

## ORIGINAL ARTICLE

# Partial root zone drying and early plantation for identification of drought tolerant cultivars of potato and sustainable productivity under water deficit conditions

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### ABSTRACT

*Collaborative studies were conducted by PTC, Karnal during 2018-19 to identify climate smart varieties having drought tolerance and higher productivity under water scarce conditions. Two partial root zone drying (PRD) experiments were conducted at Modipuram during 2018-19 for early potato and main season potato. In early season PRD trial (mid September to early December), two potato varieties KufriBahar and Kufri Surya and two water treatments (PRD and well-watered control). In main season PRD trial (October to January), two varieties Kufri Mohan and KufriPukhraj, and one advanced hybrid WS/05-146 with two water treatments (PRD and well-watered control). Both the experiments were laid out in split-plot design with three replications. After emergence of the crop, irrigation was applied in all furrows in control plots and only in alternate furrows in PRD plots. One early plantation trial (3<sup>rd</sup> week of September) was conducted at PTC, Karnal to explore suitability of different clones/ varieties to hot weather at PTC, Karnal, with five clone/ varieties Kufri Surya, Kufri Lima, Kufri Mohan and Kufri Pukhraj and CP-4393 (7008) laid out in randomized block design with three replications. In early season PRD trial, water used in PRD was 36% lesser (150 ha mm) than in control (233 ha mm). Potato variety Kufri Surya (only 16% decrease) was found better performing under water scarce conditions under early season PRD. In main season PRD trial, total water used in PRD was 27% lesser (184 ha mm) than in control (251 ha mm). Sustainable yields of potato (only 8% reduction in yield) were obtained under PRD, and advance hybrid WS/05-146 showed only 2% reduction in yield. Kufri Mohan was found adapted for early sowing under hot weather conditions. Growing of these climate smart varieties with PRD could help farmers achieve higher economic returns.*

**Keywords:** Potato, Drought tolerant, Varieties, Partial root zone drying, Early plantation

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### INTRODUCTION

Potato is an important crop in India, which fits in different cropping systems due to flexibility in its sowing and harvesting due to its early maturity. In India, it is grown on an area of 2.14 million ha with 51.3 million tons production [3]. To meet the growing population's need there is need to increase the production of potato up to 122 million tons by 2050 [2]. Unfortunately, the extent, frequency and severity of drought occurrences have been increasing globally due to climate change, and to feed the ever-increasing global population, increasing drought tolerance or resistance in potato is essential [5]. In addition to breeding tools, there is need for identification of climate smart clones/ varieties having drought tolerance character from the existing ones. Secondly, there is also need to get higher productivity with less quantity of water. Partial root zone drying (PRD) technique is being used for evaluation and selection of drought tolerant clones of potato and for getting higher productivity under water deficit conditions. Studies were undertaken by Potato Technology Centre, Shamgarh, Karnal, India in collaboration with International Potato Centre (CIP) and Central Potato Research Institute (CPRI) to identify drought tolerant clones and optimize yields of potato under water deficit conditions of semi-arid agro-ecologies of north-western India through PRD.

### MATERIAL AND METHODS

Two partial root zone drying (PRD) experiments were conducted at Modipuram during 2018-19 for early potato and main season potato. Irrigation was applied in all furrows in control plots and only in alternate

furrows in PRD plots, so as to dry the root zone partially, and thus best performing clones/ varieties are selected as drought tolerant. In addition, one early plantation trial was conducted at PTC, Karnal to explore suitability of different clones/ varieties adaptability to hot weather, thus to help identification of climate smart clones/ varieties of potato.

#### **PRD in early potatoes**

An experiment with two varieties of potato (KufriBahar and Kufri Surya) and two water treatments (PRD and well-watered control) was conducted at Modipuram in split plot design with three replications. All other recommended package of practices for early season (mid September to early December) were followed for raising the 75 days crop. To ensure optimum plant emergence, 1<sup>st</sup> and 2<sup>nd</sup> irrigations were given in all the furrows, i.e. both in the control plots (well-watered) and in PRD plots. Earthing up was completed after the 2<sup>nd</sup> irrigation and the volume of water was measured under all the treatments. After that, irrigation was applied in all furrows in control plots and only in alternate furrows in PRD plots.

#### **PRD in main season potatoes**

Two main season potato varieties Kufri Mohan and Kufri Pukhraj, and one advanced hybrid WS/05-146 with two water treatments (PRD and well-watered control) were evaluated for the 90 days crop (October to January) as per PRD protocol at Modipuram. The treatments were replicated three times in split-plot design. The optimum crop emerged after 1<sup>st</sup> irrigation and PRD protocol was executed only after earthing up (2<sup>nd</sup> irrigation onwards). Irrigation was applied in all furrows in control plots and only in alternate furrows in PRD plots. Sampling was done as envisaged (15 plots/3 rows) in PRD protocol and yields were estimated on harvest basis.

#### **Early plantation trial**

Early plantation trial to explore climate smart clone/ varieties was conducted to explore suitability of different clones/ varieties adaptability to hot weather at PTC, Karnal. The early planting was done in the 3<sup>rd</sup> week of September, which was 15 days earlier than the normal season crop and harvesting was completed by mid-January. There were four popular varieties from CPRI, viz. Kufri Surya, Kufri Lima, Kufri Mohan and Kufri Pukhraj, along with one CIP clone CP-4393 (7008). These were laid out in randomized block design with three replications for each clone/variety with 12 tubers/row in 5 rows of each clone/variety.

