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Full Length Research Paper

Comparative study of potato cultivation through micropropagation and conventional farming methods

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A trial was carried out to evaluate the productivity of *Solanum tuberosum* L. cultivated through conventional farming and micropropagation method. Survival rate, biomass and tuber yield of both micropropagated and tuber propagated potatoes was evaluated. Survival percentages of potatoes were 90% for conventional propagation and 85% for micropropagation. The survival rate of micropropagated plants were maximum of 79% in vermicompost and minimum of 50% in the soil. The average shoot length, number of leaves and leaf area was greater in tuber propagated plants compared to the micropropagated plants. Tuber propagated plants yielded 1.360 kg/plant which was 0.370 kg/plant more than micropropagated plant.

Key words: Conventional farming, micropropagation, potatoes, tuber propagation.

INTRODUCTION

Potato *(Solanum tuberosum* L.) is one of the most productive and widely grown food crops in the world. Globally, it ranks fourth most important food crop after maize, wheat and rice. It produces approximately twice as many calories per hectare as rice or wheat. Due to its wide adaptability potato is grown in both tropical and temperate environments and elevations from sea level to 4000 m (Poehlman and David, 2003). Potato is an important crop of the world and is grown on around 18.3 million hectare with a production of 295 millions tones. Its world's average yield is 50.5 kg/year. The annual compound growth rate from 1949-1950 to 1995-1996 for area, production and yield of potato was 3.50, 6.00 and 1.41% respectively. Potato contributes about 1.23% to the gross production from agricultural and allied activities in India (Prasad, 2006).

Potato is grown in 1,140 hundred ha in India and produces 19,244 hundred tones with a yield of 16.9 tones per ha. Potato is good and cheap source of carbohydrates, vitamins, minerals and proteins. It also provides most of the trace elements which can meet the energy requirements of humans (Sharma, 2001).

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Nutritionally, potatoes are best known for their carbohydrate content. The predominant form of this carbohydrate is starch. A small but significant portion of this starch is resistant to digestion by enzymes in the stomach and small intestine, and so reaches the large intestine essentially intact. This resistant starch is considered to have similar physiological effects and health benefits as fibers. It provides bulk, offers protection against colon cancer, improves glucose tolerance and insulin sensitivity, lowers plasma cholesterol and triglyceride concentrations, and possibly even reduces fat storage (Hylla et al., 1998).

Potato is normally vegetatively propagated. Contamination of seed material by pathogens (bacteria, virus and fungi) causes severe reduction in yield. That is why, despite tremendous efforts little success had been achieved in conventional seed plant potato production scheme. In this event plant biotechnology offers a great potential to complement conventional breeding methodology for potato improvement and production via plant tissue culture techniques. But, lack of budget, limited resource allocation and relatively high recurrent cost (chemical expenses) this technology has been envisaged as a major obstacle in benefiting from this technology in developing countries, particularly in India. *In vitro* propagation by nodal cutting has become an established

Table 1. The composition and percentage of nutrient in fertilizer and amount of fertilizer.

Nutrient	Fertilizer	Composition of nutrient	% of nutrient in fertilizer	Amount of fertilizer applied
N	Urea	NH_2	46%	18 kg
P	SSP	P_2O_5	16%	22.75 kg
K	MoP	K_2O	14%	32.48 kg

method of rapid multiplication in potatoes (Ranalli et al., 1994) and in blueberry by Zimmerman and Broome (1980). Micropropagation of potato has great advantage in cultivation for increased yield and uniformity in germplasm. Hence, in the present investigation a comparison in cultivation methods of potato crop was carried out to observe the change on productivity and yield.

MATERIALS AND METHODS

Murashige and Skoog medium (MS, 1962) with sucrose 3% (w/v) and 8% (w/v) agar was used as basal medium throughout the experiment. Growth hormones, N_6-benzyladenine (BA) and naphthalene acetic acid (NAA) were added to the basal medium. Sprouts from sterilized potato tubers (grown in plant growth chamber) were aseptically cultured in culture tubes containing 5 ml medium. After inoculation cultures were maintained in the growth room under 16 h photoperiod, 2000 to 3000 lux light intensity and 8 h dark period at 25 ± 1°C.

