

Effect of plant density on mini-tuber production potential of potato varieties through micro-plants under net-house in North Eastern Himalayan region

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Abstract

The present study was conducted to standardize the crop geometry under net-house with micro-plants of two popular potato varieties, Kufri Himsona and Kufri Girdhari planted at two spacing *viz.*, 20 x 10 cm and 15 x 10 cm at Central Potato Research Station, Shillong during 2013 and 2014. The effect due to spacing and varieties was significant for all the plant growth and yield parameters except for plant survival among varieties. Plant survival was better in all treatments (> 80%). The plant growth was superior in terms of plant height, at wide spacing (20 x 10 cm) although canopy cover was more at narrow spacing (15 x 10 cm). Kufri Himsona exhibited better growth with more stem height, number of leaves/plant, stems per plant and better canopy cover at 30 DAP than Kufri Girdhari. Kufri Himsona yielded better in terms of numbers and weight of mini-tubers per plant as well as per unit area compared to the variety Kufri Girdhari. More number of tubers per plant was observed at closer spacing (15 x 10 cm) but better yield per plant was obtained at wider spacing (20 x 10 cm) due to increased competition for nutrients, space, sunlight *etc.* leading to an increase in number of tubers per plant but subsequent decrease in total tuber yield per plant at closer spacing. At closer spacing more small sized tubers were harvested (<3g to 20g) while at wider spacing more larger sized tubers were harvested (over 20g). Among varieties, Kufri Himsona yielded more large sized tubers as compared to Kufri Girdhari. Thus depending on the seed size requirement and availability of area under net house, either narrow or wide spacing can be followed for production of mini-tubers from potato micro-plants in North Eastern Himalayan region.

Key words: Potato, micro-plants, plant density, yields potential, net-house.

Introduction

Potato is an important crop for livelihood security of the North Eastern Himalayan (NEH) region of India. The region contributes about 10% of the total potato area in the country. The area under potato, as a percentage of the net-cropped area, is about four times of the national level in the region (Kumar *et al.*, 2008). However, potato yield in all NEH states has been low as compared to national average of 22.76 t/ha (NHB, 2013).

Potato being a clonally propagated crop suffers from typical clonal degeneration over years of multiplication in open field. Breeder's seed production through conventional field multiplication is not possible in the region due to abundance of various soil borne and viral diseases throughout the growing season (Srivastava *et al.*, 2012b). Protected multiplication using 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). Tissue culture based seed production has been successfully reported from north western hills (Sharma *et al.*, 2010) and north western plains (Kumar *et al.*, 2011; 2012) in the country. The net houses prevent the exposure of crops to various insect pests like aphids, white flies *etc.* which serve as a vector for viral diseases. The prevalent growth condition *viz.*, weather condition, soil type, growing period *etc.* has paramount effect on mini-tuber production under net-house and only limited inference about production potential can be drawn from net house propagation techniques used in different regions. The basic agronomy like

the planting geometry, genotypes, growing condition *etc.* has to be standardised in new environment. Not much information on net house based potato micro-propagation is available for NEH region. In the present study, an attempt has been made to evaluate the effect of varieties and micro-plant spacing on mini-tuber production potential under net-house cultivation.

Materials and methods

The present study was conducted under net-house using micro-plants of two popular potato varieties of the NEH region namely Kufri Himsona and Kufri Girdhari at Central Potato Research Station, Shillong (1800 m AMSL, 25.54°N, 91.85°E) during 2013 and 2014. These micro-plants were produced through serial multiplication from virus free micro-plants following standard protocol (Srivastava *et al.*, 2012a). Fully grown micro-plants were first planted in pro trays in coco-peat media and hardened for about 10 days. These were then transplanted under net house at two plant spacing *viz.* 20 x 10 cm and 15 x 10 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 net house.

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), number of leaves/plant and number of stem/plant were recorded at 60 DAP. The harvested tubers were grouped into five size categories *viz.* <3 g, 3-10 g, 10-20 g, 20-30 g and >30 g and their number and weight (kg)

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

Results and discussion

In the present study, the effect due to micro-plant spacing and varieties was significant for all the plant growth and yield parameters except for plant survival among varieties. This indicated that under net house growth condition, the plant growth and yield were influenced by variation in the micro-plants spacing and varieties. The micro-plant spacing x 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 growth parameters

Plant survival (%): Micro-plant survival is a crucial factor for successful production of mini-tubers under net house condition. Although the plant survival was better in all treatments (> 80%), it was significantly superior with less plant density (20 x 10 cm) (Table 1). Sharma *et al.* (2014) have attributed it to increased competition among the plants for space and other nutrients at closer spacing resulting in mortality of some of the plantlets. There was no varietal difference for plant survival.

Stem height: Stem height showed significant variation among different spacing as well as between varieties. Kufri Himsona plants were significantly taller than Kufri Girdhari (Table 1). This may be due to faster growth habit of Kufri Himsona as compared to Kufri Girdhari. With increase in spacing there was a corresponding increase in plant height. Kumar *et al.* (2012) has attributed it to less intra-specific competition for nutrient, water, space and light at lower plant densities *i.e.* increased plant spacing.

Leaves/plant: The number of leaves/plant followed similar pattern as plant height. As the spacing increased, the number of leaves/plant also increased. In general, Kufri Himsona exhibited more number of leaves than Kufri Girdhari (Table 1). An increase in plant height may result from increase in the number of nodes leading to increased number of leaves/plant. Singh *et al.* (1997) have accounted it due to better space and nutrient availability at wide spacing.

