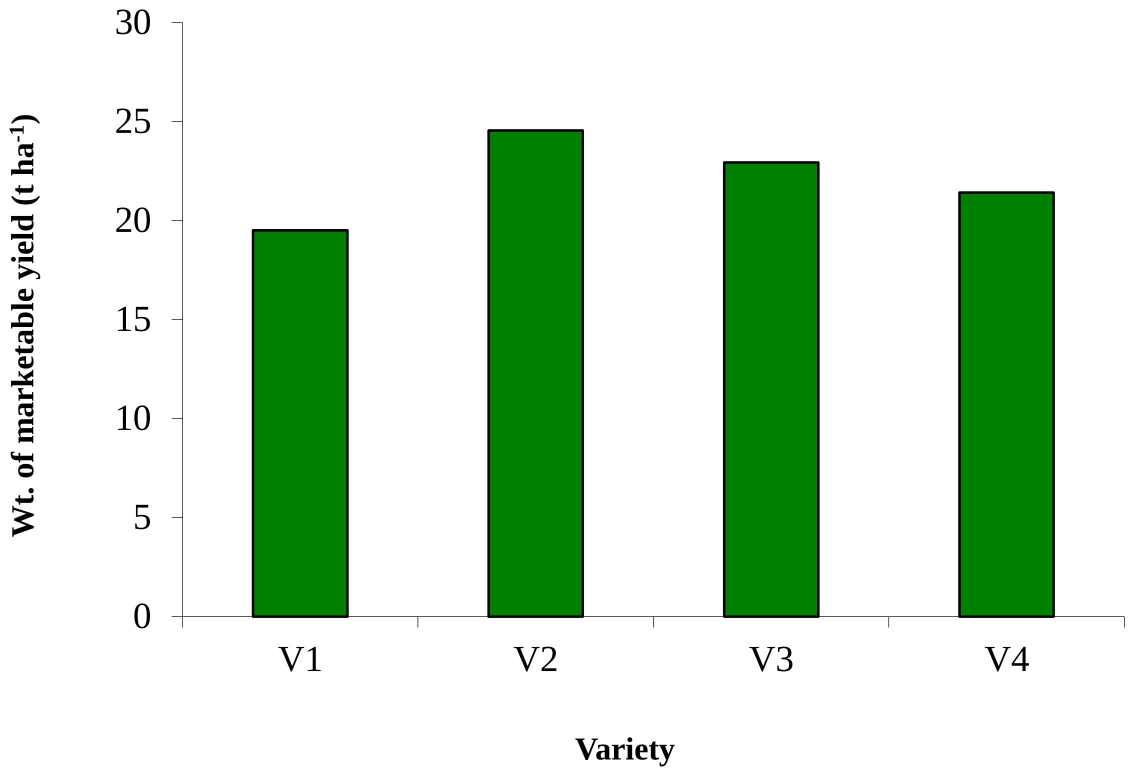

Figure 17.Effect of varieties on weight of marketable yield of potato (SE value = 0.16)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.2.3.2 Effect of vermicompost levels

Weight of marketable yield (t ha^{-1}) has significantly influenced vermicompost level (Appendix VIII and Figure 18). The highest marketable yield (t ha^{-1}) (27.65) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (16.69) was found from the 'Vermicompost 0 t ha^{-1}'. This variation might be due to change in tuber size under different vermicompost level.

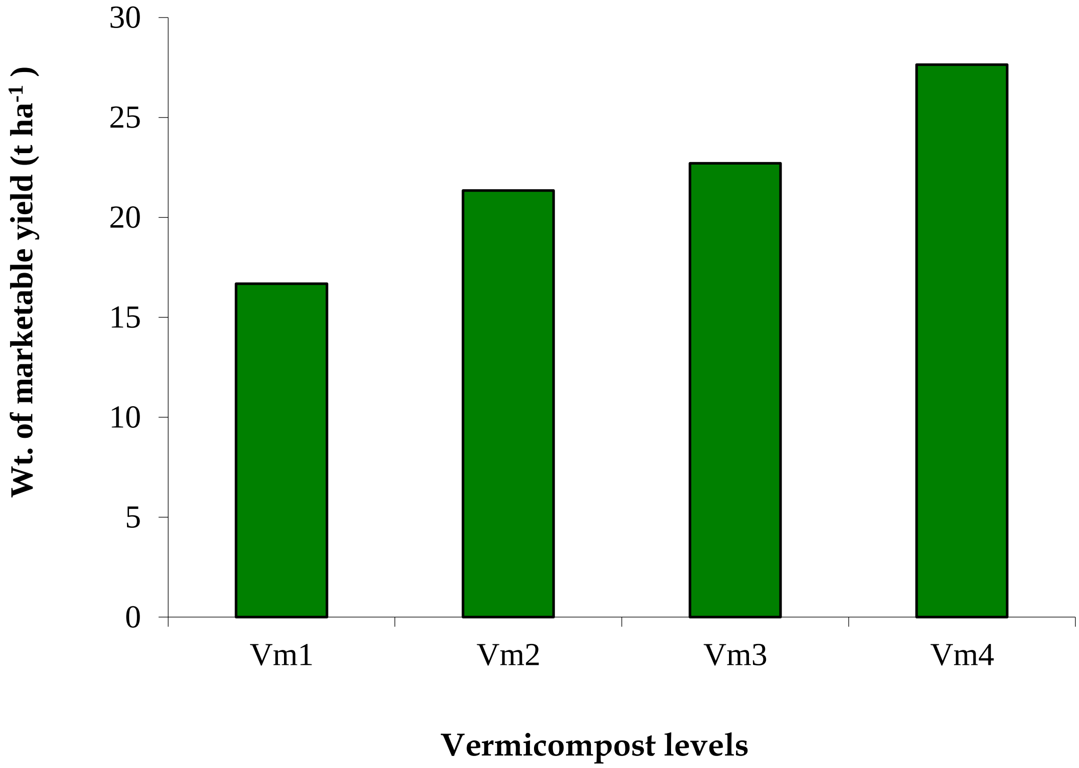

Figure 18. Effect of vermicompost levels weight of marketable yield of potato (SE value = 0.206)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.2.3.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and Vermicompost level levels had significant effect on marketable tuber yield t ha^{-1} (Appendix VIII and Table 19). The maximum marketable yield t ha^{-1} (28.78) was recorded in V_2Vm_4 which statistically similar with the V_4M_4 (27.76) and V_3M_4 (28.66).The minimum marketable tuber yield (13.55) was observed in V_1M_1.

4.2.4 Weight of non-marketable yield (t ha^{-1})

4.2.4.1 Effect of varieties

Weight of non-marketable yield (t/ha) has significantly influenced by the potato varieties (Appendix VIII and Figure 19). The highest non-marketable yield (4.34 t ha^{-1}) was recorded from the 'BARI Alu-28' and the minimum result (3.55 t ha^{-1}) was found from the 'BARI Alu-29. This variation might be due to different tuber size and percentage of tuber size of potato varieties.

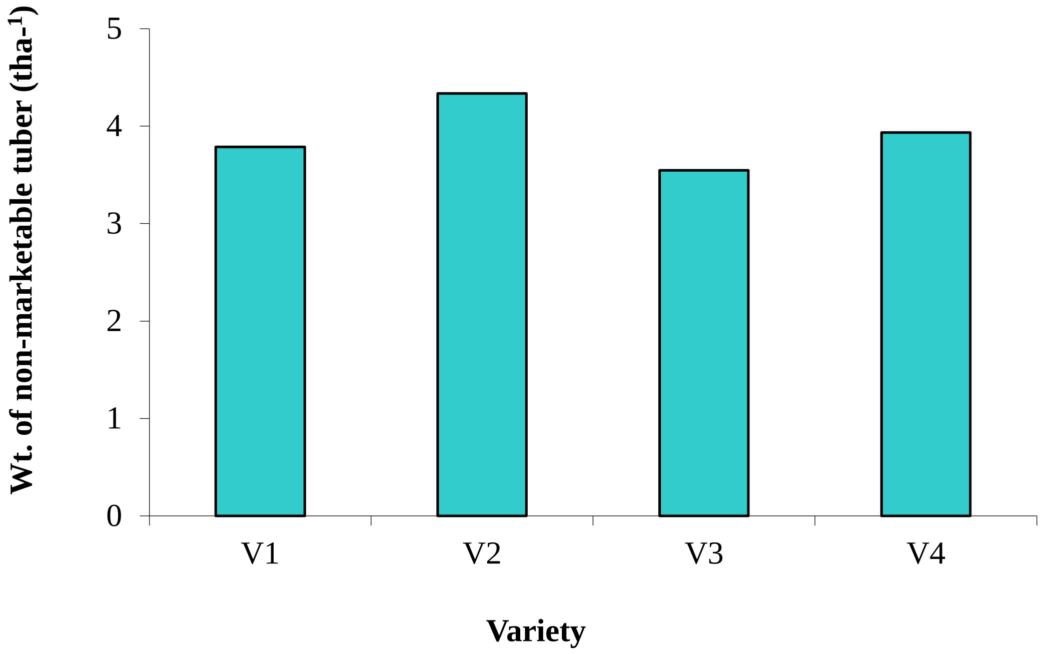

Figure 19. Effect of varieties on weight of non-marketable tuber of potato (SE value = 0.05)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.2.4.2 Effect of vermicompost

Weigh of non-marketable yield (t ha^{-1}) has significantly influenced vermicompost level (Appendix VIII and Figure 20). The highest non-marketable yield (t ha^{-1}) (4.88) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (2.95 t ha^{-1}) was found from the 'Vermicompost 0 t ha^{-1}'. This variation might be due to change in tuber size under different vermicompost level. Present experiment showed that amount of non-marketable tuber number increases with increasing vermicompost levels.

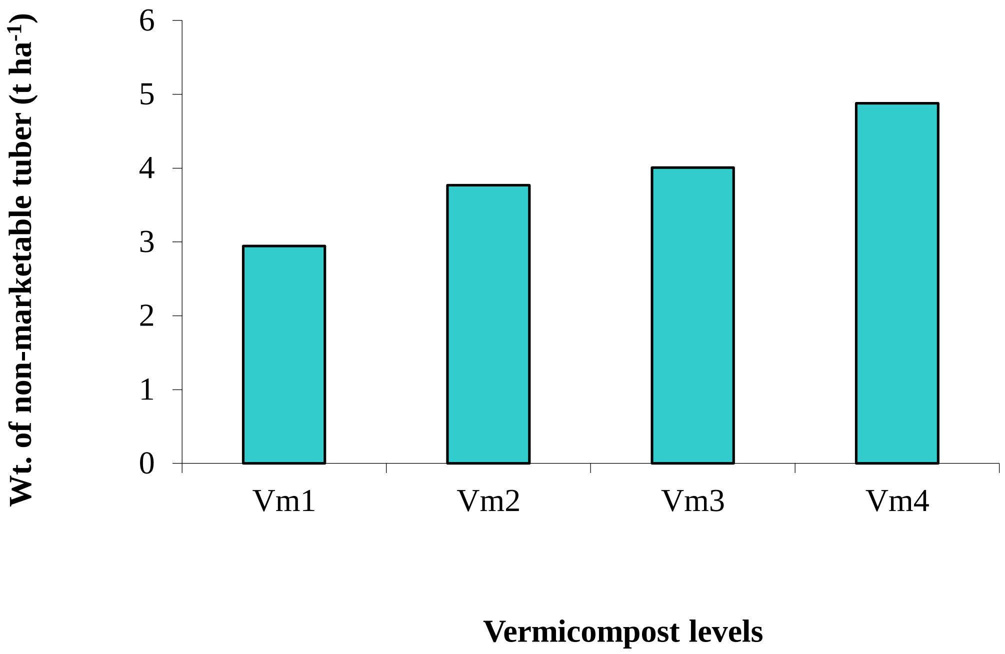

Figure 20.Effect of vermicompost levels on weight non-marketable tuber of potato (SE value = 0.06)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.2.3.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and vermicompost level levels had significant effect on non-marketable tuber yield t ha^{-1} (Appendix VIII and Table 6). The maximum non-marketable yield t ha^{-1} (5.08) was recorded in V_2Vm_4 which statistically similar with the V_4M_4 (5.06 t ha^{-1}) and V_3M_4 (4.90 t ha^{-1}).The minimum non-marketable tuber yield (2.39) was observed in V_3M_1.

4.2.5 Weight of seed potato (t ha^{-1})

4.2.5.1 Effect of varieties

Weight of seed potato has significantly influenced by the potato varieties (Appendix VIII and Figure 21). The highest seed potato (21.67 t ha^{-1}) was recorded from the 'BARI Alu-28' and the minimum result (18.94 t ha^{-1}) was found from the 'BARI TPS-1. This variation might be due to different tuber size of potato varieties.