Newly formed shoots measuring 3 to 4 cm in length were excised individually from the clump and transferred to MS basal media supplemented with Indole Butyric Acid (5 µM) for rooting. Plants with newly formed roots were carefully planted in polythene bags containing soil mixture having vermicompost, perlite, Farm yard manure and soil in varying ratio. After 2 week plants were transferred to pots. Field trial was conducted in Kuberpur farm, Agra where average maximum temperature was 26°C and minimum was 8°C during the experimentation period. The sterilized seed tubers of potato variety 3797 were purchased from Praveen Naveen Chetan (PNC) Kuberpur cold storage Agra. These tubers were almost 3 cm in diameter and each tuber had 3 to 5 eyes. An experiment in a randomized complete block design (RCBD) with three replications was established. Each gross plot had eight furrows spaced at 45 cm × 15 cm. Plant to plant spacing was 15 cm, giving a plant population of 200 plants per block. Urea, single super phosphate and Murate potash were used as fertilizer source of nitrogen, phosphorus and potassium, respectively (Table 1) and were applied at standard recommended rates as: N – 180 kg, P – 80 kg/ha and K – 100 kg/ha (Govindakrishnan and Kushwah., 2003; Sharma, 2006). Thereafter irrigation was carried out according to crop water requirements. A comparative observation of the following parameters was done on plants grown by conventional methods and plants developed by micropropagation. The observations were taken for plant growth responses namely: germination, biomass and yield performance.

RESULTS AND DISCUSSION

The present investigation was planned to compare the yield performance of potato (*S. tuberosum* L.) grown by conventional method of propagation and micropropagation. The results obtained are described below:

Germination

In the field, the germination was considered when radicles came out from soil and attained a length of 2cm. In the *in vitro* propagation the survival rate of micropropagated plants was taken as criterion for germination at hardening stage. Here, 87.12% germination was attained in the field. Pot experiment (micropropagated plants) showed less germination than field experiment. In pots the best results that is, 79% was obtained in the mixture of vermicompost, perlite, FYM and soil in 1: 1:1:1 ratio.

Seed treatment improved the germination ability in field. Shoot culture initiation and shoot proliferation study was also carried out before hardening. For shoot culture initiation MS media supplemented with 2 µM NAA was used. Shoot cultures inoculated on MS medium supplemented with BA showed increase in the multiplication. This is in conformity with the findings of Lane (1979), Bhojwani (1980), Garland and Stolz (1981); Bhojwani and Razdan (1992); Hussain et al. 1990. According to their study in micropropagation, for shoot proliferation growth regulators, especially cytokinins are one of the most important factors affecting the response. A range of cytokinins (Kinetin, BA, 2-ip and zeatin) has been used in micropropagation work. BA was the most effective cytokinin for shoot tip, meristem and bud culture.

Biomass

Shoot length

Data presented in Table 2 clearly indicates that average shoot length was more in tuber propagated plant. It was 33.67 ± 0.546 cm. The average shoot length of micropropagated plants were 31.67 ± 0.720 cm. In the present experiment plant height increased in response to the fertilizers treatment and nitrogen fertilizers increased potato plant height more in the fields (Figure 1). Tiwary et al. (1970) also reported that nitrogen increases plant height in *zea mays*.

Number of leaves

Data presented in Table 2 showed that number of leaves increased with days in both tuber propagated and micropropagated plants. After 90 days of germination,

Table 2. Characteristics of plants produced from seed tubers and micropropagation data were recorded after 15 days.