Stems/plant: Kufri Himsona produced significantly more number of stems as compared to Kufri Girdhari which may be attributed to its genetic feature. More number of stem per plant were observed in wide spacing (20 x 10 cm) compared to narrow one (15 x 10 cm) (Table 1). Difference in plant vigour of varieties under similar condition can be attributed to specific genotypic response for plant growth behaviour (Sharma and Singh, 2010). Singh *et al.* (1997) has reported that reduced number of stems and compoundleaves per plant with increasing plant population per unit area due to reduced availability of space and nutrients for the plants to develop to their full vigour.

Canopy cover: In the present study, the closer the spacing, better was the canopy growth rate at both 30 and 60 days after planting, although it was statistically non-significant at latter date. Kufri Himsona exhibited much better canopy growth than Kufri Girdhari at 30 days after planting (Table 1). Variation in canopy cover due to cultivars can be attributed to variation in plant height and number of compound leaves per plant of these cultivars (Kumar *et al.*, 2011). Both Kufri Himsona and Kufri Girdhari are long duration varieties which show slow initial growth. Hence, better canopy growth was observed at closer spacing due to more plant population. At later stage (60 days after planting), luxuriant growth was observed at both the spacing leading to insignificant difference among the two.

Yield parameter: In the present study, Kufri Himsona yielded better in terms of numbers and weight of mini-tubers per plant as well as per unit area compared to the variety Kufri Girdhari (Table 2). Differences in the production potential can be attributed to the variable genetic base of the varieties as well as to the corresponding growth vigour. 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; Bukema and Zaag, 1990). Significantly superior yield was obtained at closer spacing (15 x 10 cm) as compared to wide spacing (20 x 15 cm). Such result was expected due to more number of shoots per unit area under close spacing resulting in production of more number of tubers and better yield (Zamil *et al.*, 2010; Kumar *et al.*, 2012)

More number of tubers per plant was observed at closer spacing (15 x 10 cm) but better yield per plant was obtained at wider spacing (20 x 10 cm). At closer spacing the tuber size is expected to be reduced due to increased competition for nutrients, space,

Table 1. Growth performance of potato micro-plants under net house

Treatments	Survival (%)	Stem height (cm)	Leaves/plant	Stem/plant	Canopy cover	
					(30 DAP)	(60 DAP)
Variety						
Kufri Himsona	83.9	77.9	60.2	3.9	74.3	93.1
Kufri Girdhari	82.9	70.6	44.3	2.2	67.6	92.4
LSD ($P=0.05$)	ns	4.2	5.2	0.4	2.9	ns
Spacing						
20 cm x 10 cm	86.0	78.0	55.1	3.4	67.1	92.1
15 cm x 10 cm	80.8	70.5	49.4	2.6	74.8	93.4
LSD ($P=0.05$)	1.3	2.9	3.7	0.3	2.0	ns

Table 2. Yield performance of potato micro-plants under net house

Treatments	Yield of mini tubers /m ² (kg)	Number of mini tubers /m ²	Yield of mini tubers /plant (g)	Number of mini tubers/plant
Variety (V)				
Kufri Himsona	3.43	255.70	110.35	8.60
Kufri Girdhari	3.23	211.50	100.75	7.00
LSD ($P=0.05$)	0.14	7.23	3.56	0.36
Spacing (S)				
20 cm x 10 cm	3.25	211.30	114.70	7.25
15 cm x 10 cm	3.41	255.90	96.40	8.35
LSD ($P=0.05$)	0.15	8.29	4.39	0.42
V x S LSD ($P=0.05$)	ns	10.25	ns	ns

Table 3. Grade wise mini-tuber production by potato micro-plants under net house

Treatments	Yield of mini tubers /m ² (kg)				
	<3g	3-10g	10-20g	20-30g	>30g
Variety					
Kufri Himsona	0.12	0.38	1.11	0.69	1.11
Kufri Girdhari	0.28	0.43	0.89	0.62	0.99
LSD (<i>P</i> =0.05)	0.01	0.02	0.03	0.01	0.06
Spacing					
20 cm x 10 cm	0.13	0.22	0.88	0.83	1.15
15 cm x 10 cm	0.27	0.60	1.11	0.47	0.95
LSD (<i>P</i> =0.05)	0.01	0.01	0.03	0.02	0.05
V x S LSD (<i>P</i> =0.05)	0.01	0.02	0.04	0.01	0.08

sunlight *etc.* leading to an increase in number of tubers per plant but subsequent decrease in total tuber yield per plant. The distribution of different tuber grades at closer and wider spacing further reiterates this obvious fact (Table 3). At closer spacing more small sized tubers were harvested (<3g to 20g) while at wider spacing more larger sized tubers were harvested (over 20 g). Among varieties, Kufri Himsona yielded more large sized tubers as compared to Kufri Girdhari. The difference for tuber size distribution can be influenced by the genotype (Ranalli *et al.*, 1994) as well as initial growth and vigour during vegetative stage (Kumar *et al.*, 2007).

The present study revealed that potato micro-plants planted in net-house at wider spacing (20 x 15 cm) exhibited better morphological growth as well as yield per plant with more number of large sized tubers. Micro-plants planted at narrow spacing (15 x 10 cm) showed relatively poor morphology but were able to produce more number of tubers per plant and better yield per unit area although majority of tubers were of small size. Thus, potato micro-plants can successfully be used for mini-tuber production under net-houses in North eastern Himalayan region and the spacing can be wide or narrow depending on our seed size requirement and area available under net house.

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