

Morphological characteristics and yield attributes of twenty three potato varieties

M.A. Awal¹, S.K. Das¹ and M. Dhar²

¹Department of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

²Agricultural Research Station, Pahartali, Chittagong, Bangladesh

Abstract: An experiment was carried out to study the morphological characteristics and yield potentialities of 23 potato varieties viz., Almera, Ampera, Asterix, Aziza, Courage, Dheera, Diamant, Eldena, Espirit, Felsine, Granola, Innovator, Ladyolympic, Ladyrosetta, Laura, Marbel, Markies, Melody, Processor, Provento, Quiney, Remarka and Terragold. The varieties Ladyrosetta, Diamant, Provento, Granola and Dheera showed greater number of seed tuber emergence (>90%) while Terragold, Ladyolympic, Processor, Laura, Remarka and Almera showed poor performance (<40%) within 20 days after planting. Plant height ranged between 37 (Processor) to 76 cm (Quiney). Highest number of sprout per hill was produced in Diamant (8.53) followed by Innovator or Asterix while lowest in Ladyolympic (2.73). Largest canopy foliage expansion was noticed in Diamant (93%) followed by Quiney, Dheera and Innovator, and minimum (47%) in Ladyolympic. On an average, the plants of Almera and Provento produced the heavier individual tuber while Ampera, Melody and Aziza produced small sized tubers. The varieties Diamant, Markies, Espirit and Ladyrosetta were found superior for most of the growth traits and produced more than 18 t ha⁻¹ tuber while Ladyolympic, Eldena, and Terragold exhibited as poor yielder (<10 t ha⁻¹). The higher tuber yield of Diamant, Markies, Espirit and Ladyrosetta might be attributed due to the higher number or weight of tuber hill⁻¹.

Key words: Potato varieties, Tuber bulking, Tuber yield.

Introduction

Potato (*Solanum tuberosum* L.), one of most important food crops of the world and hold the fourth position in production next to wheat, rice and maize. It is grown almost in all the countries of the world. In Bangladesh, potato is one of the major crops next to rice and wheat and covers about 0.25 million hectares of land producing 3.39 million tons of potato tubers (Anonymous, 2004a). It is considered as an important vegetable crop which contributes as much 68% of the total vegetable production in Bangladesh (Anonymous, 2004b).

A good number of potato varieties were gradually introduced and cultivated in Bangladesh and many of them are now in highly degenerated condition, yielding rather poorly with enjoying a general popularity for taste and keeping quality. Two groups of potato varieties are generally recognized, namely indigenous and modern varieties. The potato varieties those bred in the recent past especially those introduced in Bangladesh after 1960 are recognized as modern varieties (Hashem, 1990). Both the growing area and yield of potato began to increase rapidly following the introduction of modern potato varieties from Holland which creates a new era of potato production and now-a-days almost all new areas are covered by the modern potato varieties in Bangladesh (Hashem, 1990). It is mentionable that the national average yield of modern potato varieties in Bangladesh is about 13.9 t ha⁻¹ which almost two-folds higher than that of the potato yield of indigenous varieties, 6.9 t ha⁻¹ (Anonymous, 2004b). The scope of horizontal expansion of potato cultivation in Bangladesh is very limited due to shortage of land, henceforth production of modern potato varieties got extreme popularity to the growers. However, it does not indicate that the present area under the indigenous potato varieties will be replaced soon by the modern varieties (Rashid, 1993).

Most of the modern potato varieties are actually bred and developed in other countries which are recommended for commercial cultivation in Bangladesh on the basis of evaluation under local climatic condition. Therefore, the modern varieties,

introduced in the distant past, are lost their potentialities due to degeneration for growing in the different climates rather than bred climate. That's why new modern varieties are added almost every year to replace those go out of production from time to time. For example from 1960 to 1990, about 222 modern varieties of potato have been introduced from abroad (Rashid, 1993). There are always good possibilities of finding potential or ideal suitable varieties among the introduced exotic varieties. The yield performances supported by morphological characteristics in an agro-ecosystem are the primary requisite for better understanding about the potentiality of a variety (Maity and Chatterjee, 1977; Deblonde and Ledent, 2001; Huaman and Spooner, 2002). Therefore, the present research work was undertaken to assess the morphological characteristics with yield potentialities of 23 modern potato varieties in south-eastern part i.e., Chittagong region of Bangladesh.

