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Effect of cultivars and seed size on field performance of potato micro-tubers in North Eastern Himalayan region in India

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Abstract: The present study was carried out at Central Potato Research Station, Shillong during 2013 and 2014 to assess the growth and yield performance of three grades of *in-vitro* produced micro-tubers *viz.* >8 mm, 4-8 mm and <4 mm of two potato (*Solanum tuberosum*) cultivars namely Kufri Girdhari and Kufri Megha under field planting conditions. The experiment was laid out in a randomised block design with four replications using a common spacing of 50 × 20 cm. The larger grade micro-tubers generally exhibited better physiological growth as well as yield parameters. The larger sized micro-tuber (>8 mm) showed significantly superior plant survival, canopy cover, plant height, number of compound leaves per plant, number of stems per plant and plant vigour followed by 4-8 mm grade and <4 mm grade micro-tubers. Similar trend was observed for all the yield parameters. Among varieties, Kufri Girdhari out performed Kufri Megha in all the growth and yield parameters in all the micro-tuber grades. Thus both micro-tuber size and genotype influenced the field performance. The overall finding indicates that micro-tubers irrespective of the size for both the varieties can produce mini-tubers successfully under direct field conditions in the NEH region which will facilitate quality seed production.

Keywords: Field performance, Micro-tuber grades, NEH India, Potato micro-tubers

INTRODUCTION

Quality seed is the most critical input for attaining better yield in potato and it alone accounts about 40-50% of the total cost of cultivation (Singh, 2003). The North Eastern Himalayan (NEH) region is deficient in seed potato availability. The seed from plains is costly due to long distance transport and is of inappropriate physiological age due to difference in growing season. The entire NEH region is unsuitable for producing potato breeder's seed through conventional field multiplication method due to high aphid pressure during crop season, high rate of degeneration due to viruses and soil borne pathogens like bacterial wilt (Sah *et al*., 2007). Non-conventional approaches, through micro-propagation of nodal cuttings and micro -tuber production followed by further multiplication of mini-tubers in net houses can be followed to produce high quality potato seed within the region (Ramani and Srivastava, 2010). Almost half a century has passed since potato micro-tubers were first described in potato, but their adoption as a seed propagule has been underwhelming. Despite being less delicate than plantlets and easy to transport and handle, their role in the seed tuber industry and their potential use for evaluation of agronomic characters is still uncertain (Wang and Hu, 1982). Many components affect tuber yield from micro-tubers like tuber size, physiological age, green sprouting methods, size grading and crop husbandry techniques (Struik and Lommen, 1999). Among these factors, micro-tuber size is one factor that is the main determinant of yield and is easy to measure (Peterson *et al.,* 1985). Large scale production of micro-tubers is usually not done due to limited space for their multiplication in the poly-houses and few reports are available for their performance under direct field planting. Kawakami and Iwama (2012) have reported the suitability of micro-tubers of all sizes ranging from 0.3g to 5g for direct field planting in Japan. Radouani and Lauer (2015) have reported influence of both genotype and micro-tuber size on field performance. In the present study an attempt has been made to evaluate the relative performance of different grades of micro-tubers of potato (*Solanum tuberosum*) varieties in the NEH region of India.

MATERIALS AND METHODS

The present field experiment was conducted at Central Potato Research Station, Shillong (1800 m AMSL, 25.54°N, 91.85°E) during 2013 and 2014. The experimental material comprised of micro-tubers of two popular potato varieties of the NEH region namely Kufri Megha and Kufri Girdhari. These micro-tubers were produced in the laboratory from *in-vitro* raised virus free micro-plants following standard protocol

(Srivastava *et al*., 2012). While harvesting, the micro-tubers were graded into three categories based on size i.e. <4mm, 4-8mm and >8mm diameter. These were stored for about six months to break dormancy and taken out one month before planting from storage and kept at room temperature for sprouting. The micro-tubers were initially planted in pro-trays with coco-peat media till they grow up to three to four leaf stage. The well grown plants were selected and transplanted in the field in four replications following a row spacing of 50 cm and plant spacing of 20 cm. Standard agronomic and plant protection measures for raising a good seed crop were followed. Plants were harvested at 120 days from date of transplanting in field. Observations were recorded on various plant growth and yield parameters. Survival (%) was recorded at 30 days after transplanting (DAP) and canopy cover at 30 and 60 DAP. Other observations like stem height (cm), no. of leaves/plant, no. of stem/plant and plant vigour were recorded at 60 DAP. Plant vigour was scored on a 1-5 scale where 1 meant very poor vigour and 5 meant excellent vigour.

