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Potato Cultivation in Non-traditional Areas of Rajasthan

With the ever-increasing population pressure and the need to ensure food security, it is imperative to find suitable alternative crops for augmenting farm productivity in non-traditional areas of *Thar Desert* of Rajasthan. For the first time, potato cultivars like Kufri Chipsona-4 and Kufri Frysona (for processing) and Kufri Jyoti, Kufri Garima and Kufri Surya were assessed for their production potential under drip and microsprinkler system of irrigation in the hot arid region of north-western Rajasthan. After experimentation for three consecutive years (2015-16, 2016-17 and 2017-18), it was found that these cultivars are agronomically most efficient in resource poor conditions and had given high yield, better quality tubers and good returns. This will increase the demand and will further motivate the farmers to grow potatoes in this region. It is therefore necessary to educate the farmers on proper skill development coupled with field demonstrations on good agricultural practices for potato cultivation in the hot arid region of Rajasthan.

IN India potato plays a crucial role in addressing the threat of hunger and malnutrition particularly in rural areas. India is the second largest potato producer in the world (45.3 million tonnes) after China (89.0 million tonnes). The demand for potato has considerably increased during recent past due to the rapid growth of processing industries. Moreover, 80% of potato is still grown in the Indo-Gangetic Plains during the *rabi* season with more than half of the production being concentrated Uttar Pradesh and West Bengal. The Plateau region only accounts for 7% of the area and 4% of the production. However, India will require 125 million metric tonnes of potato from 3.6 million hectare area by the end of 2050. Thus, to achieve this massive target, the country needs to explore non-traditional areas for potatoes.

Potato in arid region

Potato is not a new crop for Rajasthan but mostly confined to the areas with better soil and good rainfall conditions like Kota, Dholpur, Bharatpur, Sirohi, Jhalawar and Sri Ganganagar districts. However, 12 district of north-western Rajasthan (Barmer, Bikaner, Churu, Sri Ganganagar, Hanumangarh, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, Pali and Sikar) accounts for 63.4% area of the hot arid realm of the country, where negligible area is under potato cultivation. On the other hand, potato produced in North India, when transported to western Rajasthan is subjected to quality deterioration. In this context, augmentation of the growing demand for potato through region-specific supply chain management seems to be the better alternative. The main reasons for non-adoption of potato in hot arid region are due to sandy soils with poor fertility and subjected to wind erosion, very low and erratic rainfall (average of about 213 mm/annum), extremes of temperature, occurrence of frost during

Potato Block at ICAR-CIAH, Bikaner

Potato under sprinkler irrigation at ICAR-CIAH Bikaner

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winter, poor water resource, besides lack of situation specific knowledge about scientific cultivation of potato etc. In order to increase the area under potato, there is a need to venture into non-traditional areas. North-western Rajasthan is dominated by the hot arid climate, which is not a traditional potato growing area. The idea of potato introduction in the arid zone of Rajasthan was perceived from Banaskantha district which lies in the isoclimatic region of Gujarat. Almost three decades back Banaskantha district was poverty-stricken but the introduction of potato crop and the adoption of micro-irrigation brought a huge change in their socio-economic status. Thereby, it was thought that if Banaskantha district of Gujarat can flourish by adopting potato crop, why not Bikaner district of Rajasthan with similar abiotic situations?

ICAR-Central Institute for Arid Horticulture, Bikaner and ICAR-Central Potato Research Institute, Shimla has made systematic efforts to introduce potato crop in Thar Deserts of Rajasthan and to assess their suitability in sandy soils of Thar Desert under drip and sprinkler system of irrigation. Proper management of soil moisture in sandy soil is a crucial factor in potato cultivation, as moisture holding capacity of sandy soil is very poor, besides poor fertility status. Thereafter, a series of experimentations were conducted including varietal screening, standardization of sowing time, irrigation management, fertilizer application, etc. Considering above in view, the technology of potato cultivation in hot arid region was standardized and several demonstrations were taken on farmer's fields for their quick dissemination and adoption by the farming community.