Materials and Methods

An experiment was conducted at the Field Laboratory of the Agricultural Research Station, Pahartali, Chittagong, Bangladesh during the period from November 2005 to February 2006. The experimental site is situated at the south-eastern part of Bangladesh under the Agro-ecological Zone 23. The experimental site belongs to the Non Calcareous Gray Flood Plain Soil. The site was medium high land and the soil is silt-loam in texture with pH of 6.2-6.8. The area belongs to the tropical monsoon climate characterized by heavy rainfall, high humidity and long photoperiod from April to September while scanty rainfall, low humidity, low temperature and short day between October and March. During the study period, average maximum and minimum air temperatures were 24.9 and 17.6°C, respectively, and the crop received total rainfall of 26.5 mm only.

The experiment comprised twenty three potato varieties viz., Almera, Ampera, Asterix, Aziza, Courage, Dheera, Diamant, Eldena, Espirit, Felsine, Granola, Innovator, Ladyolympic, Ladyrosetta, Laura, Marbel, Markies, Melody, Processor, Provento,

Quiney, Remarka and Terragold which were laid out in a Randomised Complete Block Design (RCBD) with three replicates. The seed tubers were collected from Tuber Crop Research Centre, Bangladesh Agricultural Research Institute (BARI), Gazipur. The soil/crop was fertilized with cow dung (15 t ha^{-1}), urea (350 kg ha^{-1}), triple super phosphate (225 kg ha^{-1}), muriate of potash (260 kg ha^{-1}), gypsum (125 kg ha^{-1}) and zinc sulphate (25 kg ha^{-1}) (Rashid, 1993). Cow dung was applied during final land preparation. Half amount of the urea and entire amount of the other fertilizers were applied in soil during final land preparation as basal dose. The remaining amount of urea was applied in two equal installments at 30 and 50 days after planting (DAP) as side dressing. Well sprouted healthy seed tubers were planted on 25 November 2005 in a unit plot size of $3 \times 3 \text{ m}$. The whole seed tubers were planted at a depth of 5-8 cm maintaining 60 cm for row to row distance and 25 cm for plant to plant within a row. The earthing-up was done during the planting of seed tuber, and at 30 and 50 DAP just after side dressing of urea installments. Plant protection measures, weeding, irrigation and other cultural operations were done as and when required to optimize the growth and development of the crop.

Data were collected on the emergence percentage of seed tubers at 20 DAP, plant height (distance from the soil surface up to the top of uppermost leaf, Deblonde and Ledent, 2001) at 50, 60 and 70 DAP, number of sprout per hill at 50 DAP, percentage of canopy foliage coverage through eye estimation as area covered by the green haulms at 60 DAP, number and weight of tuber per hill at 60, 70 and 80 DAP, and individual tuber weight and fresh tuber yield at physiological maturity. Maturity symptom was determined as dropping the stems along with yellowing the leaves (Rashid, 1993). The tuber yield obtained from unit plot was converted into ton per hectare (t ha^{-1}). The collected data were statistically analysed and the ANOVA was performed with *F*-test and the treatment means were evaluated by the Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Emergence of seed tuber: Most of the potato varieties emerged within 20 DAP (Table 1) and emergences of seed tubers were ranged from 28 to 97%. The varieties Ladyrosetta, Diamant, Provento, Granola and Dheera showed best (>90%) and Terragold, Ladyolympic, Processor, Laura, Remarka and Almera showed poor emergence potentiality (<40%) while remaining varieties showed intermediate performance. The emergence of seed tuber is strongly controlled by the environmental factors especially soil temperature and soil moisture, however, genetic composition of the variety might exert decisive role as reflected in this experiment. The varietal differences in sprout emergence in potato were also reported by Beukema and Vander Zaag (1979) which supports the present result. Early emergence of the seed tuber is a good indicator of plant vigor which not only protects the

young plantlet from unfavorable field conditions but also influence the plant growth, tuber initiation and ultimately tuber yield.