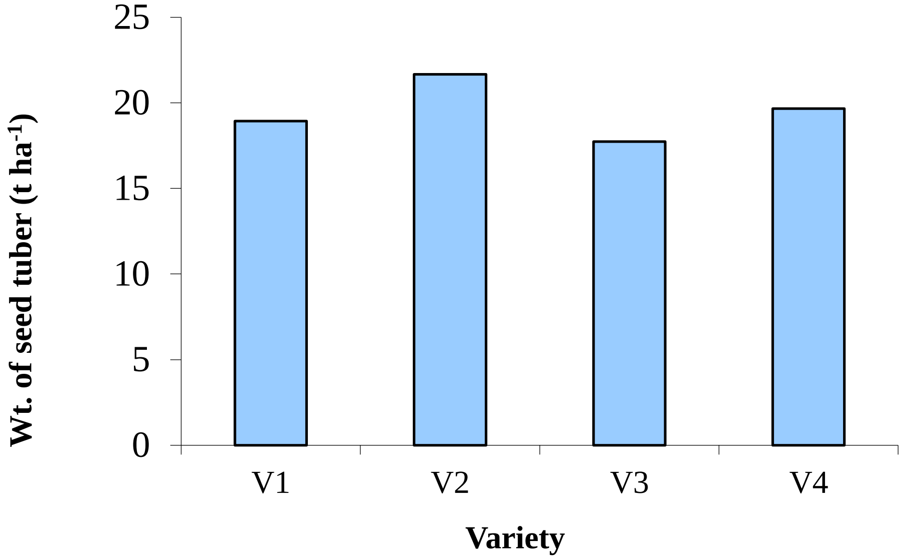

Figure 21.Effect of varieties on weight of seed tuber yield of potato (SE value = 0.20)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.2.5.2 Effect of vermicompost

Weigh of seed potato has significantly influenced vermicompost level (Appendix VIII and Figure 22). The highest seed potato (t ha^{-1}) (40.27) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (25.36 t ha^{-1}) was found from the 'vermicompost 0 t ha^{-1}'. This variation might be due to change in tuber size under different vermicompost level.

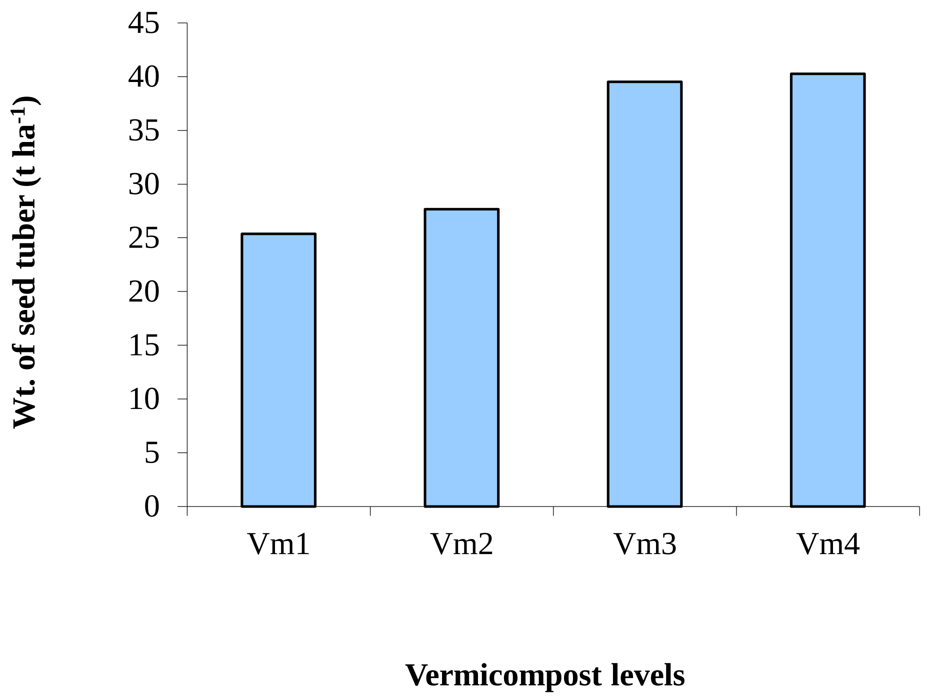

Figure 22. Effect of vermicompost levels on seed tuber yield of potato (SE value = 0.91)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

Table 6. Interaction effect of varieties and vermicompost levels on tuber yield , weight of average tuber, weight of marketable tuber potato, weight of non- marketable potato and weight of seed tuber potato

Variety x Vermicompost level	Average tuber weight(g)	Yield (t ha^{-1})	Weight of marketable yield (t ha^{-1})	Weight of non -marketable yield (t ha^{-1})	Weight seed potato (t ha^{-1})
V_1Vm_1	29.59 i	15.93 g	13.55 g	2.803 g	14.02 f
V_1Vm_2	32.84 h	21.69 e	18.44 e	3.780 cd	18.89 d
V_1Vm_3	36.03 fg	24.31 d	20.66 d	4.090 c	20.46 c
V_1Vm_4	39.32 e	29.88 b	25.40 b	4.480 b	22.41 b
V_2Vm_1	37.12 f	22.19 e	18.86 e	3.330 ef	16.65 e

V_2Vm_2	51.71 b	29.51 b	25.08 b	4.430 b	22.13 b
V_2Vm_3	55.74 a	29.98 b	25.48 b	4.497 b	22.49 b
V_2Vm_4	57.18 a	33.86 a	28.78 a	5.083 a	25.40 a
V_3Vm_1	34.72 gh	21.75 e	18.48 e	2.390 h	11.95 g
V_3Vm_2	40.02 e	25.18 d	21.40 d	3.250 f	16.27 e
V_3Vm_3	40.48 e	27.28 c	23.19 c	3.650 de	18.23 d
V_3Vm_4	45.98 c	33.71 a	28.66 a	4.900 a	24.49 a
V_4Vm_1	33.56 h	18.69 f	15.88 f	3.260 f	16.31 e
V_4Vm_2	36.75 fg	24.12 d	20.50 d	3.620 de	18.09 d
V_4Vm_3	40.19 e	25.30 d	21.51d	3.800 cd	18.98 d
V_4Vm_4	43.83 d	32.65 a	27.76 a	5.060 a	25.29 a
SE value	0.73	0.59	0.41	0.11	0.41
Level of significance	**	**	**	**	**
CV (%)	3.07	3.92	3.23	4.83	3.59

** = Significant at 1% level of probability,

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.2.5.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and vermicompost level levels had significant effect on seed tuber t ha^{-1} (Appendix VIII and Table 6). The maximum amount of seed potato t ha^{-1} (25.40) was recorded in V_2Vm_4 which statistically similar with the V_4M_4 (25.40 t ha^{-1}) and V_3M_4 (24.49 t ha^{-1}). The minimum of seed tuber potato (11.95 t ha^{-1}) was observed in V_3M_1.

4.3 Quality characters

4.3.1 Skin color of potato

4.3.1.1 Effect of variety

The statistical analysis revealed significant differences ($p<0.05$) for lightness (L*), green-red chromaticity (a*), blue-yellow chromaticity (b*), of potato skin in different varieties (Appendix IX). Among four varieties, the skin of 'BARI TPS-1' had the highest L* value (68.44) compared to those of others whereas the lowest was observed in 'BARI ALu-28' (57.58) (figure 23). In case of a* 'BARI Alu-25' produced the maximum result (9.12) which was statistically similar with BARI Alu-28 (9.07) whereas 'BARI TPS-1' produced the minimum a* value (3.32). In case of b* 'BARI TPS-1' produced the maximum result (26.35) whereas 'BARI Alu-28' produced the minimum b* value (14.36).

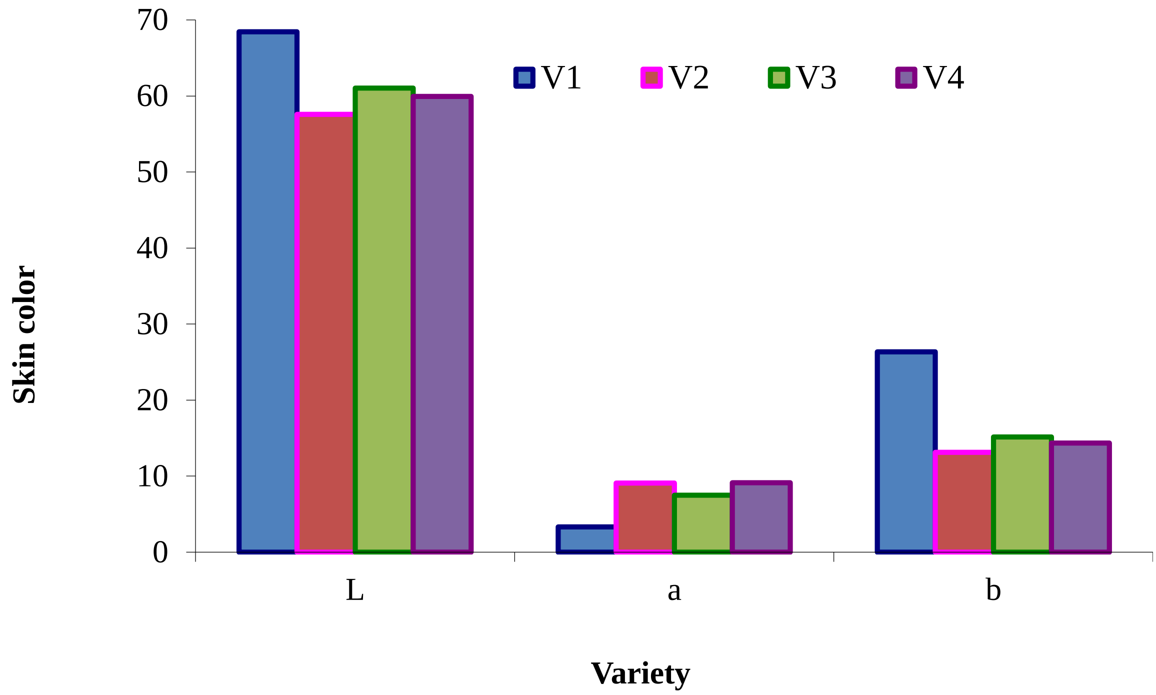

Figure 23.Effect of varieties on skin color of potato (SE value of L, a and b are 0.22, 0.10 and 0.09 respectively)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.3.1.2 Effect of vermicompost levels

Vermicompost levels had significance effect on lightness (L*), but no significant effect on degree of yellowness (b*), redness (a*) for skin. (Appendix IX).The highest L* value (62.55) was recorded from the 'vermicompost 0t/ha' which is statistically similar with 2 t/ha and the minimum value (60.64) was found from the 'Vermicompost 6 t ha^{-1}'. Incases of a* numerically highest value (7.47) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (6.82) was found from the 'Vermicompost 0 t ha^{-1}'. The numerically highest b* value (17.99) was recorded from the 'vermicompost 0 t ha^{-1}' and the minimum (16.56) was found from the 'Vermicompost 6 t ha^{-1}'.

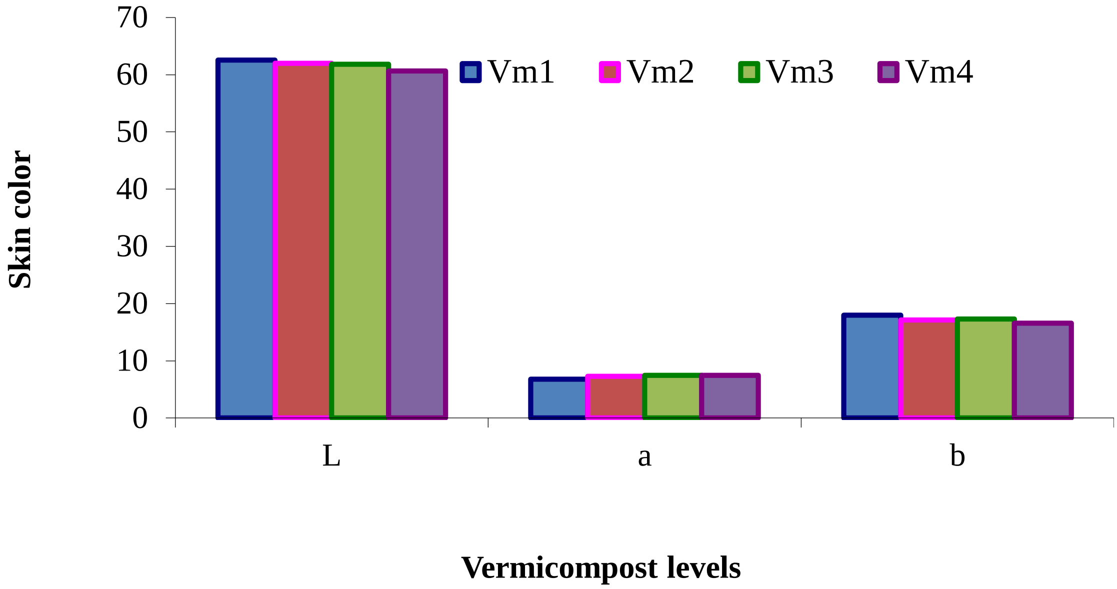

Figure 24. Effect of vermicompost levels on skin color of potato (SE value of L, a and b are 0.24, 0.07 and 0.09 respectively)

Note : Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.1.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and Vermicompost level levels had significant effect on lightness (L*), green-red chromaticity (a*) but no significance effect on blue-yellow chromaticity (b*) (Appendix IX and Table 7). The highest L* value (69.52) was recorded in V_1Vm_1 which statistically similar with the V_1Vm_2 (68.98) and V_1Vm_3 (68.25).The lowest one (56.23) was observed in V_2Vm_1 which is statistically similar with V_2Vm_1 (57.13).Incases of a* highest value (9.92) was recorded from the V_2Vm_3 which is statistically similar with V_2Vm_4 (9.83), V_4Vm (9.68), V_4Vm_4

(9.38), V_4Vm_2 (8.88), V_3Vm_2 (8.60), V_2Vm_2 (8.53) and V_4Vm_1 (8.53) and the minimum (3.12) was found from V_1Vm_2 which is statistically similar with V_1Vm_4 (3.18), V_1Vm3 (3.37) and V_1Vm_1 (3.62). The numerically highest b* value (27.57) was recorded from the V_1Vm_1 and the minimum (11.45) was found from the V_2Vm_4.

