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Yield potential study of meristem derived plantlets of ten potato varieties (*Solanum tuberosum* L.)

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Abstract

Ten exotic potato varieties (var. All Blue, All Red, Cardinal, Diamant, Daisy, Granulla, Green Mountain, Japanese Red, Pontiac and Summerset) were used the present experiment during November 2010 to January 2011. *In vitro* grown plantlets were spend 21 days old and achieve 4-5 cm long with good root system, were transferred and established in the trial field for showing yield performance of tuber number per plant and tuber weight per plant from 10 randomly selected potato plants of each variety. The highest tuber number (57.52) per plant was recorded in var. Daisy and the lowest tuber number (8.82) per plant was recorded in red varieties. On the other hand total tuber weight per plant was the highest (344.60g) recorded in var. Diamant and total tuber weight per plant was the lowest (65.05 g) recorded in var. All blue varieties showed the most potential yield in this experiment.

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Introduction

Potato (*Solanum tuberosum* L.) is an important food and cash crop in Bangladesh. It is a member of the family Solanaceae and belongs to the genus *Solanum*. Potato varieties are highly heterogeneous and usually vegetative propagated. Potato can be grown in all types of soil, except saline and alkaline soils. Loamy soil, sandy loamy soil and organic matter enriched soil are the most suitable for cultivation of potato crop. The potato is a crop of temperate climate and it is moderately tolerant to frost. The young plants grow best at a temperature of 24 ^{o}C. Late growth is favored at a temperature of 18 ^{o}C. Tuber production is the maximum at 20 ^{o}C and decrease with rise in temperature. At about 30 ^{o}C the tuber production is totally stop. Relative humidity is need above 50 %. Photo period are need 14-16 hours. The varieties can be grouped into two parts in Bangladesh such as indigenous potato varieties and modern varieties. Indigenous potato varieties are popular for good test but low yielding and high price. On the other hand modern varieties are high yielding. Potato is very much susceptible to the viral diseases. The yield reduction may be up to 75 % caused by the infection of some viruses. Meristem culture is one of important methods to produce virus-free stock plants. The virus-free clone produced more vigorous haulm and about 10% higher yields, attributed to more tubers rather than large ones (Bawden and Kassams, 1965). The technique has been widely applied in many countries. In our country, average production of potato was 14-16 MTs/, hectares (2008).But in our research field and many developed countries of the world it's yield 30-40 MTs /hectares. The main causes of yield reduction in Bangladesh are lack of quality seed potato, pathogen infected seed potato used, low yielding variety used and faulty management. It is proved that use of quality seed potato may produced 20-30% high yield. However, at present there is no alternative way of high yielding variety developed in the world. Because agricultural land has decrease and the people increase. Plant Breeders feel of this subject and conducted research for developed and selection of high yielding variety. As that part, study of yield potential of plantlets of ten exotic varieties of potato developed through meristem culture.

Materials and methods

The experiment was conducted at 'Aka-Fuji Agro Technologies' Nursery, Namovodra, Rajshahi, Bangladesh. The bed was prepared after the field well pulverized. Before few days of transplantation the beds were treated with 1% formaldehyde solution and covered with polyethane paper for 5-6 days. After removing polyethane the bed was kept open for 3 days. The field was comprised an area of 920 X 950 sq cm having four replications. Each replication consisted of 10 beds. Each bed consisted of five rows and each rows consisted of 32 plants. The length of each bed was 180 cm and breadth was 60 cm. There was foot path or distance between two beds was 30 cm and boundary of the field was 40 cm. Ten exotic potato varieties (All Blue, All Red, Cardinal, Daisy, Diamant, Granulla, Green Mountain, Japanese Red, Pontiac and Summerset) were the experimental used. When the plantlets were 4-5 cm height and developed a good root system, they were ready for transplanting in the beds. Before transfer, the closures of the flasks or test tubes containing the plantlets were removed and kept in growth room for 3-5 days for acclimatization. The plantlets were transplanted in rows keeping 15.24 cm space between two plants. The distance between two rows was 36 cm. Care was taken to avoid damage to the roots and to ensure good contact between roots and soil. The plants were kept in an environment with high relative humidity for the first few days flowing transplantation by covering the beds with polyethane sheet and regular spraying of water in order to prevent viral vectors, the entire field was covered with a nylon nets. Interim care was taken by periodic irrigation, weeding. Mulching and spraying insecticide. After plantation of in vitro grown plantlets, potatoes were collected from the field within 90-100 days. When haulms of potato plants started

yellowing and falling on the ground, it was proper time for potato harvesting. Potato plants were haulm pulling before 8-10 days of potato harvesting. The total no. of tubers of individual selected plant was counted and recorded at the time of harvesting. On the other hand the total tuber weight/selected plant was measured after harvesting.

Results and discussion

The potato crop is 83% more efficient than rice in producing protein. It is one of the cheapest sources of dietary energy of carbohydrates, in developing countries. Potato is grown not only for food, but also for animal feed, industrial uses and seed tuber production. Varietals differences were observed in the present study which was confirmed through different analysis among the ten potato varieties. Primary established meristem culture derived plantlets were gradually acclimatized and successfully established in the field. Visual evaluation of the morphological traits of the meristem culture derived plants indicates that all plants did not show any symptoms of viral disease (Such as, PLRV, PVM, PVS, PVX, and PVY).

Table 1a. Total tubers number / plant in *in-vivo* cultivation condition of 10 potato varieties. (Four replications and from each replication 10 plants were randomly selected).