Plant height: Potato varieties showed significant variation in respect of plant height (Table 1). All the varieties showed gradual increase in plant height till 70 DAP. Plant height ranged between 37.2 to 76 cm, where the variety Processor appeared as shorter and Quiney as taller stature. The other varieties exhibited intermediate stature. Variation in plant height among the potato varieties was also recorded by Bashir (1978) and Rabbani (1996). 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 under same environment and cultural practices, the variation in plant height among the varieties may be due to the variation of varietal performances.

Sprout per hill: Significant variations were observed in respect of number of sprout per hill among the varieties studied (Table 1). The sprouts produced per hill ranged from 2.73 in the variety Ladyolympic to 8.53 in Diamant. The other varieties lie intermediate in number. The results are in good agreement with Habib and Khan (1984) who recorded that the number of sprout per hill was ranged from 3.84 to 10.4 in the different potato varieties.

Individual tuber weight: Significant variations were recorded in the individual tuber weight for the different potato varieties (Table 1). Mean individual tuber weight ranged from 25.7 to $68.1 \text{ g tuber}^{-1}$, the smaller in Ampera and heavier in Almera while the other varieties ranked in middle. These variations in the individual tuber weight might be due to the variation of their genetic make-up of the varieties (Rashid, 1993).

Tuber per hill: The seasonal time-course of tuber initiation in terms of number of tuber per hill from 60 to 80 DAP showed significant difference among the potato varieties and the result is presented in Fig. 1. More than 70% of the tubers have been initiated within 60 DAP in most of the varieties except Terragold, Almera, Aziza, Eldena, Felsine and Ampera. Tuber initiation was completed within 60 DAP in Marbel and Processor, and within 70 DAP in Markies, Ampera and Innovator indicates that these are early maturing varieties, a good character for the growers. Across the season, increased number of tuber per hill was recorded in the variety Ampera (13) followed by Diamant and Granola while lowest in the Processor (6). The other varieties produced intermediate number of tuber per hill. The varieties with greater sprout number produces greater number of tuber per hill and the result is in agreement with Shakh *et al.* (2001).

Tuber weight per hill: Significant varietal differences were observed in the seasonal time-course of tuber weight per hill from 60 to 80 DAP (Fig. 2). Bulking of tuber i.e., biomass accumulation gradually increased until 80 DAP and on an average, 80% of tuber bulking was occurred within 60 DAP except the varieties Aziza, Dheera, Terragold, Eldena, Melody etc. Only 2-5% of tuber bulking was happened for the period from 70 to

80 DAP except few varieties like Aziza, Dheera, Eldena etc. Over the whole growing period, maximum tuber bulking was occurred in the variety Diamant (403 g hill⁻¹) followed by Espirit and Almera, and minimum in Terragold (215 g hill⁻¹). Such variation might be attributed due to the variation of bulking rate of potato tuber among the varieties. The varieties those exhibited maximum tuber weight per hill might be due to the higher number of tuber per hill (Fig. 1) or heavier individual tuber weight (Table 1). Elias *et al.* (1998) also reported the larger varietal differences of tuber weight per hill in potato crop that agrees the present result.

Tuber yield: The variation of tuber yield among the potato varieties was significant (Table 1). The highest tuber yield (20 t ha⁻¹) was recorded in the variety Diamant followed by Markies, Espirit and Ladyrosetta while the lowest was recorded in the Eldina (9.2 t ha⁻¹). The other varieties exhibited as intermediate yielder. The higher tuber yield in the varieties Diamant, Espirit and Ladyrosetta might be due to the higher number of tuber per hill (Fig. 1) in spite of smaller individual tuber weight i.e., number of tuber per hill was so higher that it compensates the small sized tuber resulted higher tuber yield. In contrast, the higher yield of Markies might be favoured by the bigger sized tuber rather than the higher number of tuber per hill. Bashar (1978), Roy and Nafzigerb (1978) and Rashid (1982) also reported the wide variation of tuber yield for the different potato varieties.