Table 7. Interaction effect of varieties and vermicompost levels on skin color at different parts of potato

Variety x Vermicompost level	Skin color at DAP		
	L	**a**	**b**
V_1Vm_1	69.52 a	3.62 f	27.57
V_1Vm_2	68.98 a	3.12 f	26.52
V_1Vm_3	68.25 ab	3.37 f	26.43
V_1Vm_4	67.02 b	3.18 f	24.88
V_2Vm_1	57.13 gh	8.00 b-e	13.07
V_2Vm_2	57.98 fg	8.53 a-d	13.92
V_2Vm_3	58.97 ef	9.91 a	14.05
V_2Vm_4	56.23 h	9.83 a	11.45
V_3Vm_1	62.30 c	7.11 de	15.70
V_3Vm_2	60.30 de	8.60 a-c	13.95
V_3Vm_3	60.95 d	6.82 e	14.30
V_3Vm_4	60.58 d	7.48 c-e	16.67
V_4Vm_1	61.23 cd	8.53 a-d	15.62
V_4Vm_2	60.62 d	8.88 a-c	14.22
V_4Vm_3	59.17 ef	9.68 a	14.38
V_4Vm_4	58.72 f	9.36 ab	13.23
SE value	0.44	0.44	-
Level of significance	**	*	NS
CV (%)	1.23	10.53	8.14

**, * = Significant at 1% and 5% level of probability respectively, NS = Not significant

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly.

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix),Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.2 Flesh color of potato

4.3.2.1 Effect of varieties

The statistical analysis revealed significant differences ($p<0.05$) for lightness (L*) but no significance effect of green-red chromaticity (a*), blue-yellow chromaticity (b*) of potato flesh color in different varieties (Appendix 8). Among four varieties, the flesh of 'BARI Alu-28' had the highest L* value (71.88) which is statistically similar with BARI TPS-1 (71.66) whereas the lowest was observed in 'BARI ALu-2' (70.16) which is statistically similar with BARI Alu-25 (70.62) (figure 25). In case of a* 'BARI Alu-28' produced the numerically maximum result (1.09) whereas 'BARI Alu-29' produced the minimum a* value (1.07). In case of b* 'BARI TPS-1' produced the numerically maximum result (19.82) whereas 'BARI Alu-28' produced the minimum b* value (18.01). The variation of colour can be explained by differences in composition within varieties, particularly in antioxidant content and enzyme activity. The varieties produced light coloured flesh (L*>50), which indicates that there was no excessive darkening. This can be attributed to low reducing sugars levels exhibited by the varieties. All the varieties tended towards the positive values of redness parameter (a*) of skin and flesh colour indicating that there was less or no excess browning of the products during frying. Lack of excess browning can be attributed to low and acceptable levels of sugars, major causes of browning during frying of potato products. Also all the potato varieties tended towards yellow as indicated by positive values of yellowness (b*) parameter. Abong and Kabira (2011) also found significant varietal differences in colour and textural properties of crisps and French fries with the product and variety. This might be attributed due to genetical, environmental or inter cultural factors. This colour parameter could be used as an objective colour index for preparing chips. Moreira *et al*. (1999) reported that low reducing sugar content (below 0.25% and preferably below 0.1% is desired for the production of potato chips.

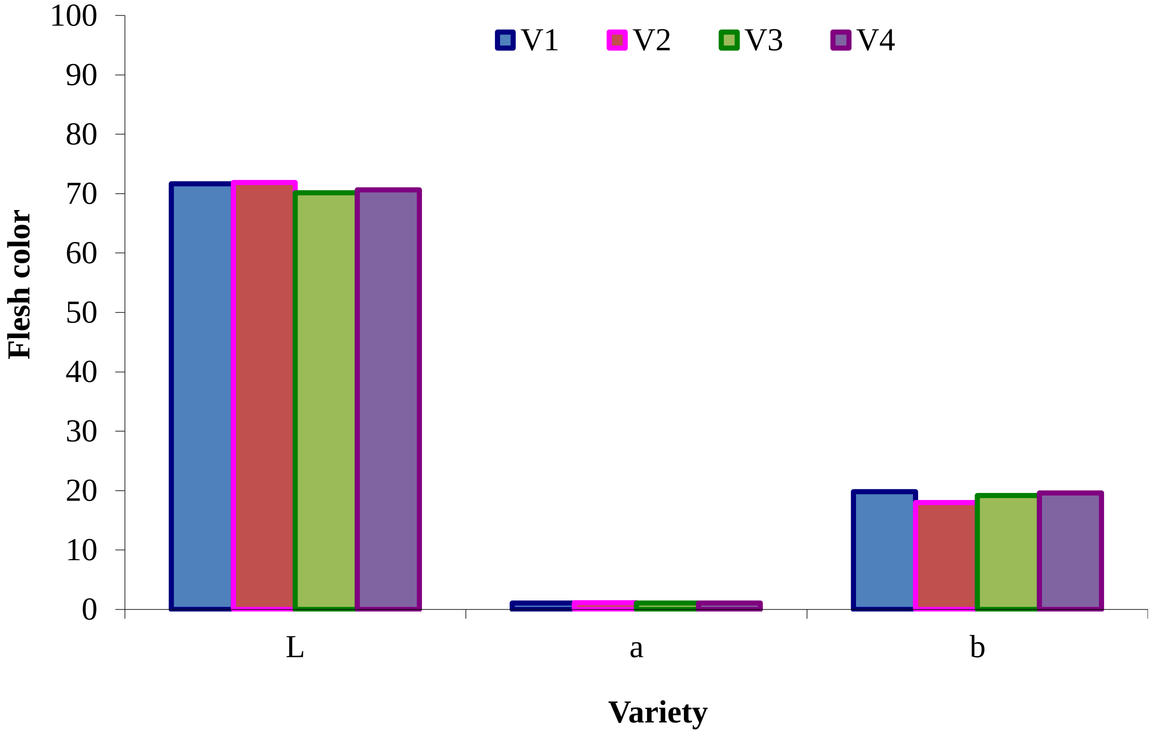

Figure 25.Effect of varieties on flesh firmness of potato (SE value of L, a and b are 0.15, 0.02 and 0.08 recpectively)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.3.2.2 Effect of vermicompost levels

Vermicompost levels had significance effect on lightness (L*), but no significant effect on degree of yellowness (b*), redness (a*) for flesh color. (Appendix X).The highest L* value (71.91) was recorded from the 'vermicompost 0 t ha^{-1} which is statistically similar with 4 t ha^{-1} (71.19) and the minimum value (70.60) was found from the 'Vermicompost 2 t ha^{-1}' which statistically similar with the 6 t ha^{-1} (70.63) and 4 t ha^{-1} (71.19).Incases of a* numerically highest value (1.17) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (1.3) was found from the 'Vermicompost 0 t ha^{-1}'. The numerically highest b* value (20.14) was recorded from the 'vermicompost 4 t ha^{-1}' and the minimum (17.74) was found from the 'Vermicompost 4 t ha^{-1}'.

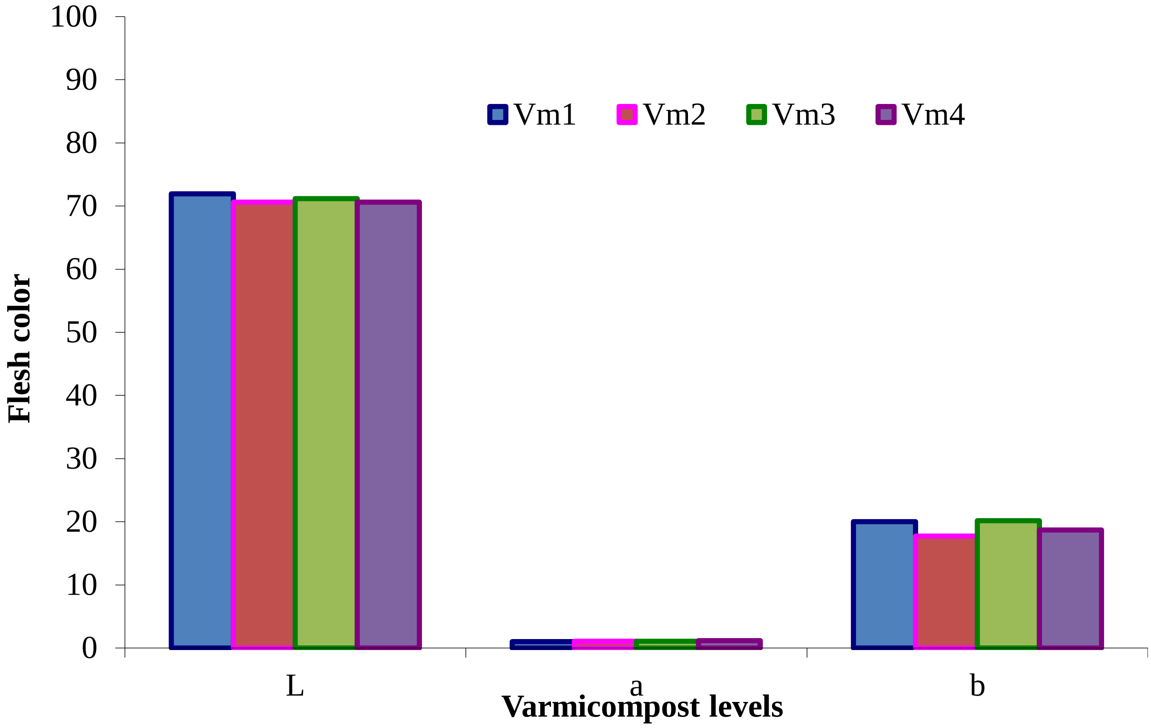

Figure 26. Effect of vermicompost levels on flesh color of potato (SE value of L, a and b are 0.15, 0.02 and 0.12 respectively)

Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.2.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and Vermicompost level levels had significant effect on lightness (L*) and blue-yellow chromaticity (b*) but no significance effect on green-red chromaticity (a*) (Appendix X and Table 8). The highest L* value (73.52) was recorded in V_1Vm_2 which statistically similar with the V_2Vm_4 (72.32) ,V_4Vm_1 (72.18), V_2Vm_3 (72.17) and V_1Vm_3 (71.98). The lowest one (68.90) was observed in V_1Vm_4 which is statistically similar with V_4Vm_2 (68.97), V_3Vm_2 (68.98), V_3Vm_4 (70.50), V_4Vm_3 (70.53) , V_4Vm_4 (70.80), V_2Vm_2 (70.93) and V_3Vm_3 (70.07). Incases of a* numerically highest value (1.50) was recorded from the V_1Vm_4 and the minimum (0.79) was found from V_1Vm_1. The highest b* value (23.88) was recorded from the V_1Vm_3 and the minimum (16.78) was found from the V_1Vm_4 which is statistically similar with V_1Vm_4 (16.82), V_4Vm_2 (17.60), V_1Vm_2 (17.70), V_2Vm_1 (71.72) and V_3Vm_3 (17.98).

Table 8. Interaction effect of varieties and vermicompost levels on flesh color at different parts of potato

Variety x Vermicompost level	Flesh color at DAP		
	L	**a**	**b**
V_1Vm_1	72.25 a-c	0.79	21.50 b
V_1Vm_2	73.52 a	0.83	17.70 d-g
V_1Vm_3	71.9 a-c	1.11	23.88 a
V_1Vm_4	68.90 d	1.50	16.18 g
V_2Vm_1	72.12 a-c	1.16	17.72 d-g
V_2Vm_2	70.93 b-d	1.15	16.82 fg
V_2Vm_3	72.17 a-c	0.973	18.63 c-f
V_2Vm_4	72.32 ab	1.06	18.87 c-f
V_3Vm_1	71.08 b-d	1.08	20.77 bc
V_3Vm_2	68.98 d	1.08	18.82 c-f
V_3Vm_3	70.07 cd	1.06	17.98 d-g
V_3Vm_4	70.50 b-d	1.06	19.10 c-f
V_4Vm_1	72.18 a-c	1.06	20.00 b-e
V_4Vm_2	68.97 d	1.07	17.60 e-g
V_4Vm_3	70.53 b-d	1.11	20.07 b-d
V_4Vm_4	70.80 b-d	1.06	20.68 bc
SE value	0.64	-	0.72
Level of significance	**	NS	**
CV (%)	1.58	26.28	6.57

** = Significant at 1% level of probability, NS = Not significant

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly. Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta) V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix) Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.3. Firmness of potato

4.3.3.1 Effect of variety

Firmness of potato has significantly influenced by the potato varieties

(Appendix XI and Figure 27). The highest firmness value (43.65) was recorded from the 'BARI Alu-28' and the minimum result (37.42) was found from the 'BARI Alu-25.

