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# PRODUCTION POTENTIAL OF AEROPONIC POTATO AS INFLUENCED BY DIFFERENT PLANTING AND IRRIGATION METHODS IN NORTH-CENTRAL INDIA

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**ABSTRACT: Aeroponic is well established technology for more efficient and high quality seed potato production. An experiment was carried out at Central Potato Research Institute, Regional Station, Gwalior (MP) to find out the suitable method of planting and irrigation for further multiplication of aeroponic minitubers under net house conditions with six treatment combinations. Aeroponic minitubers of two popular potato variety of the region *viz* Kufri Lauvkar and Kufri Surya were planted with two types of seed beds *viz* flat bed and ridge and furrow with 30 cm × 10 cm spacing in which sprinkler and furrow irrigation method was applied. Among planting beds, significantly higher emergence% was recorded in ridge and furrow planting (87.22) over flatbed planting method (83.89). Weight of tubers was significantly higher in sprinkler irrigation (105.7 q/ha), ridge and furrow planting (107.8 q/ha) and variety Kufri Lauvkar (114.1q/ha) over furrow irrigation (98.3 q/ha), flat bed planting (96.2 q/ha) and variety Kufri Surya (89.8 q/ha) respectively. Significantly higher seed size (40-80g) tubers were recorded in sprinkler irrigation method (3% by number and 12.6% by weight) and variety Kufri Lauvkar (3.6% by number and 17.6% by weight) over furrow irrigation and Kufri Surya. Therefore, for higher production, minituber multiplication should be done in ridge and furrow method of planting with sprinkler irrigation under North-Central conditions of India.**

**KEYWORDS**: aeroponic minitubers, planting methods, irrigation methods, variety, potato

## INTRODUCTION

Aeroponics is a modern, soilless technology and a viable alternative for the potato minituber production in which cultivar plays a significant role in the number of tubers formed (Rykaczewska, 2016; Broćić *et al.*, 2021). Aeroponic systems for prebasic potato seed production was established following increased demand for more efficient, high quality seed production methods (Ritter *et al.*, 2001, Nichols, 2005) and has a potential of revolutionizing potato seed production industry (Buckseth and Singh 2018) which has been well integrated in India for seed production (Sadawarti *et al.*, 2021). Net houses are used in hi-tech seed production for cultivation of microplants as well as for recycling of small minitubers to get seed size or larger tubers for subsequent field multiplication and channeling into seed production generations (Kaur *et al.*, 2019). Tuber number and the size of the tubers is important for potato production. Seed size tubers are more prolific and economically more adaptive than underweight and overweight tubers. (Kaur *et al.*, 2019)

Potatoes are one of the most water-efficient crops, however, water management in potatoes is crucial as potato is one of the most water stress-sensitive crops due to its

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shallow rooting system and the sensitivity of the potato foliage characteristics. At present surface irrigation (furrow irrigation) in potato cultivation practice is less efficient compared to pressurized irrigation system. The water can be efficiently utilized by adopting the modern pressurized micro irrigation systems. Now a days, the sprinkler irrigation method is gaining popularity among the farmers which also used to maintain the healthy microclimate in the close growing crops along with irrigation (Chicham *et al*., 2022). Sprinkler irrigation method distributes water to crops by spraying it over the crop area like a natural rainfall. It is estimated that the sprinkler irrigation method substantially reduces the use of water and the crop productivity also increases (Patel and Parmar, 2020).

Flat beds potato planting are more conducive for higher planting densities to reduce average tuber size (Mundy *et al*.,1999). Flat beds offer benefits of capturing rainfall or irrigation water more efficiently (Robinson, 1999), and there are less fluctuations in temperature throughout the bed providing an insulating factor which promotes early emergence of crop (Mundy *et al*., 1999) and also offer the scope for manipulating planting densities. Sharma *et al*. (2014) observed significantly higher number of minitubers for flatbed planting during standardization of plant densities and method (flat beds versus ridge and furrow) for microplant establishment under net house conditions of Northern hills.The classification of the tubers based on weight is of immense importance as the smaller tubers, tend to develop small and lesser number of sprouts, shoots, tubers, yield, prone to virus incidence and higher weight loss in storage as compared to larger sized tubers reportedly being less vigorous (Wurr *et al*., 1992, Karafyllidis *et al*., 1996). Simultaneously, very large size or oversize tubers are economically prohibitive as seed and also more prone to diseases (Schotzko *et al*., 1983; Rex and Mazza 1989). Keeping this in mind, a study was conducted (2018-19) to analyze the effect of irrigations methods and planting methods on production potential on potato minitubers under net house conditions of North-Central India.