Days after germination	Tuber propagated		Micro propagated	
	Shoot length	Number of leaves	Shoot length	Number of leaves
15	17.0 ± 0.47	10.0 ± 0.47	11.0 ± 0.47	7.00 ± 0.47
30	20.0 ± 0.94	13.0 ± 0.47	13.3 ± 0.83	9.67 ± 0.27
45	22.0 ± 0.94	14.3 ± 0.71	15.3 ± 1.19	12.3 ± 0.27
60	24.3 ± 0.27	20.7 ± 0.27	17.0 ± 1.28	15.3 ± 0.27
75	27.0 ± 0.47	22.7 ± 0.27	21.8 ± 1.37	16.7 ± 0.54
90	29.3 ± 0.27	19.3 ± 0.54	25.9 ± 0.54	17.2 ± 0.54
105	33.0 ± 0.82	13.5 ± 0.94	30.0 ± 1.24	10.5 ± 0.47
120	33.7 ± 0.55	8.33 ± 0.18	31.8 ± 0.72	5.67 ± 0.34

Values are mean ± standard error.

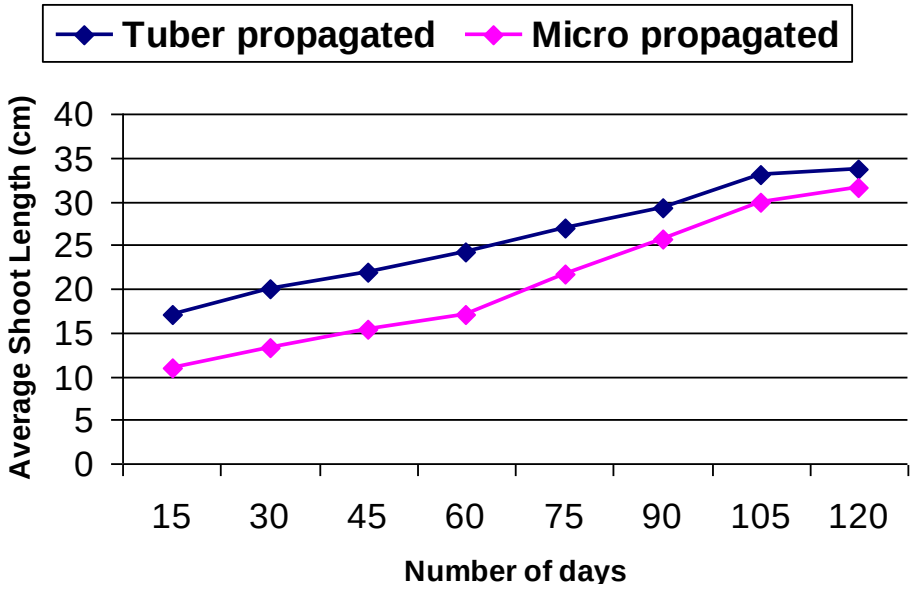

Figure 1. Showing relation between shoot length and growth period.

leaves started yellowing and falling. The counting was lowest in number in both tuber propagated and micropropagated plants after 120 days. There was a drastic increase in number of leaves up to 75 days of germination then after it showed a decline (Figure 2). In this connection, Moorby and Morris (1967) reported that nitrogen fertilizer plays a significant role in the production of stem and axillary branches, which resulted in greater numbers of leaves in field. In *Zea mays* L. Tiwari et al. (1970) reported that nitrogen increases the number of effective leave at starting stage.

Leaf area

The leaf area also increased with increase in the age of plants in both the methods. The maximum leaf area 14.30 cm^2 was found at 75 days of plant growth in field. In micropropagated plants it was 11.95 cm^2. In the present study, N, P, and K were used as fertilizers in field. Nitrogen fertilizer increased the leaf area which increase the amount of solar radiation intercepted and consequently increases days of flowering and days to physiological maturity, plant height and dry matter production of different plant part (Krishnippa, 1989). Kotsyuk (1995) also reported that fertilization increased leaf area, and encouraged the formation of many tubers.