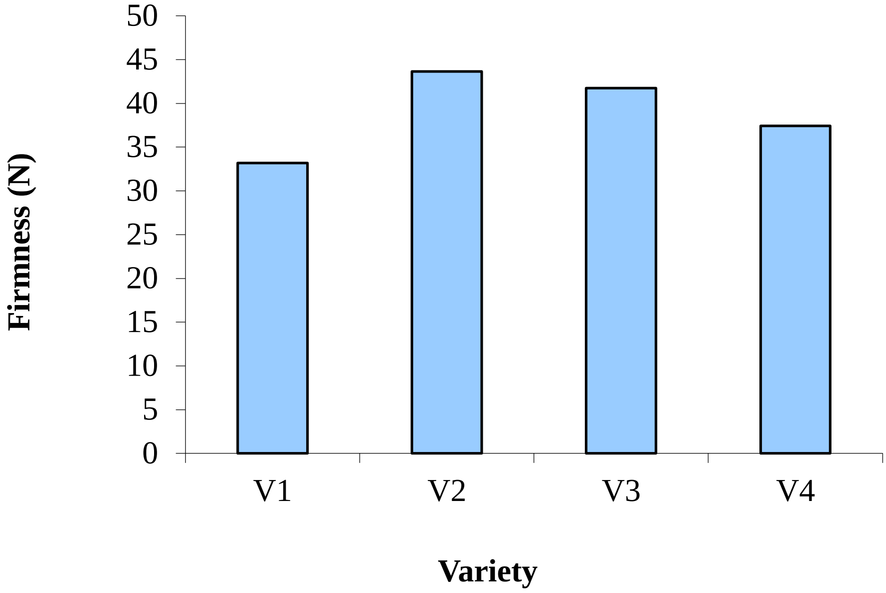

Figure 27.Effect of varieties on flesh firmness (N) of potato (SE value = 0.46)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.3.3.2 Effect of vermicompost

Firmness value has significantly influenced vermicompost level (Appendix XI and Figure 28). The highest firmness value (43.92) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (32.65) was found from the 'Vermicompost 0 t ha^{-1}'.

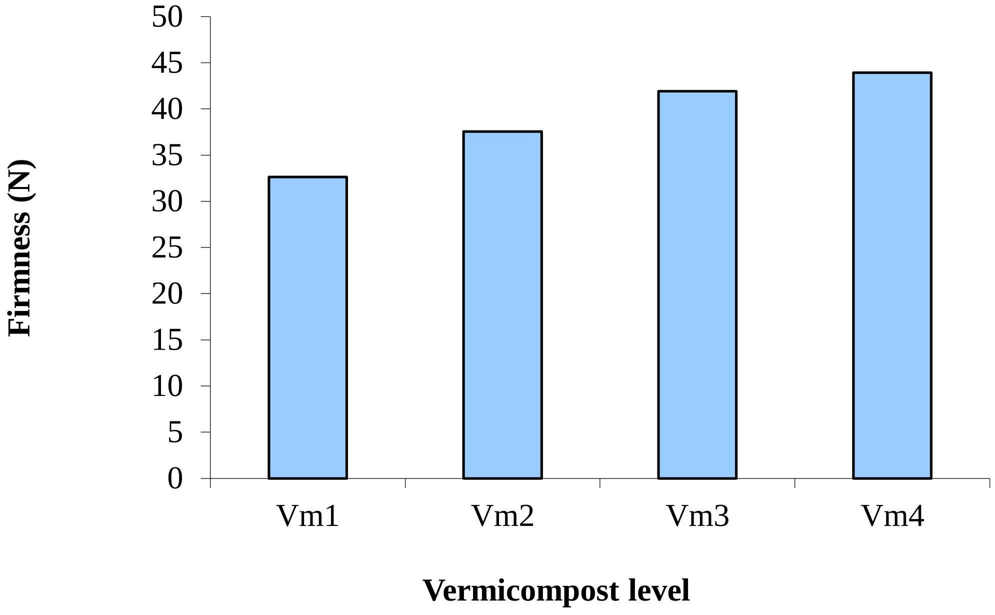

Figure 28. Effect of vermicompost levels on firmness (N) of potato (SE value = 0.45)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.3.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and vermicompost levels had significant effect on firmness of potato (Appendix XI and Table 10). The highest firmness value (46.77) was recorded in V_2Vm_4 which statistically similar with the V_2M_3 (45.59) and V_3M_4 (44.74).The lowest firmness value potato (25.36) was observed in V_1Vm1 which statistically similar with the V_4Vm_1 (26.94) and V_2Vm_2 (27.77).

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

4.3.4.1 Effect of varieties

In present study varieties had insignificant effect on specific gravity (Appendix XI and Figure 29). Numerically the highest specific gravity (1.095 g cm^{-3}) was obtained from the 'BARI TPS-1' whereas, the lowest (1.071 g g cm^{-3}) specific gravity was found from the 'BARI Alu-28' variety. Asmamaw *et al.* (2010) and Elfnesh *et al.* (2011) reported a specific gravity ranging them 1.06 to 1.09 and 1.08 to 1.10, respectively in two separate experiments with nine potato varieties during evaluated their processing quality. Ekin (2011) also reported specific gravity values ranging from 1.07 to 1.08 from a study of eight potato varieties over two consecutive years.

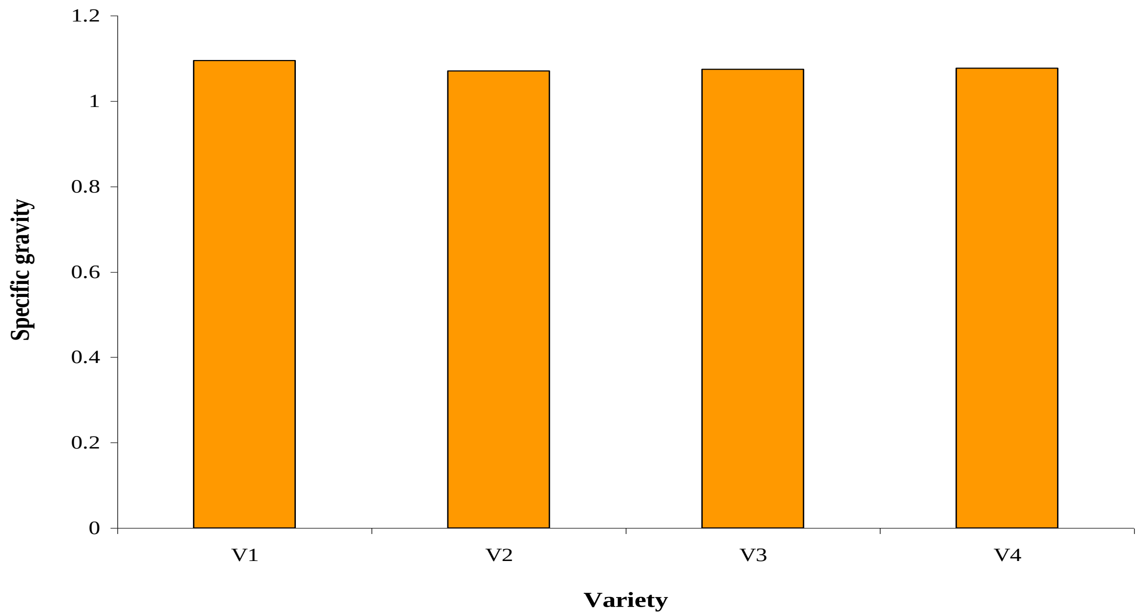

Figure 29.Effect of varieties on specific gravity of potato (SE value = 0.01)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.3.4.2 Effect of vermicompost

Specific gravity has no significantly influenced vermicompost level (Appendix XI and Figure 30). The numerically highest specific gravity (1.092 g cm^{-3}) was recorded from the 'vermicompost 4 t ha^{-1}' and the minimum (1.078 g cm^{-3}) was found from the 'Vermicompost 6 t ha^{-1}.

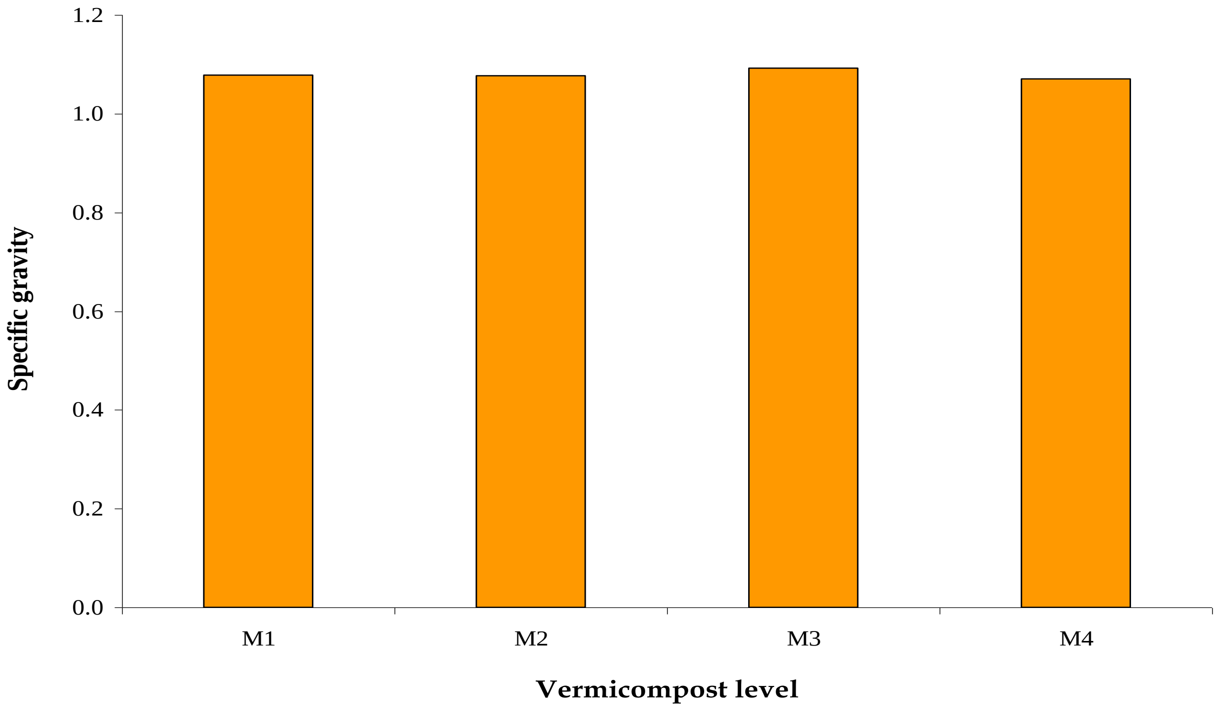

Figure 30. Effect of vermicompost levels on specific gravity of potato (SE value = 0.01)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.4.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and Vermicompost levels had significant effect on specific gravity of potato (Appendix XI and Table 9). The highest specific gravity (1.150 g cm^{-3}) was recorded in V_1Vm_3 which statistically similar with the V_4Vm_3 (1.110 g cm^{-3}), V_2Vm_2 (1.100) and V1Vm4 (1.093 g cm^{-3}).The lowest specific gravity value potato (1.040 g cm^{-3}) was observed in V_2Vm_3 which statistically similar with the V_1Vm_2 (1.047 g cm^{-3}), V_2Vm_4 (1.067 g cm^{-3}), V_3Vm_1 (1.083 g cm^{-3}), V_2Vm_2 (1.087 g cm^{-3}), V_3Vm_3 (1.067 g cm^{-3}), V_3Vm_4 (1.060 g cm^{-3}), V_4Vm_1 (1.063 g cm^{-3}), V_4Vm_2 (1.073 g cm^{-3}), V_1Vm_1 (1.090 g cm^{-3}) and V_1Vm_4 (1.093 g cm^{-3}).

4.3.5 Total soluble solids (TSS)

4.3.5.1 Effect of varieties

Varieties differed significantly between themselves regarding TSS (Appendix 9 and Figure 31). The maximum TSS (7.063) was recorded from the variety ‘BARI Alu-28 whereas, the minimum (5.90) was obtained from the variety ‘BARI tps-1.

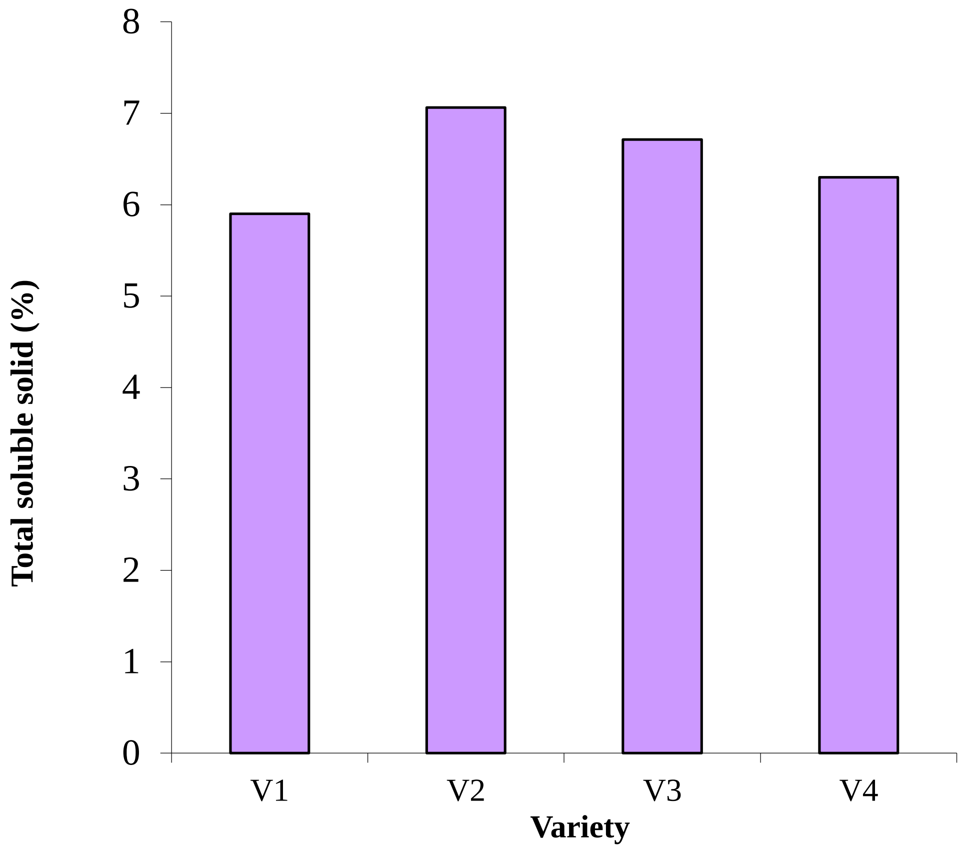

Figure 31.Effect of varieties on Total soluble solid (%) of potato (SE value = 0.07)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