## MATERIALS AND METHODS

An experiment was conducted in the net house of ICAR-Central Potato Research Institute, Regional Station, Gwalior (26° N and 78° E, altitude 207 m msl) with two early cultivar *viz* Kufri Lauvkar and Kufri Surya in 2018–19. Aeroponic minitubers were allowed to sprout under diffused light and planted in the 2$^{nd}$ week of November. Seed bed was prepared with layer of well decomposed farm yard manure and sand in the ratio of 1:1 on the top of the bed under insect-proof net house and two types of seed beds *viz* flat bed and ridge and furrow were used for trial. Well sprouted aeroponic minitubers were planted 30 cm × 10 cm in both the type of beds with 3 rows (2 m) which maintained the planting density of 333333 plants/ha. Both the beds were irrigated with sprinkler and flood furrow irrigation in ridge and furrow. The trial was planted in split plot design with three replications with irrigation method as main plot and bed method and varieties as sub plots. Trial was conducted as per standard seed plot techniques in which N:P:K was given in the ratio of 150:60:100. Full doses of P through single super phosphate, K through muriate of potash and half dose of N through ammonium sulphate were applied at the time of planting. Remaining half dose of N was applied through urea after 25-30 days of planting. Standard seed production practices were followed for the management of the crop. The emergence was recorded at 30 days after planting (DAP). The crop was terminated at 90 days by uprooting haulms and harvested after allowing skin curing for 15 days. Yield, total number of tubers, tuber grades, *viz*.

undersize <3g, 3-10g, 11-20g, 21-40g, 41-80g and >80g were recorded after harvesting. Data were pooled and analyzed statistically and means were separated according to the least significant differences (LSD) at 0.05 level of probability

## RESULTS AND DISCUSSION

### Emergence %

No significant variations were recorded in terms of emergence% among irrigation methods and varieties. Among planting beds, significantly higher emergence% was recorded in Ridge and furrow planting (87.22) over flatbed planting method (83.89). Non significant variations were reported among interactions (Table 1). Higher emergence in ridge and furrow method might be due to the availability of more water in rows and their higher water holding capacity. It is because excess rainfall is properly directed through furrows. It also increases water-use efficiency

**Table 1: Emergence and grade wise tuber number (000/ha) as influenced by irrigation method, planting method and variety**