Varieties	Range	Mean ± SE	LSD (5% level)
All Blue	14.5- 16.7	15.40± 0.42	10.96
All Red	7.8- 9.5	8.82± 0.32	
Cardinal	12.5- 14.2	13.40± 0.34	
Diamant	40.9- 42.9	41.80± 0.41	
Daisy	58.8- 58.1	57.52± 0.25	
Granulla	35.3- 36.5	35.97± 0.22	
Green Mountain	26.1- 29.4	27.80± 0.51	
Japanese Red	28.7- 30.9	29.85± 0.14	
Pontiac	12.1- 14.0	13.13± 0.42	
Summerset	8.9- 10.5	9.75± 0.33	

* Standard error (SE)

All plants of 10 Potato varieties were more vigorous than their source plants. In the present investigation plantlets of 10 potato varieties raised through meristem culture were planted in a net house in order to evaluate their performance in field condition. Varietals evaluation was done on total no. of tubers/plant and total tuber weight/plant. Samad (1991) also recorded similar results in his investigation of certain agronomic characters in rapeseed. Similar reports were also observed by Khaleque *et al.* (1991) in chemical characters of Chilli.

Table 1b. ANOVA for total no. of tubers/ plant in *in-vivo* cultivation condition.

Item / SV	DF	SS	MS	F
Replication	3	11.2250	3.7416	7.96 **
Variety	9	9410.66	1045.62	2225.62 **
Error	27	12.6850	0.4698	
Total	39	9434.57		

** = Significant at 1% level

In the present investigation total no. of tubers/plant was also markedly influenced by the genotypes. The Green Mountain showed the highest range of variation and Daisy showed the lowest range of variation. On the other hand Daisy exhibits the highest no. of tubers/plant and All Red showed the lowest no. of tubers/plant which shown in Table 1. Hussain (1993) demonstrated the maximum no. of tubers/plant for var. Daisy in respect of meristem culture derived plants. The quantitative natures of the characters of potato were also reported by Simmonds (1974), Dayal *et al.* (1972), Vakis (1978), Abd-El-Aal and Iman (1984). Number of tubers per plant recorded at 30th and 60th day was also different among the ten cultivars. The cv. Daisy showed the highest numbers of tuber per plant. On the other hand cv. All Red was the lowest. The ten potato cultivars were significantly difference in number of tuber and tuber weight per plant. In the analysis of component of variation showed a wide range of phenotypic

variation for all the characters in ten potato genotypes. (Deb, 1994) reported the presence of wide range of variation in respective number of characters in chickpea. Because these characters are economically important and quantitative in nature in their inheritance. The wide range of variation emphasizes the importance of genetic combination in potato breeding programme. Fatunla (1968) in gram and Bhargava *et al.* (1966) in green gram, Singh and Rathore (1973) *Pisum sativum* L., Joarder and Eunus (1969) in mustard and Ali and Shaik (1987) obtained similar results in summer mungbean.

Table 2a. Total tuber weight (g)/plant in *in-vivo* cultivation condition of 10 potato varieties.

Varieties	Range	Mean +_SE	LSD (5% level)
All Blue	62.4- 82.2	65.05±1.19	61.70
All Red	79.1- 82.3	80.92± 0.58	
Cardinal	110.5-113.6	112.43± 0.58	
Diamant	342.7- 346.2	344.60± 0.74	
Daisy	248.9- 257.0	253.05± 1.69	
Granulla	170.2- 174.9	172.35± 1.04	
Green Mountain	145.9- 148.2	147.03± 0.43	
Japanese Red	65.1- 68.4	66.7± 0.60	
Pontiac	123.9-130.2	127.98± 1.14	
Summerset	75.5- 82.3	79.62± 1.34	

Four replications and from each replication 10 plants were randomly selected.

Table 2b. ANOVA for total tuber weight / plant in *in-vivo* cultivation condition.

Item / SV	**DF**	**SS**	**MS**	**F**
Replication	3	24.0148	8.0049	1.54
Variety	9	298178.742	33130.97	6376.21 **
Error	27	140.2927	5.1960	
Total	39	298343.04		

** = Significant at 1% level

The ANOVA table (1b) shows that, the item variety was highly significant for variety. It is indicate that the varieties were significantly different from each other in respect of this character. The item replication was significant which indicate the soil heterogeneity.

Fig. 1. Yield performance from meristem derivatives different potato varieties.

A) var. Daisy, produce height number of potato tubers/plant.

B) var. All Red, produce lowest number of potato tubers/plant.

C) var. Diamant, serve height weight of tuber/plant.

D) var. All Blue, serve lowest weight of tuber/plant.

LSD test reveals that in respect of total no. of tubers/plant All Red, Summerset, Pontiac, Cardinal and All Blue as well as Green Mountain and Japanese Red was non-significant. On the other hand, Daisy and Diamant significantly different at level of 5%.

In respect of total tuber weight/plant All Blue was showed the highest range of variation and Green Mountain was showed the minimum range of variation. In respect of total tuber weight/plant *in vivo* Diamant was found to be superior to other varieties (Table-2a). However, the difference between

Daisy and Diamant in total tuber weight was statistically significant. This result is in agreement with Ahmed (1999), Rahman (1999) and Hussain (1993).

The ANOVA table (2b) reveals that, the item variety was highly significant for total tuber weight/plant. The item replication was significant. LSD test exhibit that in respect of total tuber weight/plant at harvesting time All Blue, Japanese Red, All Red Summerset and Cardinal were non-significantly different. Similarly, Granulla, Green Mountain and Pontiac were also non- significant. On the other hand, Diamant and daisy were significantly different at level of 5%. Many earlier workers reported similar and dissimilar results in tuber yield for different varieties of potato (Bremner and Reedley, 1966, Carlson, 1975; Breukema and vander zagg, 1979 and Hussain, 1993).

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