Table 9. Interaction effect of varieties and vermicompost levels on firmness, specific gravity and total soluble sugar (TSS) of potato tuber

Variety x Vermicompost level	Firmness(N)	Specific gravity(g cm^{-3})	Total soluble solid
V_1Vm_1	25.36 g	1.090 bc	5.50 e
V_1Vm_2	27.66 g	1.047 c	5.75 e
V_1Vm_3	39.52 ef	1.150 a	5.75 e
V_1Vm_4	40.27 ef	1.093 a-c	6.60 cd

V_2Vm_1	40.10 ef	1.077 bc	6.30 d
V_2Vm_2	4 2.13 c-e	1.100 a-c	7.15 b
V_2Vm_3	45.59 ab	1.040 c	7.15 b
V_2Vm_4	46.77 a	1.067 bc	7.65 a
V_3Vm_1	38.20 f	1.083 bc	6.25 d
V_3Vm_2	41.81de	1.087 bc	6.55 cd
V_3Vm_3	42.28c-e	1.067 bc	6.85 bc
V_3Vm_4	44.74 a-c	1.060 bc	7.20 b
V_4Vm_1	26.94 g	1.063 bc	5.60 e
V_4Vm_2	38.57 f	1.073 bc	6.40 d
V_4Vm_3	40.27 ef	1.110 ab	6.55 cd
V_4Vm_4	43.89 b-d	1.060 bc	6.65 cd
SE value	0.91	0.09	0.12
Level of significance	**	**	*
CV (%)	4.02	2.13	3.24

**, * = Significant at 1% and 5%level of probability,

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly. Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)
Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.5.2 Effect of vermicompost

Total soluble solids (TSS) has significantly influenced vermicompost level (Appendix XI and Figure 32). The highest TSS value (7.025) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (5.912) was found from the 'Vermicompost 0 t ha^{-1}.

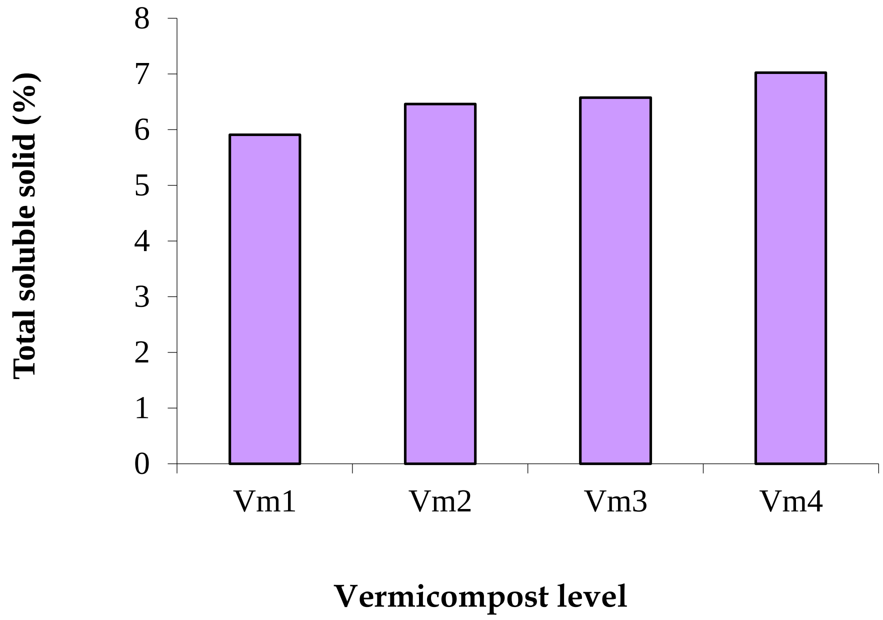

Figure 32. Effect of vermicompost levels on Total soluble solid (%) of potato (SE value = 0.06)
Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.5.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and Vermicompost levels had significant effect of total soluble solid (TSS) of potato (Appendix XI and Table 9). The highest TSS (7.65) was recorded in V_2Vm_4 and the lowest TSS value potato (5.60) was observed in V_4Vm_1 which statistically similar with the V_1Vm_1 (5.50), V_1Vm_2 (5.75) and V_1Vm_3 (5.75).

4.3.6 Water percentage

4.3.6.1 Effect of varieties

Varieties differed significantly between themselves regarding water (%) (Appendix XII and Figure 33). The maximum water (%) (80.74) was recorded from the variety ‘BARI TPS-1 whereas, the minimum (77.84) was obtained from the variety ‘BARI Alu-25.

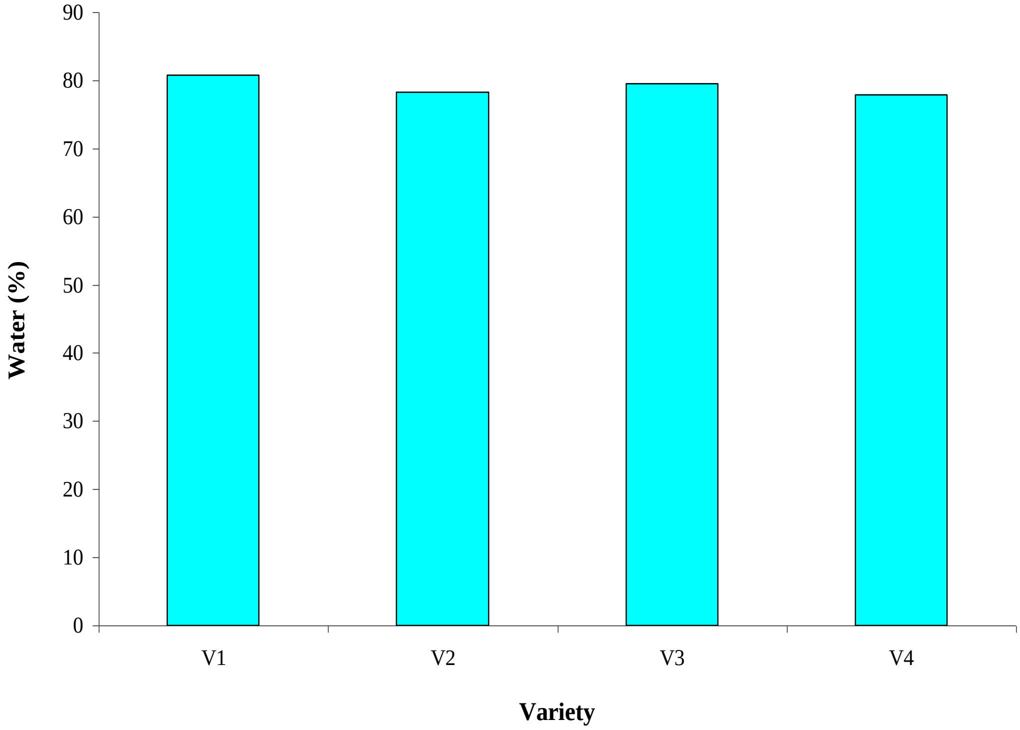

Figure 33.Effect of varieties on water (%) on potato tuber (SE value = 0.17)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.3.6.2 Effect of vermicompost

Water percentage has significantly influenced vermicompost level (Appendix XII and Figure 34). The highest water (%) value (80.00) was recorded from the 'vermicompost 4 ' and t $ha^{-1}$the minimum (78.65) was found from the 'Vermicompost 0 t ha^{-1}.

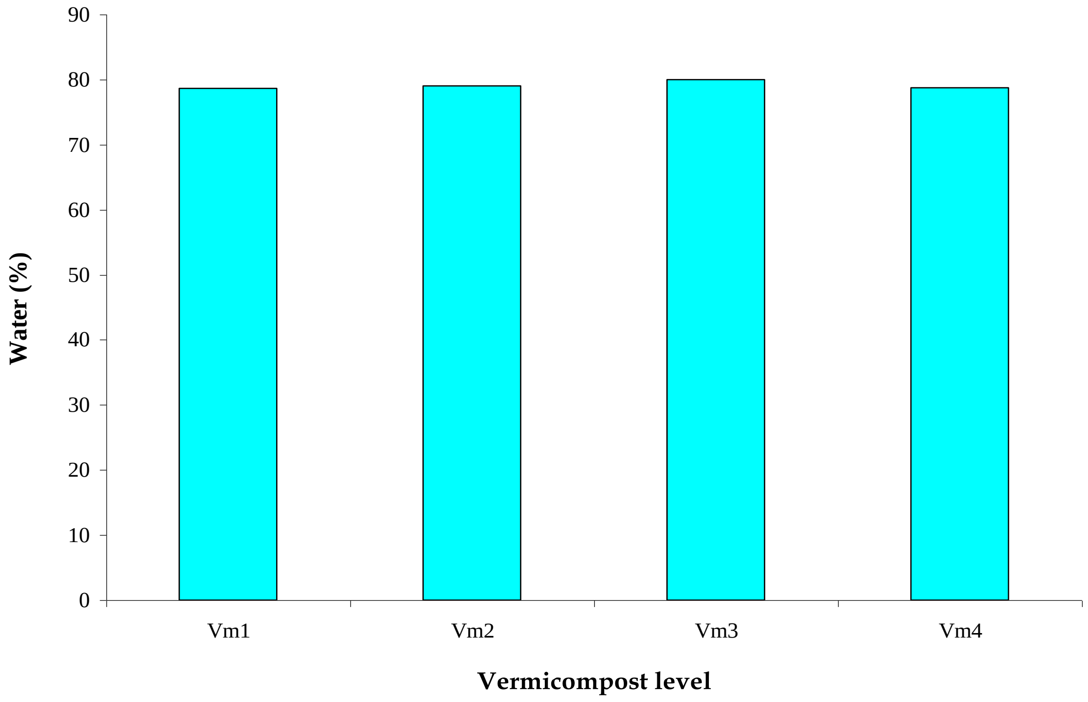

Figure 34. Effect of vermicompost levels on water (%) of potato tuber (SE value = 0.23)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.6.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and vermicompost levels had significant effect of water percentage of potato (Appendix XII and Table 10). The highest water percentage (81.61) was recorded in V_1Vm_1 which statistically similar with the V_1Vm_2 (81.42), V_4Vm_1 (81.24) , V_1Vm_3 (80.88) , V_3Vm_1 (81.58) and V_4Vm_2 (80.53) where the lowest value of potato (74.26) was observed in V_2Vm_4.

4.3.7 Dry matter (%)

4.3.7.1 Effect of varieties

Dry matter (%) content showed significant variations among the potato varieties (Appendix XII and Figure 35). The maximum dry matter content of tuber flesh (22.16 %) was recorded from the variety 'BARI Alu-25 which statis tically similar with BARI Alu-28 (21.75 %). The minimum tuber flesh dry matter content (19.26 %) was recorded from 'BARI TPS-1'. The variation in dry matter content among the potato varieties were also observed by Suyre *et al.* (1975), Lana *et al.* (1970) and Capezio (1987). Variation in tuber dry matter content may be attributed to cultivars inherent in the production of total solids. Burton (1966) reported that genetic differences among varieties a role in their ability to produce high solids when grown on the same test plot. Dry matter content is subjected to the influence of both the environment and genotypes (Miller *et al.*, 1975; Tai and Coleman, 1999).

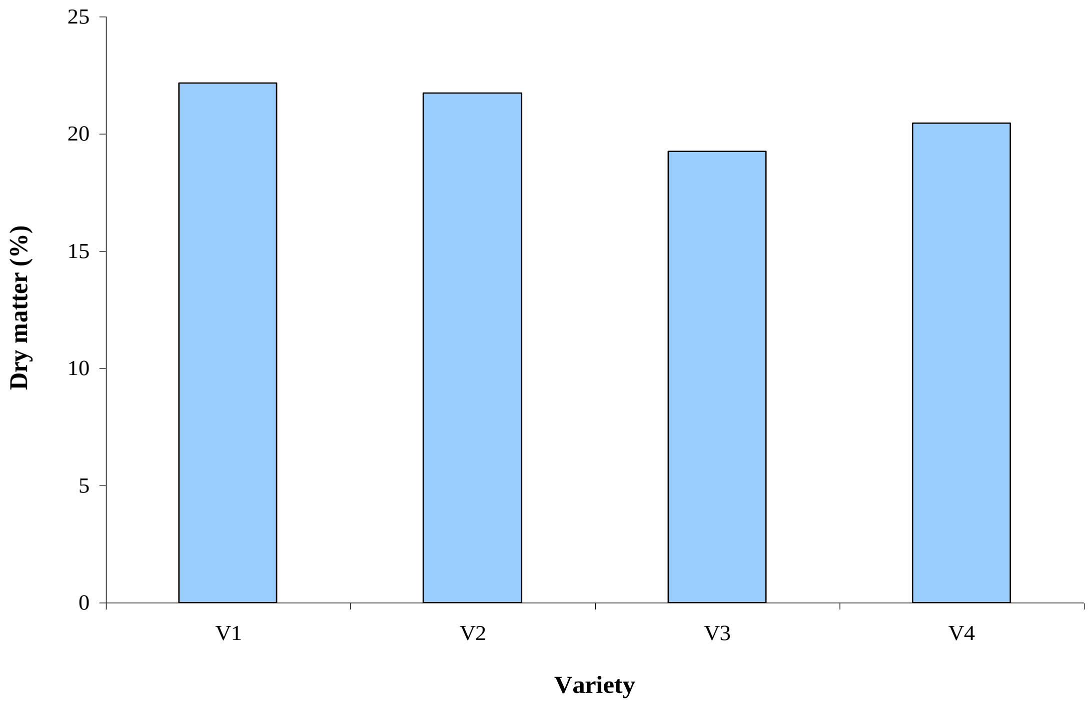

Figure 35. Effect of varieties on dry matter (%) on potato tuber (SE value = 0.17)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.3.7.2 Effect of vermicompost level

Dry matter percentage has no significantly influenced vermicompost level (Appendix XII and Figure 36). The numerically highest dry matter value (21.26 %) was recorded from the 'vermicompo6t 6 t ha^{-1}' and the minimum (20.00 %) was found from the 'Vermicompost 4 t ha^{-1}.