| Treatments | Emergence % | Grade wise tuber number (000/ha) | | | | | | | % tuber by number | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | <3g | 3-10g | 11-20g | 21-40g | 41-80g | >80g | Total | <3g | 41-80g |
| Irrigation method (A) | | | | | | | | | | |
| Furrow | 85.00 | 445 | 361 | 244 | 131 | 22 | 1.0 | 1204 | 36.8 | 1.7 |
| Sprinkle | 86.11 | 389 | 268 | 253 | 89 | 32 | 3.0 | 1034 | 37.4 | 3.0 |
| SEm± | 0.52 | 8.9 | 5.1 | 2.3 | 4.6 | 1.7 | 0.4 | 15.9 | 0.5 | 0.1 |
| CD (P=0.05) | NS | 55.0 | 31.7 | NS | 28.2 | NS | NS | 98.0 | NS | 0.7 |
| Planting method (B) | | | | | | | | | | |
| Flat Bed | 83.89 | 450 | 316 | 241 | 86 | 30 | 0.0 | 1123 | 39.9 | 2.5 |
| Ridge and furrow | 87.22 | 384 | 313 | 256 | 134 | 24 | 4.0 | 1115 | 34.5 | 2.2 |
| SEm± | 1.06 | 7.8 | 7.3 | 4.5 | 4.3 | 1.6 | 0.5 | 10.6 | 0.6 | 0.1 |
| CD (P=0.05) | 3.27 | 24.1 | NS | 13.5 | 13.2 | 4.9 | 1.7 | NS | 1.7 | NS |
| Variety (C) | | | | | | | | | | |
| Kufri Lauvkar | 86.81 | 437 | 334 | 232 | 143 | 43 | 2.0 | 1191 | 36.6 | 3.6 |
| Kufri Surya | 84.31 | 396 | 295 | 264 | 78 | 12 | 2.0 | 1047 | 37.7 | 1.1 |
| SEm± | 1.06 | 7.8 | 7.3 | 4.4 | 4.3 | 1.6 | 0.5 | 10.6 | 0.6 | 0.1 |
| CD (P=0.05) | NS | 24.1 | 22.5 | 13.5 | 13.2 | 4.9 | NS | 32.7 | NS | 0.4 |
| Interaction A×B | | | | | | | | | | |
| SEm± | 1.50 | 11.1 | 10.3 | 6.2 | 6.1 | 2.2 | 0.8 | 15.0 | 0.8 | 0.2 |
| CD (P=0.05) | NS | 34.1 | NS | 19.0 | 18.7 | NS | 2.4 | 46.2 | 2.4 | NS |
| Interaction A×C | | | | | | | | | | |
| SEm± | 1.50 | 11.1 | 10.3 | 6.2 | 6.1 | 2.2 | 0.8 | 15.0 | 0.6 | 0.2 |
| CD (P=0.05) | NS | 34.1 | 31.9 | 19.0 | 18.6 | 6.9 | NS | NS | 2.4 | 0.5 |
| Interaction B×C | | | | | | | | | | |
| SEm± | 1.50 | 11.1 | 10.3 | 6.2 | 6.1 | 2.2 | 0.8 | 15.0 | 0.6 | 0.2 |
| CD (P=0.05) | NS | 34.1 | 31.9 | 19.0 | 18.6 | 6.9 | NS | 46.2 | 2.4 | 0.5 |
| Interaction A×B×C | | | | | | | | | | |
| SEm± | 2.12 | 15.7 | 14.6 | 8.7 | 8.6 | 3.2 | 1.1 | 21.2 | 1.1 | 0.3 |
| CD (P=0.05) | NS | 48.3 | NS | NS | NS | NS | NS | 65.4 | 3.4 | 0.8 |

both under rainfed and irrigated scenarios because water moves laterally from furrows into beds thereby reducing evaporation losses (Chowdary *et al*., 2022).

## Grade wise minituber number and weight (qha)

In the present study, <3g minitubers recorded significantly higher in furrow irrigation (445 thousand/ha and 7 q/ha), flat bed planting (450 thousand/ha and 7 q/ /ha) and variety Kufri Lauvkar (437 thousand/ha and 7.1 q/ha) over sprinkler irrigation (389 thousand/ha and 5.6 q/ha), ridge and furrow planting (384 thousand/ha and 5.7 q/ha) and Kufri Surya (396 thousand/ha and 5.5 q/ha) respectively (table1 and 2). Interaction effect was found to be non significant. Similar results were reported in case of <5g minitubers in case of sprinkler irrigation study of Kufri Chandramukhi and Kufri Surya (Kaur *et al.,* 2019). Extremely small sized