All the parameters studied significantly influenced by the different potato varieties. The varieties Ladyrosetta, Diamant, Provento, Granola and Dheera not only showed early emergence but also exhibited more than 90% seed tuber emergence within 20 days after planting while the percentage of emergence was quite minimum in Terragold and Ladyolympic. The varieties Diamant, Markies, Espirit, Ladyrosetta, Provento and Quiney were found superior for most of the yield components. Maximum number of sprout per hill was observed in the variety Diamant followed by Innovator and minimum in the Ladyolympic. Maximum canopy foliage coverage was recorded in Diamant followed by Quiney, Dheera and Inovator. Maximum tuber yield was observed in Diamant (20 t ha⁻¹) followed by Markies, Espirit and Ladyrosetta due to the higher number or higher weight of tuber per hill while minimum tuber yield was recorded in Eldina (9.2 t ha⁻¹). Generally the varieties those have greater number of sprout per hill result wider canopy foliage and more number of tubers per hill, which in turn produced higher tuber yield. Finally, it is concluded that the performances of Diamant and Markies were best in terms of morphological and yield contributing characters, and yield in the existing agro-climatic condition of Chittagong, Bangladesh. However, further investigation is necessary before recommendation for commercial cultivation of these varieties in the specific region of Bangladesh.

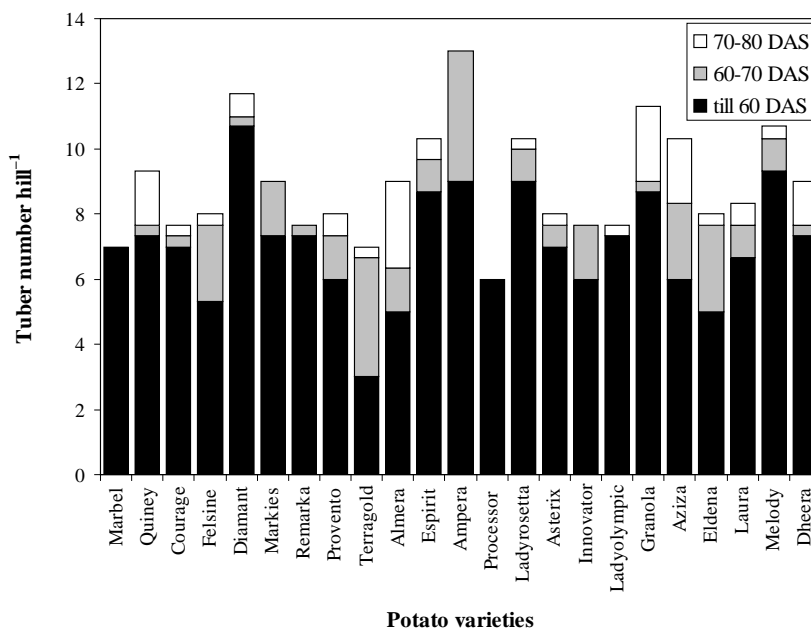


Figure 1. Seasonal time-course of tuber number per hill in the different potato varieties. Each bar entirely represents the total number of tuber per hill initiated over the whole growing period.