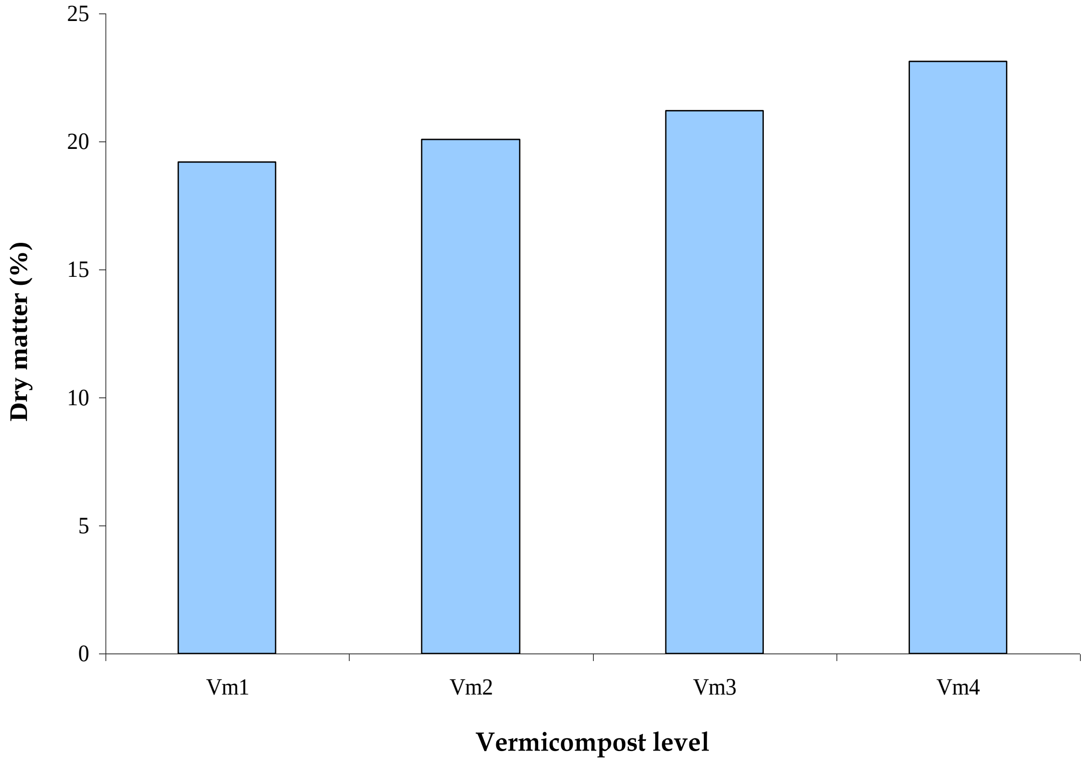

Figure 36. Effect of vermicompost levels on dry matter (%) of potato tuber (SE value = 0.23)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.7.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and Vermicompost levels had no significant effect of dry matter percentage of potato (Appendix XII and Table 10). The numerically highest dry matter percentage (25.74) was recorded in V_2Vm_1 where the lowest value of potato (18.39 %) was observed in V_1Vm_1.

4.3.8 Reducing Sugar (mg/FW)

4.3.8.1 Effect of varieties

Reducing sugar content (mg/FW) showed significant variations among the potato varieties (Appendix XII and Figure 37). The maximum reducing sugar content of tuber flesh (0.724 mg/FW) was recorded from the variety 'BARI Alu-28. The minimum tuber reducing sugar content (0.549 mg/FW) was recorded from 'BARI TPS-1'.

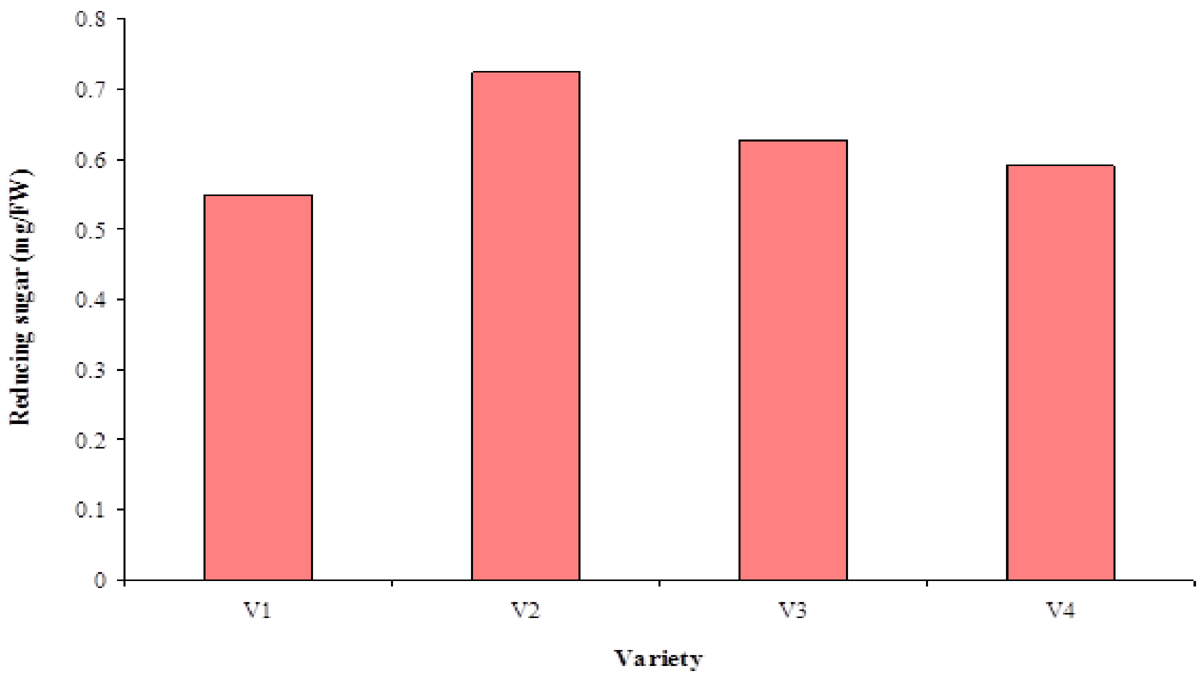

Figure 37. Effect of varieties on reducing sugar (mg/FW) on potato tuber (SE value = 0.01)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.3.8.2 Effect of vermicompost

Reducing sugar (mg/FW) has significantly influenced vermicompost level (Appendix XII and Figure 38). The highest reducing sugar value (0.693 mg/FW) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (0.539 mg/FW) was found from the 'Vermicompost 0 t ha^{-1}. Reducing sugar content increase with the increasing with the increasing vermicompost levels.

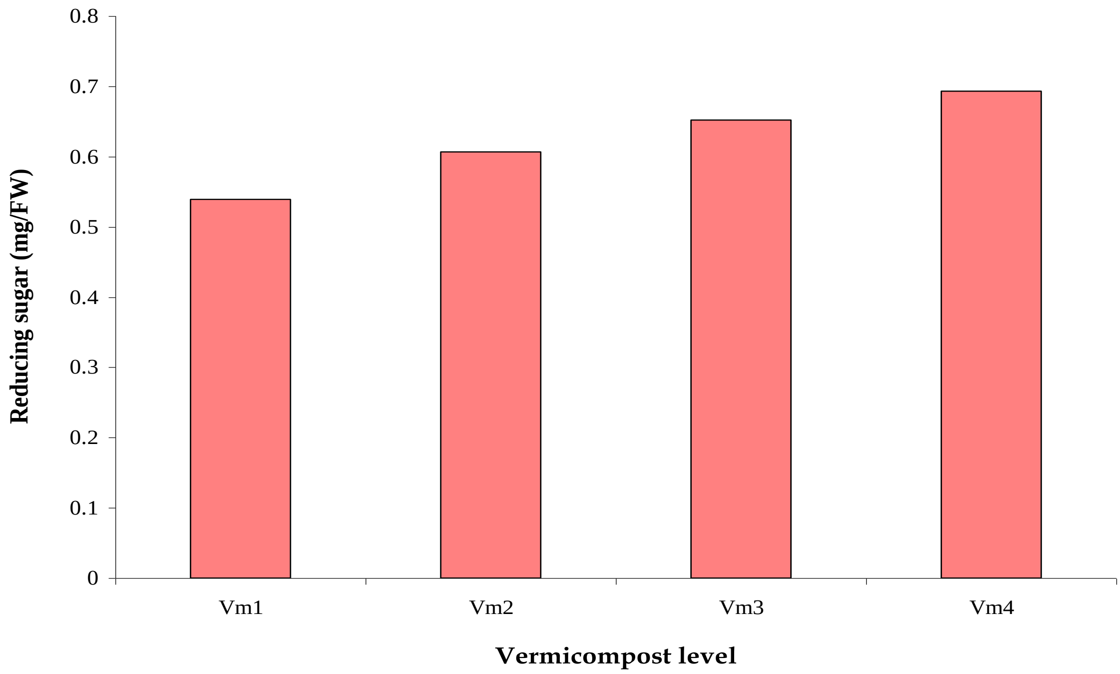

Figure 38. Effect of vermicompost levels on reducing sugar (mg/FW) of potato tuber (SE value = 0.01)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.8.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and Vermicompost levels had significant effect of reducing sugar content (mg/FW) of potato (Appendix XII and Table 10). The highest reducing sugar content (mg/FW) (0.823) was recorded in V_2Vm_4 where the lowest value of potato (0.436) was observed in V_1Vm_1.

4.3.9 Starch (%)

4.3.9.1 Effect of varieties

Starch (%) showed significant variations among the potato varieties (Appendix XII and Figure 39). The maximum starch content of tuber flesh (30.53 %) was recorded from the variety 'BARI Alu-28. The minimum tuber starch content (20.38 %) was recorded from 'BARI TPS-1'

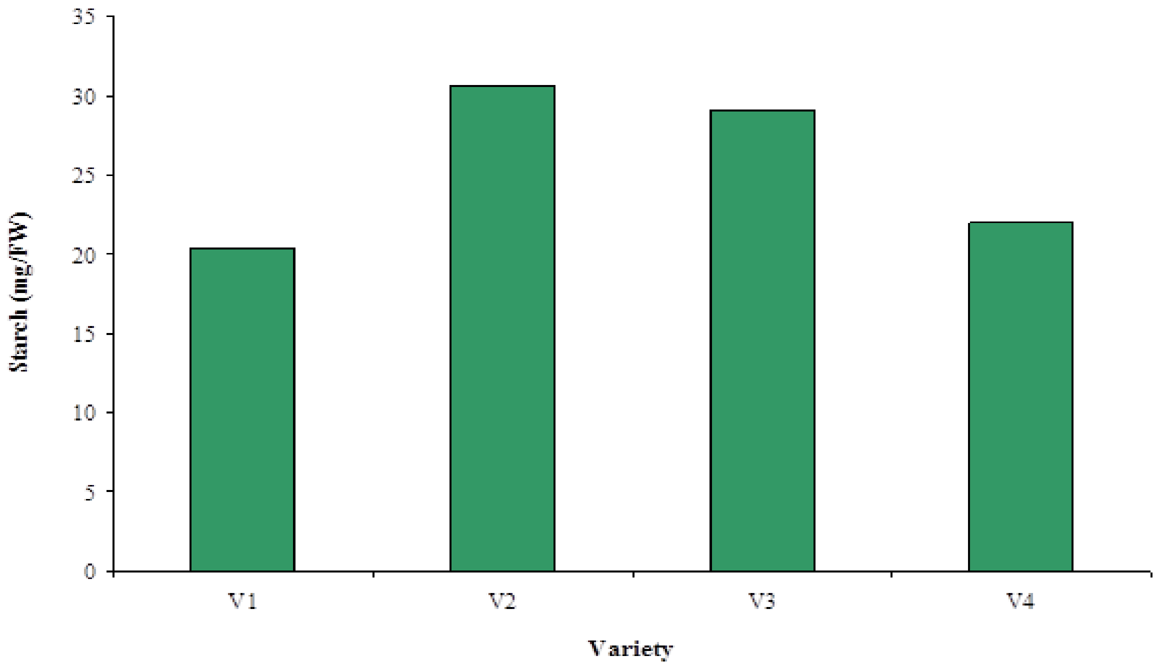

Figure 39. Effect of varieties on starch (mg/FW) on potato tuber (SE value = 0.24)

Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

4.3.9.2 Effect of vermicompost

Starch (%) has significantly influenced vermicompost level (Appendix XII and Figure 40). The highest starch (%) value (29.33) was recorded from the 'vermicompost 6 t ha^{-1}' and the minimum (21.54) was found from the 'Vermicompost 0 t ha^{-1}. Starch (%) increase with the increasing with the increasing vermicompost levels.