The data was subjected to analysis of variance (ANOVA) for testing the significance of variation due to variety, micro-tuber grades and their interaction for different characters as described by Gomez and Gomez (1984). Mean values were calculated and compared using F-test at 5% level of significance.

RESULTS AND DISCUSSION

In the present study, the effect due to micro-tuber grades and varieties was significant ($\alpha = 5\%$) for all the plant growth and yield parameters except for varietal effect on plant survival. This indicated that the plant growth and yield were influenced by variation in the micro-tubers grade and varieties under field growth condition. The micro-tuber grade and variety interaction effect was not significant for growth and yield parameters. Thus the micro-tuber grades and varieties do not exhibit differential reaction for growth and yield parameters.

Plant survival (%): Uniform growth and survival of micro-tubers in field is very much essential for proper canopy development. The micro-tuber survival was very good for the bigger sized micro-tubers *i.e.* in the grade of 4-8 mm and >8 mm for both Kufri Girdhari and Kufri Megha (>90%). Difference in micro-tuber survival due to varieties was non-significant. As the size grade decreases to <4 mm, the potential of the micro-tuber survival decreased significantly. These findings are in agreement with those of Güllüoglu and Arioglu (2009) although Somani and Venkatasalam (2012) have reported the role of both size and genotype on micro-tuber emergence (%) and survival. The growth and survival of potato tubers is supported by the food material stored in the tubers and hence relatively bigger micro-tubers have distinct advantage as far as survival is concerned.

Canopy cover: The growth of the plant canopy has a critical impact on the overall yield of potatoes and is often the limiting factor for yields. Faster the canopy development, better the sunlight interception and still better is the starch production/yield (Joyce, 1993). In the present study, the larger the micro-tuber grade, better the canopy growth rate at both 30 and 60 days after planting. Kufri Girdhari expressed much better canopy growth than Kufri Megha at both 30 and 60 days after planting. In fact Kufri Girdhari exhibited 100% canopy cover, 60 days after transplanting for both the >8mm and 4-8 mm grade micro-tubers. This may be due to the difference in growth pattern and plant architecture of the varieties. Kufri Megha possess small to narrow leaves compared to Kufri Girdhari with wide and broader leaf area. Further, Kufri Megha is usually slower in growth taking at least 2 -3 months to establish a full canopy growth.

Plant Height: Plant height showed significant variation among different grades as well as between varieties. Kufri Girdhari plants were significantly ($\alpha = 5\%$) taller than Kufri Megha. This may be due to faster growth habit of Kufri Girdhari as compared to Kufri Megha. With increase in micro-tuber size there was a corresponding increase in plant height.

Leaves/Plant: The number of leaves/plant followed similar pattern to plant height. As the micro-tuber size increased, the number of leaves/plant also increased. In general, Kufri Girdhari exhibited more number of leaves than Kufri Megha. Similar pattern among plant height and number of leaves/plant was expected due to the fact that increase in plant height may result due to an increase in the number of nodes leading to increased number of leaves/plant.

Stems/plant: Number of primary stem per plant is a function of number of eyes in the tubers. The bigger the micro-tuber size more will be the number of eyes. In the present study, the larger sized micro-tubers (>8 mm and 4-8 mm) did not exhibited significant ($\alpha = 5\%$) difference in terms of stems/plant but were superior to those in the smallest size micro-tuber (<4 mm). Kufri Girdhari had more number of stems/plant than Kufri Megha.

Plant vigour: Plant vigour represents the overall strength and stature of the plant. There were variations in the vigour of the plants between varieties and also the vigour was reduced with reduction in micro-tuber size. Kufri Girdhari had a point scale of 3 for both the 4-8 mm and >8 mm micro-tuber size. Kufri Megha however, displayed a very poor value (1 or 2) in its plant vigour with all the three micro-tuber sizes. Sharma *et al.* (2010) have reported similar findings.