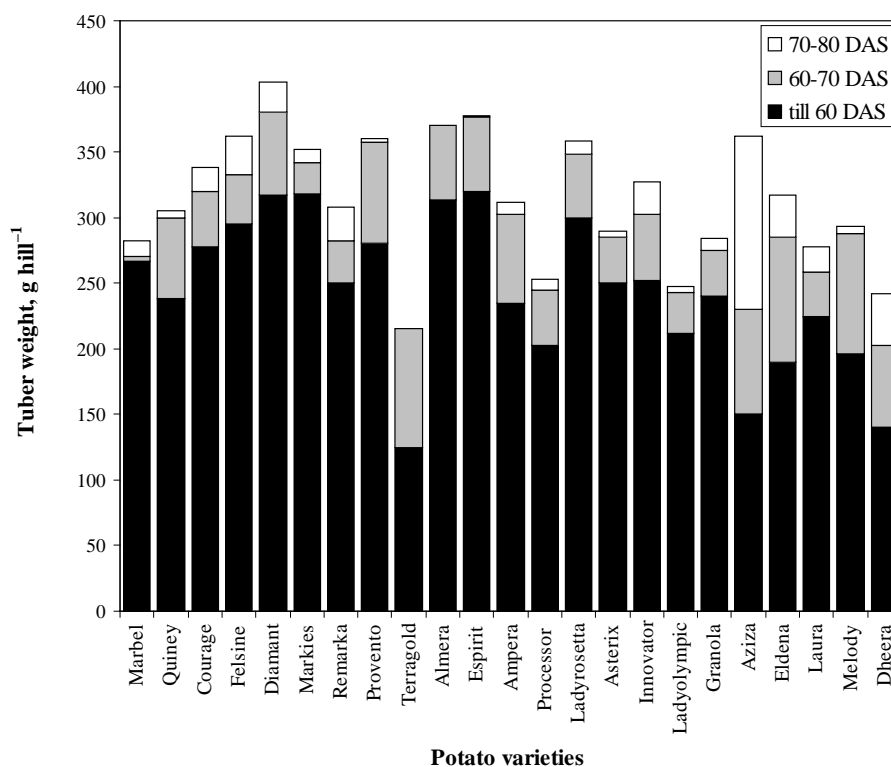


Figure 2. Seasonal time-course of tuber weight per hill in the different potato varieties. Each bar entirely represents the total tuber weight per hill bulked across whole season.

Table 1. Germination percentage, plant height, number of sprout hill⁻¹, canopy foliage coverage and individual tuber weight, and tuber yield of the different potato varieties

Potato varieties	%Seed tuber germination	Plant height (cm) at different DAP			Number of sprout hill ⁻¹	%Foliage coverage	Individual tuber weight (g)	Tuber yield (t ha ⁻¹)
		50	60	70				
Almera	37.2 i	43.3 d-f	46.8 f-h	48.1 f-j	4.93 d-g	76.7 de	68.1 a	16.5 d
Ampera	82.0 de	41.7 ef	45.7 g-i	48.4 f-i	5.47 c-e	85.0 bc	25.7 g	16.7 d
Asterix	90.0 a-c	55.1 b	61.3 bc	63.5 bc	6.60 b	71.7 e-g	36.4 f	15.9 de
Aziza	65.0 g	57.3 b	60.9 bc	62.6 bc	5.07 c-f	66.7 ef	29.9 g	10.5 i
Courage	86.1 b-d	48.8 c	51.9 d-f	53.7 d-g	2.80 j	63.3 h	43.4 de	15.0 ef
Dheera	91.1 ab	56.3 b	63.3 b	65.8 b	3.87 hi	88.3 ab	38.8 ef	12.0 gh
Diamant	94.4 a	46.9 cd	51.9 d-f	53.1 e-g	8.53 a	93.3 a	37.3 f	20.0 a
Eldena	80.6 de	57.2 b	59.9 bc	60.6 b-d	3.67 i	73.3 ef	41.8 d-f	9.2 j
Espirit	76.7 ef	49.1 c	54.3 d	57.2 c-e	5.27 c-e	83.3 b-d	40.1 d-f	18.2 bc
Felsine	50.0 h	54.9 b	61.7 b	62.4 bc	4.20 g-i	83.3 b-d	41.0 d-f	16.1 de
Granola	91.1 ab	40.9 fg	40.6 ij	42.2 i-k	5.60 cd	66.7 f-h	36.3 f	15.0 ef
Innovator	76.7 ef	37.4 g	41.4 ij	41.0 jk	7.80 a	86.7 ab	52.2 b	16.8 d
Ladyolympic	35.1 ij	42.0 ef	45.4 g-i	46.5 g-j	2.73 j	46.7 j	39.4 ef	9.18 j
Ladyrosetta	97.2 a	44.2 d-f	48.3 e-h	50.3 e-h	5.47 c-e	83.3 b-d	38.0 ef	18.1 bc
Laura	36.7 i	54.3 b	56.4 cd	51.1 d-f	4.40 f-i	78.3 c-e	39.2 ef	13.1 gh
Marbel	54.4 h	41.6 ef	43.1 h-j	44.8 i-k	4.67 e-h	66.7 f-h	50.3 bc	14.4 f
Markies	82.8 c-e	42.6 e	46.8 f-h	48.6 f-i	5.87 bc	78.3 c-e	50.7 bc	18.9 ab
Melody	72.2 fg	32.7 h	38.1 jk	39.2 k	4.80 d-g	64.3 gh	29.7 g	13.0 gh
Processor	36.4 i	33.5 h	35.3 k	37.2 k	3.93 hi	55.0 i	36.1 f	11.9 h
Provento	92.8 ab	44.5 d-f	48.7 e-g	51.4 e-g	4.20 g-i	76.7 de	63.1 a	16.8 d
Quiney	80.0 de	66.3 a	74.3 a	76.0 a	6.47 b	90.0 ab	45.6 cd	17.0 cd
Remarka	38.3 i	45.9 c-e	52.4 de	54.7 d-f	4.33 f-i	78.3 c-e	44.1 de	13.2 g
Terragold	28.3 j	44.9 d-f	52.5 de	54.3 d-f	3.93 hi	55.0 i	50.6 bc	9.9 ij