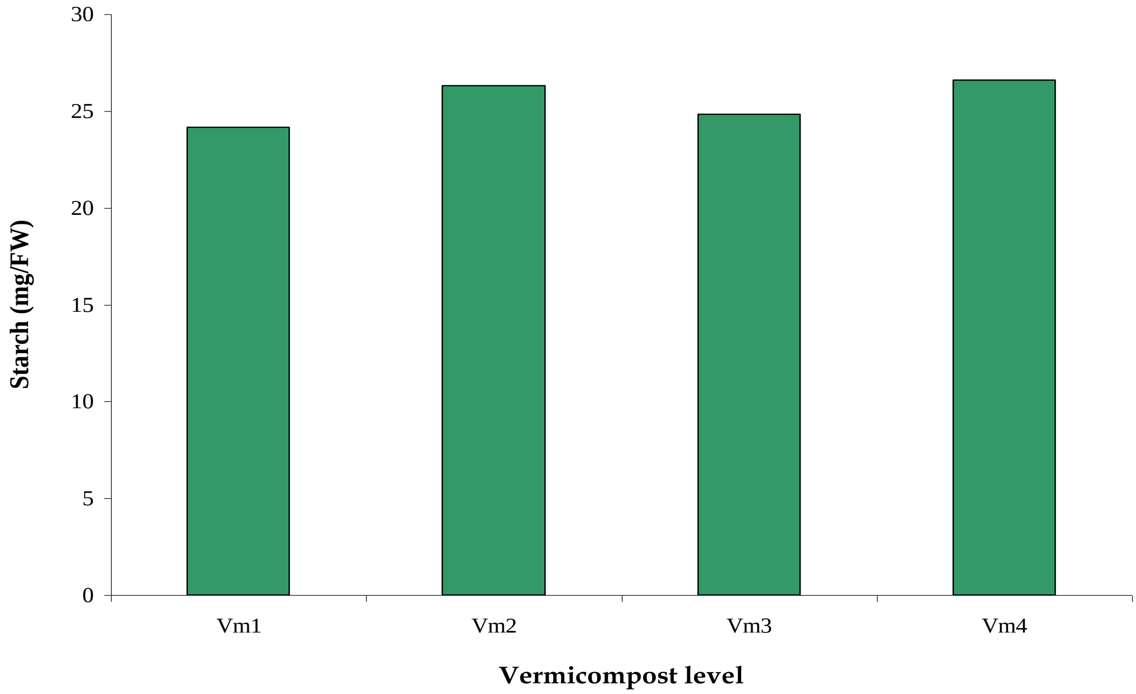

Figure 40. Effect of vermicompost levels on starch (mg/FW) of potato tuber (SE value = 0.26)

Note: Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

4.3.9.3 Interaction effect of varieties and vermicompost levels

Interaction of varieties and Vermicompost levels had significant effect of starch (%) of potato (Appendix XII and Table 10). The highest starch content (33.08 %) was recorded in V_2Vm_4 where the lowest value of potato (16.63 %) was observed in V_1Vm_1

Table 10. Interaction effect of varieties and vermicompost levels on water percentage, dry matter percentage, reducing sugar (mg/FW) and starch percentage of potato.

Variety x Vermicompost level	Water %	Tuber dry matter (%)	Reducing sugar (mg/FW)	Starch (mg/FW)
V_1Vm_1	81.61 a	20.20 c-g	0.43 h	16.63 j
V_1Vm_2	81.42 a	21.70 bc	0.56 fg	17.50 ij
V_1Vm_3	80.88 a-c	22.49 b	0.58 e-g	21.94 g
V_1Vm_4	79.06 d-g	24.26 a	0.61 de	25.45 e
V_2Vm_1	79.80 b-e	19.42 e-g	0.60 d-f	27.91 d
V_2Vm_2	78.30 f-h	19.67 d-g	0.69 c	29.41 cd
V_2Vm_3	77.51 h	22.17 bc	0.77 b	31.73 ab
V_2Vm_4	74.26 j	25.74 a	0.82 a	33.08 a
V_3Vm_1	80.58 a-c	18.39 g	0.56 fg	23.32 fg
V_3Vm_2	79.57 c-f	18.58 fg	0.59 e-g	29.28 d
V_3Vm_3	77.83 gh	19.12 e-g	0.65 d	30.92 bc
V_3Vm_4	75.74 i	20.94 b-e	0.70 c	32.75 a
V_4Vm_1	81.24 ab	18.76 fg	0.55 g	18.30 hi
V_4Vm_2	80.33 a-d	20.43 c-f	0.58 e-g	19.75 h
V_4Vm_3	79.00 d-g	21.00 b-e	0.60 ef	23.74 f
V_4Vm_4	78.40 e-h	21.60 b-d	0.63 de	26.05 e
SE value	0.45	0.59	0.02	0.52
Level of significance	*	*	**	**
CV (%)	1.00	4.94	3.93	3.53

**, * = Significant at 1% and 5% level of probability

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly. Note: V_1 – BARI TPS-1, V_2 – BARI Alu-28 (Lady Rosetta), V_3 – BARI Alu-29 (Courage), V_4 – BARI Alu-25 (Asterix)

Vm_1 – 0 t ha^{-1}, Vm_2 – 2 t ha^{-1}, Vm_3 – 4 t ha^{-1}, Vm_4 – 6 t ha^{-1}

Chapter 5

Summary and conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Agronomy field laboratory of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from November 15, 2014 to March 25, 2015 to investigate the growth, yield and quality of potato varieties under vermicompost levels under the Modhupur Tract (AEZ-28). Two factor experiment included 4 potato varieties *viz.* BARI TPS-1 (V_1), BARI Alu-28 (Lady Rosetta). (V_2), BARI Alu-29 (Courage) (V_3), BARI Alu-25 (Asterix) (V_4) and 4 vermicompost levels *viz*. 0 t ha^{-1} (control) (Vm_1), 2 t ha^{-1} (Vm_2), 4 t ha^{-1} (Vm_3), 6 t ha^{-1} (Vm_4) was outlined in spilt plot Design with 3 replications.

The data on crop growth parameters like days to first emergence, days to final emergence, plant height, number of leaves $plant^{-1}$, number of stem $hill^{-1}$and chlorophyll content of leaves (SPAD value) at different growth stages. Yield parameters like, yield of tuber (t ha^{-1}), average weight of tuber (g), marketable yield, (t ha^{-1}) non-marketable yield (t ha^{-1}), seed tuber (t ha^{-1}) were recorded after harvest. Quality character parameters like, skin color, flesh color, specific gravity, total soluble solids (TSS), firmness, water percentage, dry matter percentage, reducing sugar content and starch percentage were recorded after harvest. Data were analyzed using MSTAT package. The mean differences among the treatments were compared by Duncan's Multiple Range Test (DMRT) at 5% level of significance.

Results showed that variety had significant effect on growth parameters like days to first emergence and day to final emergence. In days to first emergence BARI Alu-28 need minimum days to emergence and BARI TPS-1 needs maximum day to emergence. On the other hand BARI Alu-28 need minimum days and BARI TPS-1 need maximum days for final emergence. Conversely, in vermicompost levels was significant effect on days to first emergence and days to final emergence .In days to first emergence and days to final emergence vermicompost 6 t ha^{-1}required minimum days and 0 t ha^{-1} need maximum days. In combination of potato variety and vermicompost levels, 'BARI Alu-28' with 6 t ha^{-1} generated the minimum days whereas 'BARI TPS-1' with 0 t ha^{-1} required maximum days in both days to first emergence and days to final emergence.

Considering the varietal characteristics, vermicompost levels and in combination of varietal and vermicompost levels, no significance effect observed in plant height (cm).

Considering the varietal characteristics, the maximum number of stem $hill^{-1}$ was generated by 'BARI Alu-29' at 40 DAP and the minimum was produced by BARI Alu-25 at 85 DAP. Whereas observing the vermicompost levels and combination of varietal effect and vermicompost levels had non-significant effect was found.

Considering the varietal characteristics, the maximum number of leaves $plant^{-1}$ was generated by 'BARI Alu-29' and the minimum number leaves were produced by 'BARI Alu-25' at 85 DAP. Whereas observing the vermicompost levels and combination of varietal effect and vermicompost levels had non-significant effect was found.

Considering the varietal characteristics, the highest amount of chlorophyll content was generated by 'BARI Alu-29' and the minimum number leaves were produced by ‘BARI Alu-28’ at 85 DAP. Whereas observing the vermicompost levels and combination of varietal effect and vermicompost levels had non-significant effect was found.

Among the varieties, the maximum yield was recorded in ‘BARI Alu-28’ and the minimum from BARI TPS-1. Whereas observing the vermicompost levels, 6t/ha generated the maximum yield while the minimum was found in 0 t ha^{-1}. In combination of potato variety and vermicompost levels, ‘BARI Alu-28’ and vermicompost levels 6 t ha^{-1} attained the highest tuber yield whereas the lowest yield was recorded in ‘BARI TPS-1’ and vermicompost t ha^{-1}.

Considering the varieties, the maximum average tuber weight was recorded in ‘BARI Alu-28’ and the minimum from BARI TPS-1. Whereas observing the vermicompost levels 6 t ha^{-1} generated the maximum yield while the minimum was found in 0 t ha^{-1}. In combination of potato variety and vermicompost levels, ‘BARI Alu-28’ and vermicompost levels 6 t ha^{-1} attained the highest average tuber weight which is statistically similar with BARI Alu-28 and 4 t/ha whereas the lowest yield was recorded in ‘BARI TPS-1’ and vermicompost 0 t ha^{-1}.

Among the varieties, the maximum marketable yield was recorded in ‘BARI Alu-28’ and the minimum from BARI TPS-1. Whereas observing the vermicompost levels, 6 t ha^{-1} generated the maximum marketable tuber yield while the minimum was found in 0 t ha^{-1}. In combination of potato variety and vermicompost levels, ‘BARI Alu-28’ and vermicompost levels 6 t ha^{-1} attained the highest marketable tuber yield which statistically similar with BARI Alu-29’ and vermicompost levels 6 and t ha^{-1} BARI Alu-25' and vermicompost levels 6 t ha^{-1} whereas the lowest yield was recorded in 'BARI TPS-1' and vermicompost 0 t ha^{-1}.

Considering the varieties, the maximum non-marketable yield was recorded in 'BARI Alu-28' and the minimum from BARI Alu-29. Whereas observing the vermicompost levels, 6 t ha^{-1} generated the maximum non-marketable yield while the minimum was found in 0 t ha^{-1}. In combination of potato variety and vermicompost levels, 'BARI Alu-28' and vermicompost levels 6 t ha^{-1} attained the highest non-marketable yield which is statistically similar with BARI Alu-29 and 6 t ha^{-1} and BARI Alu-25 and 6 t ha^{-1} whereas the lowest yield was recorded in 'BARI Alu-29' and vermicompost 0 t ha^{-1}.

Among the varieties, the maximum seed tuber yield was recorded in 'BARI Alu-28' and the minimum from BARI Alu-29. Whereas observing the vermicompost levels, 6 t ha^{-1} generated the maximum seed tuber yield while the minimum was found in 0 t ha^{-1}. In combination of potato variety and vermicompost levels, 'BARI Alu-28' and vermicompost levels 6 t ha^{-1} attained the highest see tuber yield which statistically similar with BARI Alu-29' and vermicompost levels 6 t ha^{-1} and BARI Alu-25' and vermicompost levels 6 t ha^{-1} whereas the lowest yield was recorded in 'BARI TPS-1' and vermicompost 0 t ha^{-1}.

Among the varieties the skin of BARI TPS-1 had the highest L* value compared to those of others whereas the lowest was observed in 'BARI Alu-28'. Whereas observing the vermicompost levels 0 t ha^{-1} give highest result that statistically similar with 2 t ha^{-1}. In combination the skin of 'BARI TPS-I' and vermicompost 0 t ha^{-1} and 2 t ha^{-1} give exhibited the maximum L* values and minimum was BARI Alu-28 and 6 t ha^{-1}. The skin of 'BARI Alu-25' was characterized by the highest a*, while the lowest was ‘BARI TPS-1’. Vermicompost level had no significance effect on a*.In combination BARI Alu-28 and 4 t ha^{-1} than other combination. ‘BARI TPS-1’ produced the maximum b* value while the lowest recorded on BARI Alu-28’, vermicompost levels and combination had no significance effect on value of b*.

Among four varieties, the flesh of ‘BARI TPS-1’and ‘BARI Alu-28’ had L* values that were significantly higher than the values of others. In vermicompost levels 0 t ha^{-1} give highest L* value than other and in combination BARI Alu-28 and 0 t ha^{-1} give highest alue of L*. In value of a* and b* value varietal effect and vermicompost levels had no significant effect. Whereas ‘BARI Alu-29 and 0 t ha^{-1} showed higher value of b*.

Among the varieties, the maximum firmness was recorded in ‘BARI Alu-28’ and the minimum from BARI TPS-1. Whereas observing the vermicompost levels, 6 t ha^{-1} generated the maximum firmness while the minimum was found in 0 t ha^{-1}. In combination of potato variety and vermicompost levels, ‘BARI Alu-28’ and vermicompost levels 6 t ha^{-1} attained the highest firmness whereas the lowest firmness was recorded in ‘BARI TPS-1’ and vermicompost 0 t ha^{-1} which statistically similar with BARI TPS-1 and 2 t ha^{-1}.

Considering the varietal characteristics, and vermicompost levels, no significance effect has on the specific gravity of tuber. In combination BARI TPS-1 and 0 t ha^{-1} exhibited the highest specific gravity than other combination.

Considering the varietal characteristics ‘BARI Alu-28’ tubers showed the highest total soluble solid while the lowest was recorded in ‘BARI TPS-I’.