**Table 2: Grade wise tuber weight (q/ha) as influenced by irrigation method, planting method and variety**

| Treatments | Grade wise tuber weight (q/ha) | | | | | | | % tuber by weight | |
|---|---|---|---|---|---|---|---|---|---|
| | <3g | 3-10g | 11-20g | 21-40g | 41-80g | >80g | Total | <3g | 41-80g |
| Irrigation method (A) | | | | | | | | | |
| Furrow | 7.0 | 23.0 | 28.4 | 28.0 | 11.1 | 0.7 | 98.3 | 7.4 | 10.9 |
| Sprinkle | 5.6 | 17.7 | 35.8 | 29.1 | 14.7 | 2.7 | 105.7 | 5.3 | 12.6 |
| SEm± | 0.1 | 0.5 | 0.8 | 0.6 | 0.5 | 0.3 | 0.7 | 0.2 | 0.2 |
| CD (P=0.05) | 0.4 | 3.3 | 5.1 | NS | 2.4 | 1.6 | 4.4 | 1.1 | 1.2 |
| Planting method (B) | | | | | | | | | |
| Flat Bed | 7.0 | 20.0 | 32.1 | 24.1 | 13.0 | 0.0 | 96.2 | 7.4 | 11.9 |
| Ridge and furrow | 5.7 | 20.7 | 32.1 | 33.0 | 12.8 | 3.5 | 107.8 | 5.3 | 11.6 |
| SEm± | 0.1 | 0.6 | 0.9 | 0.9 | 0.6 | 0.4 | 1.0 | 0.1 | 0.5 |
| CD (P=0.05) | 0.3 | NS | NS | 2.8 | NS | 1.3 | 3.2 | 0.4 | NS |
| Variety (C) | | | | | | | | | |
| Kufri Lauvkar | 7.1 | 23.0 | 28.0 | 35.3 | 19.9 | 1.7 | 114.1 | 6.2 | 17.1 |
| Kufri Surya | 5.5 | 18.7 | 36.1 | 21.8 | 6.0 | 1.8 | 89.8 | 6.5 | 6.4 |
| SEm± | 0.1 | 0.6 | 0.9 | 0.9 | 0.5 | 0.4 | 1.0 | 0.1 | 0.5 |
| CD (P=0.05) | 0.3 | 1.8 | 2.8 | 2.8 | 1.6 | NS | 3.2 | NS | 1.5 |
| Interaction A×B | | | | | | | | | |
| SEm± | 0.1 | 0.8 | 1.3 | 1.3 | 0.7 | 0.6 | 1.5 | 0.2 | 0.7 |
| CD (P=0.05) | NS | 2.5 | 4.0 | NS | 2.3 | 1.8 | 4.5 | NS | 2.1 |
| Interaction A×C | | | | | | | | | |
| SEm± | 0.1 | 0.8 | 1.3 | 1.3 | 0.7 | 0.6 | 1.5 | 0.2 | 0.7 |
| CD (P=0.05) | 0.4 | 2.5 | 4.0 | NS | 2.3 | NS | NS | 0.6 | 2.1 |
| Interaction B×C | | | | | | | | | |
| SEm± | 0.1 | 0.8 | 1.3 | 1.3 | 0.7 | 0.6 | 1.5 | 0.2 | 0.7 |
| CD (P=0.05) | 0.4 | 2.5 | NS | 4.0 | 2.3 | NS | 4.5 | 0.6 | 2.1 |
| Interaction A×B×C | | | | | | | | | |
| SEm± | 0.2 | 1.2 | 1.8 | 1.8 | 1.0 | 0.8 | 2.1 | 0.3 | 0.9 |
| CD (P=0.05) | NS | NS | NS | 5.6 | NS | NS | NS | 0.9 | NS |

mini-tubers (<3g) were significantly affected by method of planting (Sharma *et al*, 2014). The Under size Minituber category though of lower vigour is highly economic as it is first progeny of quality seed, and may be further be multiplied/ recycled (Kaur *et al*., 2019). <3 g minituber/$m^2$ were maximum in Kufri Sindhuri and Kufri Bahar indicating varietal differences in extremely small size tuber production (Sadawarti *et al*., 2018).

3-10g tubers were significantly higher in furrow irrigation method (361 thousand/ ha and 23.0 q/ha) and Kufri Lauvkar (334 thousand/ha and 23.0 q/ha) over sprinkler irrigation (268 thousand/ha and 17.7 q/ha) and Kufri Surya (295 thousand/ha and 18.7 t/ha) respectively. No significant difference was recorded among planting bed type. 11-20g tubers were significantly higher in ridge and furrow planting method (256 thousand/ha) and Kufri Surya (264 thousand/ha and 36.1 q/ha) over flatbed method (241 thousand/ha) and Kufri Luvakar (232 thousand/ha and 28.0 q/ha) respectively. No significant difference was recorded among irrigation method in case of number of tubers.Reverse trend was reported in case of weight of minitubers in which sprinkler irrigation (35.8 q/ha) recorded significantly higher weight over furrow irrigation (28.4 q/ha).Furrow irrigation (131 thousand/ha), ridge and furrow planting method (134 thousand/ha) and variety Kufri Lauvkar (143 thousand/ha) recorded higher 21-40g grade tubers over sprinkler irrigation, flatbed planting and Kufri Surya respectively. Weight of tubers was significantly higher in ridge and furrow planting (33.0 q/ha) and Kufri Lauvkar (35.3 q/ha) over flatbed and Kufri Surya respectively (table 1 and 2).