Yield performance

To check the yield performance, the tubers were divided into three grades there were less than 25 g, between 25 to 75 g and greater than 75 g. Table 3 and Figure 3 shows that in total the number of tubers was higher in micropropagated plants. The total weight of tubers was 0.37 kg per plant more in tuber propagated plants in

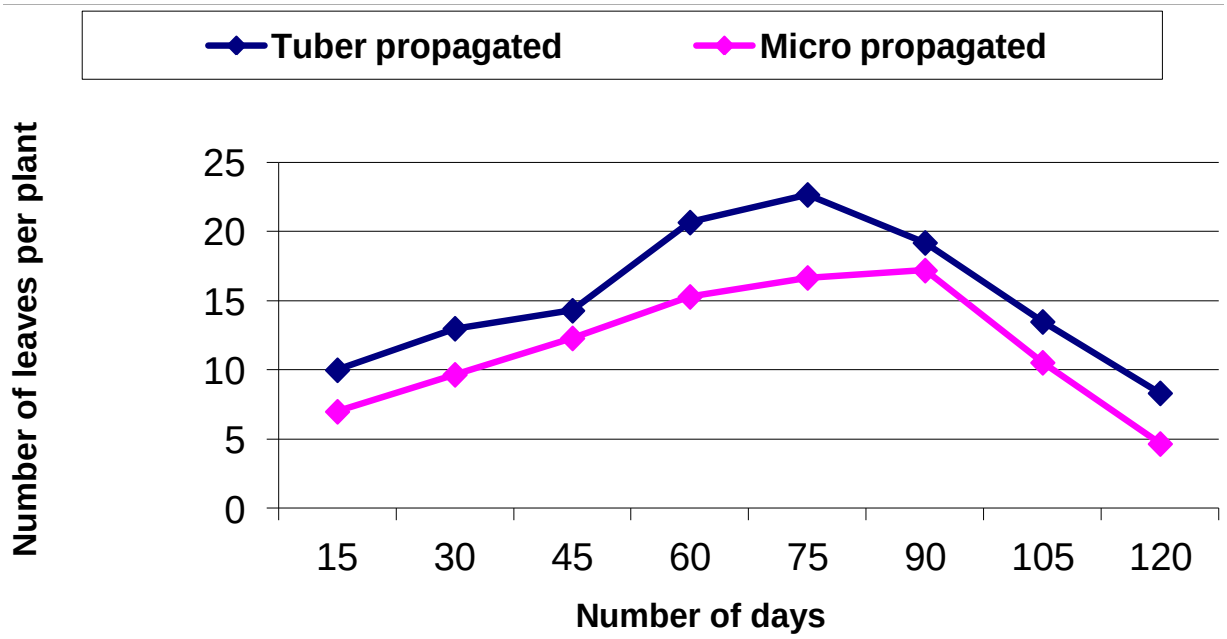

Figure 2. Showing relation between number of leaves and growth period.

Table 3. Yield performance of seed tubers as compared to micropropagated tubers (Tuber number and weight/plant).

Grade (g)	Tuber propagated		Micropropagated	
	Number of tubers	Weight of tubers (kg)	Number of tubers	Weight of tubers(kg)
< 25	3	0.07	13	0.30
25 – 75	4	0.27	06	0.43
> 75	8	1.02	02	0.26
Total	15	1.36	21	0.99

The values shown are mean.

comparison to micropropagated plants. The total weight of tubers was 1.360 kg per plant in tuber propagated plants and 0.990 kg per plant in mircopropagated plants. Nitrogen and phosphorus fertilization improved total tuber yield of potato.

The fertilizer increases the total leaf area which in turn increased the amount of solar radiation intercepted and more photo assimilate might have been produced and assimilated to tubers. In this connection, Millard and Marshall (1986), Yibekal (1988) reported that yield improvement as a result of nitrogen fertilization could be attributed to increased radiation interception. This is in conformity with the findings of Lauer (1986) and Ojala et al. (1990) who observed that high N levels promoted excessive vegetative growth. Potato tuber yield is directly dependent on the supply of N, P may substantially delay leaf senescence leading of enhanced leaf area duration and increased tuber yield (Mackerron and Heilbronn, 1985). It has been also reported that the potassium application significantly increased the tuber yield of potato by increasing the size of tubers (Verma and Grewal, 1977).

Conclusion

On the basis of the above comparison between tuber propagation and micropropagation in the present study, it can be concluded that all the morphological and physiological parameters along with the yield attributes were better in the tuber propagated plants than the micropropagated one.