Performance of potato varieties

The performance of potato varieties under microsprinkler and drip system of irrigation in the arid region (Table 1). The tuber yield is expressed on pooled basis and economics was calculated on prevailing input and output cost in local market. In general, tuber yield under microsprinkler system was more than drip system of irrigation in arid region. Among different varieties, the highest tuber yield was recorded in Kufri Chipsona-4 (534.8 q/ha) followed by Kufri Frysona (479.7 q/ha), Kufri Jyoti (465.1 q/ha), Kufri Garima (430.9 q/ha), Kufri Surya (398.6 q/ha) and Kufri Khyati (387.6 q/ha) while minimum yield was observed in Kufri Pukhraj (338.9 q/ha) under microsprinkler system of irrigation. Whereas, under drip irrigation, maximum tuber yield was obtained in Kufri Frysona (435.4 q/ha) followed by Kufri Chipsona-4 (428.67 q/ha), Kufri Garima (374.45 q/ha) and Kufri Khyati (333.34 q/ha) and minimum in Kufri Pukhraj (203.99 q/ha) with similar management practices.

Root system and tuberization

The better crop performance under microsprinkler could be attributed to the minimum influence of frost, white fly and nutrient leaching. Frequent irrigation with microsprinklers washed the leaf canopy and minimized the whitefly infestation. Apart from this, microsprinkler irrigation might have created a better microclimate, which facilitated better plant growth and photosynthesis and thus resulted in higher tuber yield. Further, during December at the tuberization stage, minimum temperature was as low as 5-12°C for few days. Microsprinkler irrigation system protect the crop from the adverse effects of low temperatures by sprinkling water droplets on the leaves, which help in better growth, early maturity and higher tuber yield as compared to drip system of irrigation. In sandy soils, root system was also very fibrous and extensively distributed in soil horizons, which might be helpful in better absorption of moisture and nutrients.

Table 1. Performance of potato varieties under micro-sprinkler and drip system of irrigation in arid region

Variety	Under Sprinkler System					Under Drip System				
	Yield (q/ha)	Gross input (₹/ha)	Gross output (₹/ha)	Net return (₹/ha)	Benefit: Cost ratio	Yield (q/ha)	Gross input (₹/ha)	Gross output (₹/ha)	Net return (₹/ha)	Benefit : Cost ratio
Kufri Khyati	387.6	69,500	135,672	66,172	1.95	333.3	69,500	116,669	47,169	1.68
Kufri Garima	430.9	69,500	150,816	81,316	2.17	324.5	69,500	113,557	61,557	1.63
Kufri Chipsona-4	534.8	69,500	187,164	11,7664	2.69	428.7	69,500	150,036	80,536	2.16
Kufri Pukhraj	338.9	69,500	118,601	49,101	1.71	204.0	69,500	117,396	47,896	1.03
Kufri Frysona	479.7	69,500	167,903	98,403	2.42	435.4	69,500	152,379	82,878	2.19
Kufri Surya	398.6	69,500	139,519	70,019	2.01	341.1	69,500	119,372	49,872	1.72
Kufri Jyoti	465.1	69,500	162,771	93,271	2.34	345.2	69,500	120,814	51,314	1.74
Mean	433.7	69,500	151,778	82,278	-	344.6	69,500	127,175	60,177	-

For obtaining better market price, the size and quality of tuber play a vital role. In this investigation, the maximum tubers (>76%) were in the large size of grading (>75 g) in all varieties irrespective of irrigation systems. The medium and small sizes tubers were very less and together constitute <24%. Besides, the shape and colour of tubers were also very attractive. The colour of tubers was light golden. While harvesting if pulls out the plant, almost all tubers are hanging without much adhering soils. This shows that potato crop can be cultivated well under sandy soils of arid region with proper management.