Whereas observing the vermicompost levels the maximum total soluble solid (TSS) of tuber was recorded from 6 t ha^{-1} whereas the minimum was recorded from 0 t ha^{-1}. In combination 6 t ha^{-1} showed highest while 'BARI TPS-1' showed the minimum TSS with other vermicompost levels.

Considering the varietal characteristics 'BARI TPS-1' tubers showed the highest water percentage while the lowest was recorded in 'BARI Alu-28'. Whereas observing the vermicompost levels the maximum water percentage of tuber was recorded from 4 t ha^{-1} whereas the minimum was recorded from 0 t ha^{-1}. In combination BARI TPS-1 and 0 t ha^{-1} showed highest while 'BARI Alu-28' and 0 t ha^{-1} showed the minimum result.

Among the varieties, 'BARI alu-28' showed the maximum DM content while the minimum was from 'BARI-TPS-1'. Whereas observing vermicompost level and combination had no significance effect on the dry matter content of tuber.

Among the varieties, reducing sugar result was recorded in 'BARI Alu-28' and the minimum from BARI TPS-1. Whereas observing the vermicompost levels, 6 t ha^{-1} generated maximum reducing sugar while the minimum was found in 0 t ha^{-1}. In combination of potato variety and vermicompost levels, 'BARI Alu-28' and vermicompost levels 6 t ha^{-1} attained the highest reducing sugar whereas the lowest was recorded in 'BARI TPS-1' and vermicompost 0 t ha^{-1}.

Among the varieties, starch (%) was recorded in 'BARI Alu-28' and the minimum from BARI TPS-1. Whereas observing the vermicompost levels, 6 t ha^{-1} generated maximum starch (%) while the minimum was found in 0 t ha^{-1}. In combination of potato variety and vermicompost levels, 'BARI Alu-28' and vermicompost levels 6 t ha^{-1} attained the highest starch (%) whereas the lowest was recorded in 'BARI TPS-1' and vermicompost 0 t ha^{-1}.

Considering the results of the present experiment, it may conclude that vermicompost levels had potential effect on tuber yield and yield attributes characters and finally on specific gravity, dry matter content and tuber color. The findings revealed that though 'BARI TPS-1', 'BARI Alu-25' and 'BARI Alu-29' produced lower yields than 'BARI Alu-28'.

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CHAPTER VI

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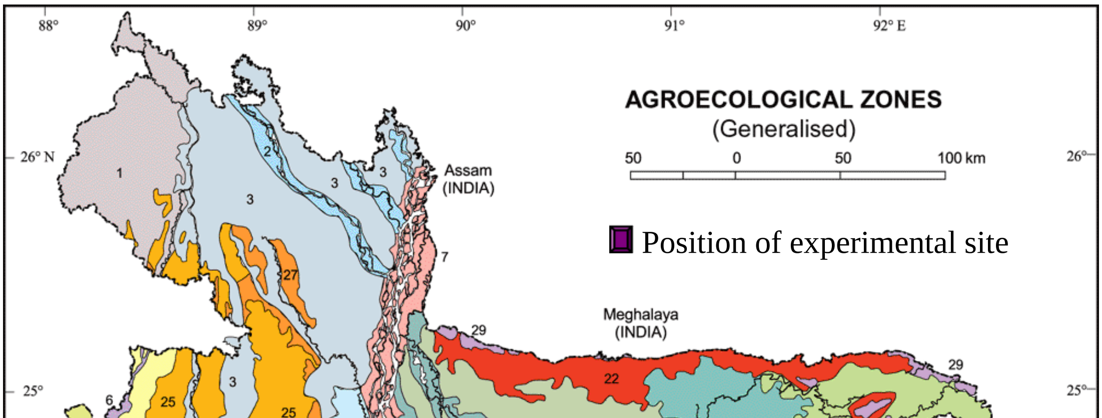
APPENDICES

Appendix I. Map showing the experimental site under study



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

Year	Month	Air temperature (^0C)		Relative humidity (%)	Total rainfall (mm)
		Maximum	Minimum		
2014-	November	28.10	11.83	58.18	47

2015	December	25.00	9.46	69.53	0
	January	23.98	10.47	73.86	Trace
	February	26.45	14.83	75.38	Trace
	March	30.45	18.36	69.44	59
	April	35.93	42.35	73.92	103

Source: Metrological Centre, Agargaon, Dhaka (Climate Division)

Appendix III. Mean square values for days to first emergence and days to finalemergence of potato

Source of variation	Df	Day to first emergence	Day to final emergence
Replication	2	0.073	0.531
Variety (A)	3	7.058**	46.507**
Error	6	0.054	0.435
Vermicompost (B)	3	13.471**	30.531**
A x B	9	0.114*	1.146*
Error	24	0.049	0.460

** = Significant at 1% level of probability, * = Significant at 5% level of probability

Appendix IV. Mean square values for plant height of potato at different DAP

Source of variation	df	Plant height (cm) at DAS			
		40	**55**	**70**	**85**

Replication	2	13.230	126.943	519.72	904.13
Variety (A)	3	113.455NS	61.311NS	801.14*	675.45*
Error	6	40.756	59.540	159.49	105.74
Vermicompost (B)	3	16.180NS	17.769NS	4.11NS	13.17NS
A x B	9	34.115NS	80.255NS	82.41NS	67.36NS
Error	24	22.994	38.467	82.89	79.54

* = Significant at 5% level of probability, NS = Not significant

Appendix V. Mean square values for number of stem^{-1} of potato at different DAP

Source of variation	df	Number of stem at DAS			
		40	**55**	**70**	**85**
Replication	2	1.938	1.083	1.396	0.438
Variety (A)	3	27.500**	24.139**	23.472**	18.132**
Error	6	2.438	1.306	1.618	0.715
Vermicompost (B)	3	1.389NS	1.250NS	0.806NS	0.632NS
A x B	9	0.370NS	0.491NS	1.009NS	1.058NS
Error	24	0.896	1.139	1.313	1.201

** = Significant at 1% level of probability, NS = Not significant

Appendix VI. Mean square values for number of leaves plant^{-1} of potato at different DAP

Source of variation	df	Number of leaves/plant at DAS			
		40	**55**	**70**	**85**

Replication	2	28.58	601.58	4536.00	671.27
Variety (A)	3	4438.38**	4941.96**	13166.56NS	1838.74**
Error	6	189.72	450.02	2939.74	107.16
Vermicompost (B)	3	263.61NS	284.85NS	688.28NS	99.24NS
A x B	9	145.92NS	236.18NS	2981.50NS	432.11NS
Error	24	142.49	336.33	1929.57	378.27

** = Significant at 1% level of probability, NS = Not significant

AppendixVII. Mean square values for chlorophyll content of leaves (SPAD value) of potato

Source of variation	df	Chlorophyll content at DAS			
		40	**55**	**70**	**85**
Replication	2	11.710	6.89	0.821	6.18
Variety (A)	3	82.331**	52.37**	35.705NS	188.42**
Error	6	10.968	4.80	10.380	13.31
Vermicompost (B)	3	13.393NS	19.42NS	6.447NS	21.44NS
A x B	9	13.881NS	7.84NS	19.548NS	34.85NS
Error	24	8.164	13.25	15.624	24.79

** = Significant at 1% level of probability, NS = Not significant

Appendix VIII. Mean square values for yield of tuber (t ha^{-1}), average weight of tuber (g), weight of marketable yield, weight of non-marketable yield and weight of seed tuber yield of potato

Source of variation	df	Average tuber wt (g)	Yield t ha^{-1}	Weight of marketable yield t ha^{-1}	Weight of non-marketable yield t ha^{-1}	Weight seed potato t ha^{-1}
Replication	2	1.37	1.86	0.996	0.038	0.516
Variety (A)	3	553.42**	76.89**	55.499**	1.309**	32.575**
Error	6	1.65	0.72	0.324	0.034	0.461
Vermicompost (B)	3	354.37**	337.22**	243.924**	7.605**	189.737**
A x B	9	24.27**	3.23**	2.332**	0.216**	5.381**
Error	24	1.58	1.03	0.510	0.036	0.489

** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant

Appendix IX. Mean square values for skin color at different parts of potato

Source of variation	df	Skin color at DAS		
		L	**a**	**b**
Replication	2	0.028	4.085	0.184
Variety (A)	3	264.053**	89.108**	450.272**
Error	6	2.820	0.886	0.213
Vermicompost (B)	3	7.705**	1.097NS	4.145NS
A x B	9	2.165**	1.462*	3.826NS
Error	24	0.581	0.583	1.971

** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant

Appendix X. Mean square values for flesh color at different parts of potato

Source of	df	Flesh color at DAS

variation		L	a	b
Replication	2	3.155	0.001	16.555
Variety (A)	3	8.174**	0.002NS	7.753NS
Error	6	0.893	0.009	7.022
Vermicompost (B)	3	4.526*	0.054NS	15.580**
A x B	9	5.265**	0.099NS	11.251**
Error	24	1.260	0.080	1.584

** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant

Appendix XI. Mean square values for firmness, specific gravity and total soluble sugar (TSS) of potato tuber

Source of variation	df	Firmness	**Specific gravity**	TSS
Replication	2	3.53	0.000	0.013
Variety (A)	3	261.28**	0.001NS	3.046**
Error	6	2.56	0.001	0.058
Vermicompost (B)	3	300.51**	0.001NS	2.511**
A x B	9	30.97**	0.003**	0.103*
Error	24	2.46	0.001	0.044

** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant

Appendix XII. Mean square values for on water percentage, dry matter percentage, reducing sugar (mg/FW) and starch percentage of potato.

Source of variation	df	Water %	Dry matter (%)	Reducing sugar (mg/FW)	Starch (mg/FW)
Replication	2	1.014	1.630	0.0003	1.507
Variety (A)	3	24.896**	20.871**	0.6639**	307.250**
Error	6	0.348	0.350	0.0035	0.684
Vermicompost (B)	3	34.568**	34.539**	0.5232**	140.709**
A x B	9	1.454*	2.800*	0.0287**	4.712**
Error	24	0.628	1.065	0.0060	0.807

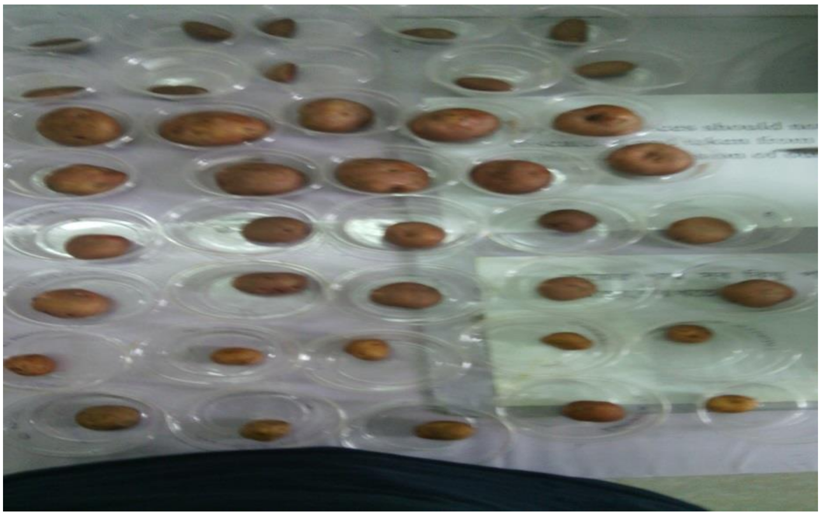
** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant

LIST OF PLATES

Plate 1: Experimental view

Plate.1 Continued

Plate.2 : Harvesting Stage



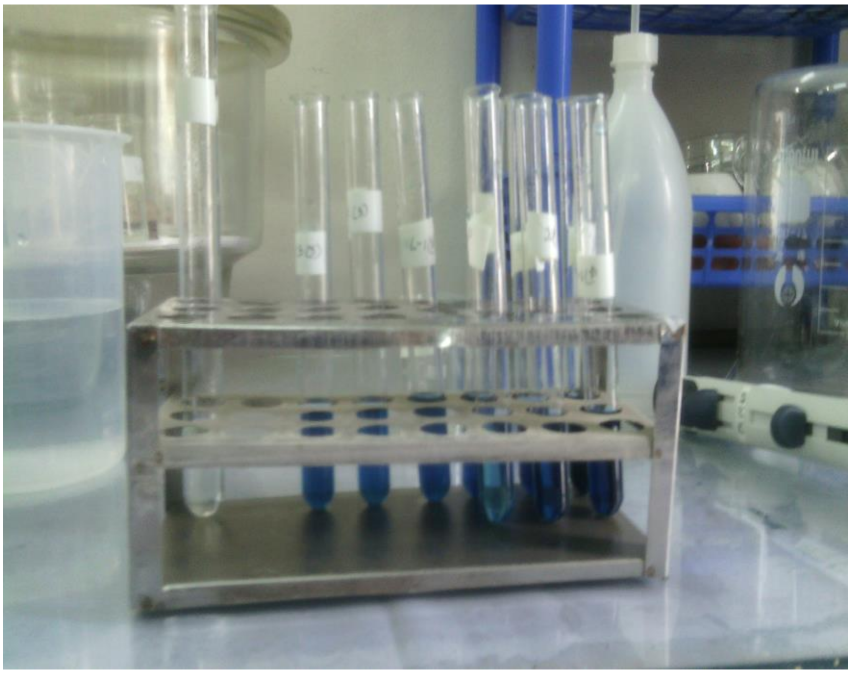


Plate.3: Processing Stage

Appendices