Yield components: A well-developed crop canopy can translate into better tuber yield in potato. Better growth of the above ground shoot system leads to increased photosynthate formation and translocation thereby enhancing its accumulation in the tuber resulting in higher yield. Malik (1995) has reported that the number

Table 1. Potato micro-tubers growth parameters as influenced by grades and varieties.

Treatments	Survival (%)	CC (30 DAP)	CC (60 DAP)	PH (cm)	Leaves/ plant	Stems/ plant	PV
Micro-tubers Grade							
>8 mm	94.63 a	41.75 a	88.00 a	28.88 a	47.50 a	2.69 a	2.61 a
4-8 mm	90.63 a	35.25 b	77.13 b	26.75 b	45.00 b	2.69 a	2.36 b
<4 mm	79.25 b	27.75 c	60.88 c	25.25 c	39.00 c	2.19 b	1.63 c
CD (P=0.05)	6.89	3.67	2.22	1.48	2.36	0.14	0.10
Variety							
Kufri Girdhari	89.83 x	45.33 x	89.25 x	34.42 x	51.71 x	3.04 x	2.62 x
Kufri Megha	86.50 x	24.50 y	61.42 y	19.50 y	35.96 y	2.00 y	1.77 y
CD (P=0.05)	ns	2.12	1.28	0.41	1.36	0.08	0.06

Same letter in column indicate non-significant differences; letters a, b and c used for micro-tuber grades while x and y used for variety;Survival (%): Plant survival at 30 DAP, CC (30DAP): canopy cover at 30 days after planting; CC (60DAP): canopy cover at 60 days after planting; PH: plant height (cm); Leaves/ Plant: no. of leaves per plant; Stems/ Plant: no. of stems per plant; PV: plant vigor.

Table 2. Potato micro-tubers yield potential as influenced by grades and varieties.

Treatments	No. of tubers/plant	Yield/plant (g)	No. of tubers/m^2	Yield/m^2 (Kg)
Micro-tubers Grade				
>8 mm	9.25	263.87	75.63	2.10
4-8 mm	7.98	221.78	71.36	1.82
<4 mm	6.66	155.91	59.52	1.41
CD (P=0.05)	0.36	10.01	11.02	0.31
Variety				
Kufri Girdhari	8.42	259.55	73.65	2.25
Kufri Megha	7.52	168.16	64.03	1.30
CD (P=0.05)	0.10	5.78	6.88	0.18

of leaves influences the tuber production due to more vegetative growth that leads to better carbohydrate formation. Bukema and Zaag (1990) have reported that the number of main stem arising from a seed is important because it influences the number and size of tubers at harvest.

In the present study the large size micro-tubers out yielded the smaller sized ones and Kufri Girdhari yielded better in terms of numbers and weight of mini-tubers compared to the variety Kufri Megha. Differences in the production potential can be attributed to the variable genetic base of the varieties evaluated as well as to the corresponding growth vigour.

In general, the small sized micro-tubers (<4 mm) produced relatively less number of small sized tubers per plant as compared to the larger sized micro-tubers (4-8 mm and >8 mm). Thus maximum yield per plant was produced by >8 mm grade micro-tubers followed by 4-8 mm and <4 mm grade micro-tubers. Similar yield pattern was observed for number of tubers/m^2 and yield/m^2. The difference for tuber size distribution can be influenced by the micro-tuber size as well as the genotype (Ranalli *et al.*, 1994). Total yield variation may also be accounted to the initial growth and survival rate at the time of planting (Kumar *et al.*, 2007).

Conclusion

The present study concluded that potato micro-tubers can be used as initial planting material for open field planting during the summer season in the NEH region of India. All the grades of micro-tubers (<4 mm, 4-8 mm and >8 mm) of both the varieties Kufri Megha and Kufri Girdhari were able to produce mini-tubers albeit with different efficiencies distinctly showing the effect of micro-tuber size and genotypes. Earlier studies have also shown such effect and emphasised the need for location and genotype specific optimization of micro-tuber multiplication in the open field. Our study indicates that the micro-tubers can be produced in large numbers and planted directly in the field for mini-tuber production. Such mini-tubers can be multiplied 2-3 times in the field for producing high quality seed potato thereby helping in attaining self-sufficiency for seed potato availability within the NE region.

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