Seed grade 41-80g tubers were significantly higher in flat bed planting method (30 thousand/ha) and variety Kufri Lauvkar (43 thousand/ha and 19.9 q/ha) over ridge and furrow bed (24 thousand/ha) and Kufri Surya (12 thousand/ha and 6.0 q/ha) respectively. Sprinkler irrigation method (32 thousand/ ha) recorded non significantly higher 41-80 g minitubers over furrow irrigation (22 thousand/ha) by number but by weight it was significantly higher over furrow irrigation (table 1 and 2). Seed size mini-tubers indicate the economically most important class of tubers with respect to seed multiplication and vigour. Varietal differences were significant with K. Surya producing higher number of seed sized tubers per square meter as compared to Kufri Chandramukhi for >30g minitubers (Kaur *et al*., 2019). Over size >80g tubers recorded significantly higher minituber number in ridge and furrow method (4.0 thousand/ha) over flat bed system. In terms of weight >80g tubers grade was significantly higher in sprinkler irrigation (2.7 q/ha) over furrow irrigation (0.7 q/ha) and in ridge and furrow planting (3.5 q/ha) over flat bed system of planting. Large size mini-tubers (>20g) were significantly higher with flat bed method, whereas, 10-20g mini-tubers were almost same under both the methods of planting under microplant study (Sharma *et al*., 2014).

## Total minituber number and weight (q/ha)

For total numbers of minituber, furrow irrigation (1204 thousand/ha) and Kufri Lauvkar (1191 thousand/ha) cultivar recorded significantly higher minitubers over sprinkler irrigation (1034 thousand/ha) and Kufri Surya (1047 thousand/ha). With regard to planting bed method flatbed method recorded non significantly higher total minitubers over ridge and furrow planting method. But interaction effects of irrigation× planting method× variety were significant (Table 1). Among varieties, Kufri Chipsona-1 recorded higher total tuber number in both, Gen-0 and Gen-1 over other two varieties under minituber multiplication study under Gwalior

conditions of India (Sadawarti *et al*, 2021). Weight of tubers was significantly higher in sprinkler irrigation (105.7 q/ha), Ridge and furrow planting (107.8 q/ha) and variety Kufri Lauvkar (114.1) over furrow irrigation (98.3 q/ha), flat bed planting (96.2 q/ha) and variety Kufri Surya (89.8 q/ha) respectively (table 2). Advanced methods of irrigation such as sprinkler, micro sprinkler and drip produced higher tuber yield (21.87, 19.57 and 15.90 tonnes/ha respectively) as compared to conventional method of irrigation (Pawar and Dingre, 2014)) The treatments 30×10 cm under flat bed and ridge and furrow were at par for total number of tubers produced per square meter under aeroponic minituber multiplication study under net house (Kaur *et al*, 2019). Under microplant multiplication study under two different spacing's, flatbed method of planting resulted in significantly higher number and yield of mini-tubers over the ridge furrow method (Sharma *et al*, 2014). The significantly higher yield was obtained for the variety Kufri Surya as compared to variety Kufri Chandramukhi. (Kaur *et al*., 2019). This also confirms present study wherein varietal differences were recorded. Significantly higher tuber yield (t/ha) was recorded in Kufri Lauvkar over Kufri Mohan and Kufri Chipsona-1 under minituber multiplication study (Sadawarti *et al*., 2021). This indicate the varietal differences in terms of yield.

### *Per cent* extremely small (<3g) and seed size minitubers (40-80g)

By number, only flatbed planting method (39.9%) recorded significantly higher <3g minitubers over ridge and furrow (34.5%). No significant difference was recorded among irrigation methods and cultivars (table1). By weight furrow irrigation and flat bed planting method (7.4%) recorded significantly higher <3g minitubers over sprinkler and ridge and furrow method of planting (5.3%). No significant difference was recorded among cultivars (table 2). Varietal differences were reported for production of <3g minitubers (Sadawarti *et al*., 2018). For seed size (40-80g), significantly higher seed size tubers were recorded in sprinkler irrigation method (3% by number and 12.6% by weight) and variety Kufri Lauvkar (3.6% by number and 17.1% by weight) over furrow irrigation and Kufri Surya. No significant but higher seed size tubers were reported both by number and weight in flat beds method over ridge and furrow method. Significantly higher > 20g minitubers were reported under flatbed method over ridge and furrow in microplant multiplication study under Kufi-Fagu conditions (Sharma *et al*., 2014)

## CONCLUSION

The study suggests that for higher production potential of aeroponically produced minitubers under nethouse, ridge and furrow method of planting along with sprinkler irrigation is suitable under North-Central conditions of India.

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

## ETHICAL STATEMENT

This article does not contain any studies with human participants or animals performed by any of the authors

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