In a column, figures having similar letters do not differ significantly at 5% level of probability by DMRT.

References

Anonymous. 2004a. Handbook of Agricultural Statistics. Market Monitoring and Information System. Ministry Agric., Govt. People’s Repub. Bangladesh. p. 8.

Anonymous. 2004b. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics. Statistic Div., Ministry Planning, Govt. People’s Repub. Bangladesh.

Bashar, M.A. 1978. Testing six varieties of potato at Jaintiapur. Proc. 1st Work. Potato Res. Workers,

- Potato Res. Centre, BARI, Joydebpur, Gazipur, Bangladesh. pp. 30-31.
- Beukema, H.P. and Vander Zaag, D.E. 1979. 'Potato Improvement': Some Factors and Facts. Int'l. Agric. Centre, Wageningen, The Netherlands. p. 224.
- Deblonde, P.M.K., Ledent, J.F. 2001. Effects of moderate drought conditions on green leaf number, stem height, leaf length and tuber yield of potato cultivars. Eur. J. Agron. 14: 31-41.
- Elias, R. and Jaiswal, V.P. 1998. Physiological analysis of seasonal variation in the growth and yield of the potato crop. Indian J. Plant Physiol. 33 (2): 136-140.
- Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedures for Agricultural Research. Intl. Rice Res. Inst. John Wiley & Sons, New York. pp. 139-240.
- Habib, A.K.M.A. and Khan, A.L. 1984. A study on yield potential of the indigenous potato varieties. Proc. 6th Work. Potato Res. Workers, Potato Res. Centre, BARI, Joydebpur, Gazipur, Bangladesh. pp. 24-29.
- Hashem, A. 1990. An Introduction to the Potato Seed Industry of Bangladesh. In: Rashid, M.M., Siddique, M.A. and Hussain, M.M. (eds.). Seed Potato in Bangladesh. Proc. Int'l. Sem. Seed Potato. BADC, Dhaka, Bangladesh. pp. 1-15.
- Huaman, Z. and Spooner, D.M. 2002. Reclassification of landrace populations of cultivated potatoes (*Solanum* Sect. *Petota*). Amer. J. Bot. 89(6): 947-965.
- Maity, S., Chatterjee, B.N. 1977. Growth attributes of potato, and their interrelationships with yield. Potato Res. 20: 337-347.
- Rabbani, M.G. 1996. Performance of 13 potato varieties multiplied from microtubers. A report of Netherlands Technical Assistant Unit, CDP, Khamarbari, Dhaka. pp. 27-47.
- Rashid, A. 1982. Performance of potato varieties in their second generation. Proc. 4th Workshop of Potato Res. Workers, Potato Res. Centre, BARI, Joydebpur, Gazipur, Bangladesh. pp. 18-19.
- Rashid, M.M. 1993. Sabjibinjan (Olericulture in Bengali). First edition. Bangla Academi, Dhaka. pp. 106-136.
- Roy, S.K. and Nafziger, E.D. 1978. Yield trial with six Holland potato varieties at four locations. Proc. 1st Work. Potato Res. Workers, Potato Res. Centre, BARI, Joydebpur, Gazipur, Bangladesh. pp. 20-22.
- Shakh, M.N.U., Awal, M.A., Ahmed, S.U. and Baten, M.A., 2001. Effect of eyes number in cut seed tuber and different levels of nitrogen on growth, yield and grading of tuber size in potato (*Solanum tuberosum* L.). Pak. J. Biol. Sci. 4 (10): 1184-1187.