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STANDARDIZATION OF FUNDAMENTAL COMPONENTS IN AEROPONICS FOR MINITUBER SEED POTATO PRODUCTION : A REVIEW

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Abstract

Potato seed production under conventional system causes accrual of tissue-borne fungal, viral and other pathogens and is also considered as slower system of seed multiplication. Above all, this system led to reduction in quality potato seed, low crop yields and ultimately insufficient supply of good quality seed tubers. Scarcity of potato seed has also been accepted as one of the vital factors that limit potato production in developing countries. In mitigating the problem of shortage of good quality seeds, various strategies were developed to rapidly multiply the seed tubers. Advanced technologies like tissue culture, hydroponics and aeroponics needs to be given a serious thought and should be promoted for optimization of tuber production. These techniques areoften used in combination with each-other to get the best results in a short time and reduce numerous labour steps accompanying with direct use of seedlings from lab into the field. This paper insights the standardization of fundamental components in aeroponics system for minituber seed potato production.

Key words : Aeroponics, minituber, nutrient medium, rapid multiplication, soil-less production.

Introduction

Potato (*Solanum tuberosum* L.) is 4th important non-cereal horticultural food crop after corn, rice and wheat [Food and Agriculture Organization of the United Nations (FAO), 2015]. In most of the countries its cultivation is gaining importance due to nutritional assessment and the prospect of procuring high yields per unit area in a short growing time (Hirpa *et al.,* 2010). Extent of cultivation depends on the use and accessibility of good quality tuber seeds (free from various diseases) (Thomas-Sharma *et al.,* 2016). Presently higher yields along with good quality of minituber seed potatoes have also been obtained in some recent advanced production systems, such as hydroponics (Farran and Mingo-Castel 2006; Chang *et al.,* 2012; Mateus-Rodríguez *et al.,* 2012). Multiple techniques have been assayed during the last years, such as high concentration cultures along with non-destructive harvests (Lommen, 1995), hydroponic systems using dissimilar inert substrates, deep water culture methods (Chang *et al.,* 2000), the NFT technique (Wheeler 2006) and hydroponic systems with recirculating nutrient solutions in low volume materials (Struik and Wiersema, 1999). However, these techniques have their own limitations due to an inadequate aeration of roots. Among these methods, preliminary experiments gave promising results over other methods because aeroponics has numerous advantages over all other techniques (Ritter *et al.,* 2001; Otazu, 2007). Roots are kept in a dark enclosed environment drenched with an aerosol of nutrient medium (Christie and Nichols, 2004) as aeroponics is a soilless culture. It is apioneering technology that results biomass and higher tuber production, improves root oxygenation (Soffer and Burger, 1988) and reduces the depletion of water and nutrients (Farran and Mingo-Castel, 2006). It can be more beneficial than conventional seed tuber production methodsas better utilization of the vertical space in protected structure and consecutive harvests of reasonably, regular and pathogen free seed tubers.

Major compensations of this technique include less wastage of water, satisfactory hygienic quality and higher multiplication frequency and stepped harvest (Ritter *et*

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al., 2001). This technique has many disadvantages also as vulnerability to energy outages (Farran and Mingo-Castel 2006; Chang *et al.,* 2008), the high initial investment (Mateus-Rodrýguez *et al.,* 2013) and the lack of awareness in crop management.

Under hot climatic conditions viral diseases insect vectors are more prevalent. For connecting this gap, large-scale combination of conventional and rapid multiplication methods like micro propagation at commercial scale is needed for producing sufficient quantity seed tubers (Pandey 2006). The common technique for propagation of commercial potato cultivars suffers from seed borne viruses, fungi and bacterial diseases in subsequent generations and results in significant losses in yield and tuber quality (Nyende *et al.,* 2005). Seed potato produced by recurring clonal multiplications of preliminary disease-free tubers, suffers from low multiplication proportion and accumulation of various deteriorating viral diseases (Naik *et al.,* 2000).

Plant height

Various authors have described that higher temperatures environment also induce the plants with thin stems, small sized leaves and more length of internodes (Steward *et al.,*1981). Wolf *et al.,* (1990) emphasize that warm conditions cause more translocation of photosynthate material towards branches, stems and leaves and accomplished that there is a noteworthy effect of temperature on the height of the plant and number of leaves in potato. The temperature of the root environment of highland areas presents average records below 10°C during the early period of plant development. This might be due to the incidence of frost in the exterior environment, which could have meaningfully affected the plant height of the genotypes assessed (Mateus-Rodríguez *et al.,* 2014). Hamid *et al.,* (2013) showed significantly higher potato plant height in Morn variety, whereas, the lowest shoot and roots fresh weight, and plant height were observed in Marfana variety in aeroponics as compared to hydroponics. Tierno *et al.,* (2013) evaluated different cultivars of potato in aeroponic system and showed increased growth with vegetative cycle prolonged between 12 and 36% compared to the greenhouse beds cultivation.