Economic viability

Adoption and sustainability of any crop in new areas not only depends on its climatic suitability and productivity but also on economic viability and practical feasibility of cultivation practices. Since this was a new introduction in a hot arid region, therefore, simple economics based on prevailing rates for inputs and output in the local market was calculated. The management practices and input used under both irrigation systems were the same, thus, the cultivation cost in form of gross input was ₹ 69,500/ha for each cultivar. Only based on gross output the net return varied (Table 1). The net return was higher under microsprinkler system as compared to drip irrigation system, due to higher tuber yield/ha in almost all the cultivars under sprinkler system of irrigation. The highest net return was obtained by the cultivation of Kufri Chipsona-4 under microsprinkler system (₹ 1,17,664/ha) followed by Kufri Frysona (₹ 98,403/ha) and Kufri Jyoti (₹ 93,271/ha) and minimum in Kufri Khyati (₹ 66,172/ha). Whereas, under the drip system, the highest net return was obtained is Kufri Frysona (₹82,878/ha) followed by Kufri Chipsona-4 (₹ 80,536/ha) and minimum in Kufri Khyati (₹ 471,49/ha). The economics was directly proportional to the productivity level of individual variety. The B:C ratio was also computed and it corresponded with net returns received under different varieties. The highest B:C ratio was recorded in Kufri Chipsona-4 (2.69) followed by Kufri Fysona (2.42) under sprinkler system, whereas it was highest in Kufri Frysona (2.19) followed by Kufri Chipsona-4 (2.16) under drip irrigation system. The economic analysis of data revealed that potato cultivation under the hot arid ecosystem is economically viable.

Points for consideration

- Seed tubers must be procured from authentic sources. About 20-25 q/ha seed tuber is required. Sowing of whole tuber of 30-40 g is suggested. The big-size tubers after cutting into pieces and treating with fungicide can also be used for sowing.
- The fertilizer requirement is worked out to be 250:100:50 Kg NPK/ha. The full dose of P and K and 1/4th N should be given as basal dose during planting time while 1/4th of the remaining N should be given at first earthing (35-40 days after planting), 1/4th at second earthing (55-65 days after planting) and 1/4th at bulking stage (70-75 days after planting).
- The water requirement for potato crop of 90-110 days is about 350-600 mm, depending on edapho-climatic conditions. Fields must be irrigated through micro-sprinklers at 4 days intervals for 30 minutes up to 30 days after planting, 40 minutes up to 40 days after planting, 50 minutes up to 50 days after planting and 60 minutes up to 90 days after planting. Thereafter irrigation must be stopped for maturation.
- In hot arid region, January is the most sensitive month of frost occurrence, thus early sowing is recommended, so that tuberization must be completed well before this period. Irrigation through micro-sprinklers will minimize the damage to the crop by low temperatures.
- There is no serious problem of pests and diseases in potato in the arid region. However, as prophylactic measure, spray of Imidacloprid (0.5 ml/l) and Carbendazim + Mancozeb (1.5-2 g/l) at full vegetative growth stage (50 days after planting) to minimize the problem of sucking pest and late blight may be done.
- For processing purpose, Kufri Chipsona-4 and Kufri Frysona are the best varieties with high dry matter content. Whereas, Kufri Garima and Jyoti are high yielding varieties and suitable for vegetable purpose.
- Harvesting must be done well before 15 February, otherwise increasing temperature will affect tuber quality adversely.
- Size grading should be done to fetch better prices in the market. Proper packaging in gunny bags after harvesting and storage at a cool and dry place should be done after treating tubers with 3% Boric acid, in order to avoid storage loss.

Technology Dissemination

After visualizing the success of potato cultivation at the Experimental Farm of ICAR-Central Institute for Arid Horticulture, Bikaner (Rajasthan); systematic efforts were made to disseminate the technology in farmer's field by involving a multidisciplinary team of scientists. Firstly, farmers of the locality were invited to see the crop performance at the Experimental Field of this institute. Thereafter, a series of farmers' trainings were conducted both in-campus and off-campus about potato cultivation practices. Exhibitions were also organized to display potato tubers of different varieties. Initially, seed tubers were also arranged and distributed to the farmers for field demonstrations. Several on-farm visits were made by the multidisciplinary team of scientists. With the efforts of ICAR-CIAH, Bikaner, first a cluster of farmers in Khichiya village of Bikaner have started potato cultivation on about 10 acres of land. Now, in arid region of Rajasthan, more than 1,041 ha area is covered under potato cultivation with 13,897 tonnes of production, particularly in canal command areas, where ground water irrigation facilities are available.

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