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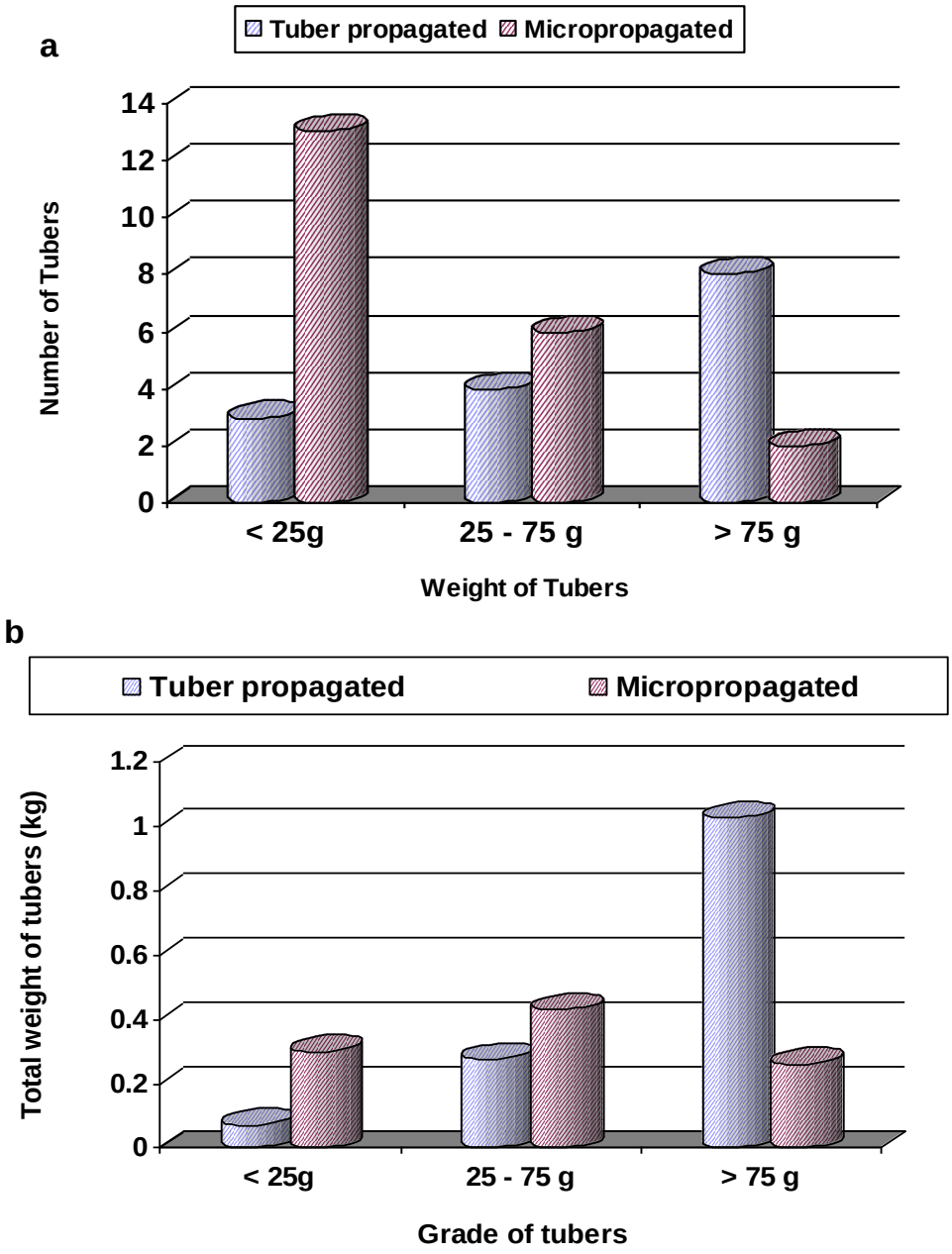

Figure 3. Showing the comparative response of tuber yield (per plant) under various weight and grades (A) weight of tubers (B) grade of tubers.

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