Plant spread

Early growth and survival of potato micro-plants is critical in attaining successful development under aeroponic cultivation. Crocco *et al.,* (2000) reported that the growth, enlargement and yield of potato tubers were subjective to canopy size, whereas Parveen *et al.,* (2010) proved that many environmental factors influence the yield of potato tubers.

Root length

TK Bag *et al.,* (2015) evaluated the performance of three potato varieties, *viz.* Kufri Megha, Kufri Himsona and Kufri Himalini in an aeroponics system installed under net cum polyhouse and observed that more than 90% endurance with root commencement within 4-5 DAT. Aeroponics advances root aeration and resulting in more yields than that of hydroponics system (Soffer and Burger, 1988). Hamid *et al.,* (2013) established by experimenting on potato varieties (Marfana, Santana and Morn) for minituber production in aeroponics is considerably higher fresh weight of roots and potato plant height resulted in aeroponics system. The number of saffron plants root was also significantly better in aeroponics than that in hydroponics system and soil culture (Souret and Weathers, 2000).

Initiation of tuber formation

Inmaculada and Angel (2006) obtained higher number of stolons at low plant densities and plants exhibited a lengthy vegetative cycle of 5 months after transplanting. Tuber formation was also speeded when N supply was decreased. Chang, D.C. *et al.,* (2008) observed that the stoppage of nutrient quantity for at least 10 days expressively improved root movement and stolon anthocyanins, but it declined photosynthesis and transpiration activity rates and nutrient uptake rate in leaves. Application of nutrition by spraying foliage and roots, expressively increased yield after tuber formation. Application of nutrients only by spraying foliage produced very few tubers. They suggested that foliage absorption of nutrition is important for seed potato production in aeroponics system, especially after initial tuber formation. TK Bag *et al.,* (2015) evaluated that more than 90% survival with initiation of roots within 4-5 days of transplanting.

No. of tubers per plant

Beukema and Zaag (2001) described that the number of main stems arising from a seed is important because it influences the number and size of tubers. Basically there are four factors-variety, seed size, spacing and physiological conditions of the seed which decide tuber production. Zkaynak and Samanci (2009) reported that tuber yields depend on minituber classes, planting dates and cultivars which effects stem density. The tuber yield per plant in the aeroponic technique was almost 70% higher and number of tubers is more than 2.5 fold higher.

Tuber size (Large, medium, small)

Large Tuber size

Sakha *et al.,* (2004) established that the tuber size effects the yield of potato. Park *et al.,* (2009) observed the bigger potato tubers resulted in more vigorous plantlets in the subsequent generation than little ones and concluded that tuber size should be at least 0.5 g to be used as potato seed. Beukema & Zaag (2001) also stated that the potato yield was subjectiveto the size of tubers.

Medium Tuber size

Park *et al.,* (2009) submitted that the size of tubers can be used as a guide for categorizing them as seed potatoes. Increase in starch results in incline the size of the potato minituber and the amounts of sugars are certainly co-related with the size of the seed potato.

Small Tuber size

Crocco*et al.,* (2004) established that planting small entire seed abolishes the cost of cutting seed tuber, lessens the transmission of seed-borne diseases, diminishes seed piece deterioration and improves the performance of some potato planters like the "cup type".

Tuber yield per plant

Tekalign and Hammes (2005) recognized that dissimilar potato cultivars are diverse in tuber number, size and tuber yield. Multiplication rates are described to be meaningfully higher in aeroponics than those acquired in conventional systems, by using less water and without using solid substrates (Soffer and Burger 1988; Ritter *et al.,* 2001; Farran and Mingo-Castel 2006). Nichols (2005) highlighted the potential of aeroponics for lessening at least one generation of seed reproduction in the field, with lower costs and conserving high quality. Aeroponics has thus been adapted by CIP along with many national partners in Colombia, Bolivia, Peru, Ethiopia, Kenya, Malawi, Uganda, and Ecuador as part of the 3G approach.

Yield of required size mini-tubers

The consecutive harvesting of mini-tubers in aeroponic system inclines the yield especially number of tuber as the elimination of the large tubers which allows commencement of new tubers as well as the development of current ones (Ritter *et al.,* 2001).

Total crop duration

Alterations in vegetative cycle of potato genotypes cultivated in aeroponics and from those grown under field situations had been perceived by previous workers and accredited to high oxygen and nitrogen accessibility in the nutrient solution (Ritter *et al.,* 2001 and Masengesho *et al.,* 2012). Variety Kufri Megha is reported as late maturing variety (120-145 days) while Kufri Himalini and Kufri Himsona are considered as medium maturing varieties (110-120 days) under field conditions (Luthra *et al.,* 2008).

Conclusion

From the above article it could be concluded and implemented for the production of potato minitubers, the aeroponic system appears to be the best in many aspects. Considering the probable advantages of the aeroponics system like reduced production cycle duration, higher yield, good nutrient management system, growth, endurance rate of plantlets and good aeration facility, helps this system to be more viable. Further, standardizing plant foliage density, initiation of tuber formation, crop cycle in single season and harvesting index including crop seasons as well as interactions between productions factors are needed to make the approach more popular.

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