## **RESULTS AND DISCUSSION**

#### **PRD in early potato**

A total of seven irrigation events occurred, out of which the last five were executed as prescribed in PRD in the duration of 75 days of crop under heat stress. Water used in PRD was 36% lesser (150 ha mm) than in control (233 ha mm) conditions. Results at 75 days harvest suggest a significant reduction (31%) in tuber yield, which could be attributed to lesser number of tubers formed and also to the reduced size of the tubers, apart from low biomass of the foliage (Table 1). However, varieties tested had differential response to PRD. Kufri Surya suffered only 16% loss while KufriBahar was reduced by 43%, when analyzed separately (Fig. 1), hence Kufri Surya was found more drought tolerant. Varietal differences under water deficit conditions have been documented earlier also [1].

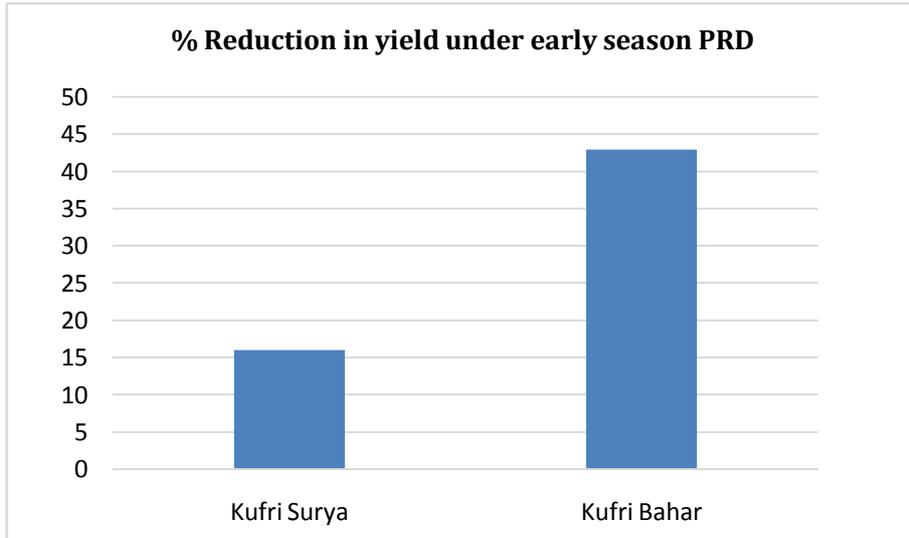
Table 1. Tuber yield and its composition in partial root-zone drying

Treatment	Tuber numbers*			Tuber weight (kg)			Foliage (kg)	Root pulling force (kg/plant)
	M (>25g)	NM(<25g)	Total	M (>25g)	NM(<25g)	Total		
Control	3.92	3.75	7.67	1.02	0.21	1.23	0.60	11.5
PRD	3.33	2.25	5.58	0.70	0.15	0.85	0.34	9.4
SEm±	0.29	0.31	0.40	0.07	0.02	0.08	0.04	1.2
CD (0.05)	NS	0.93	1.22	0.23	NS	0.26	0.11	NS

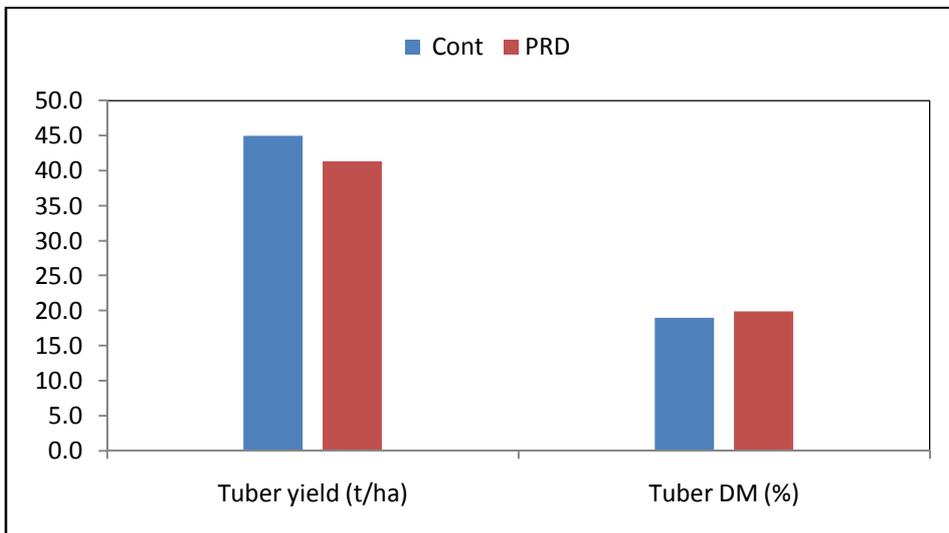
\*Sample size five plants, M- marketable tubers, NM- non-marketable tubers

#### **PRD in main season potato**

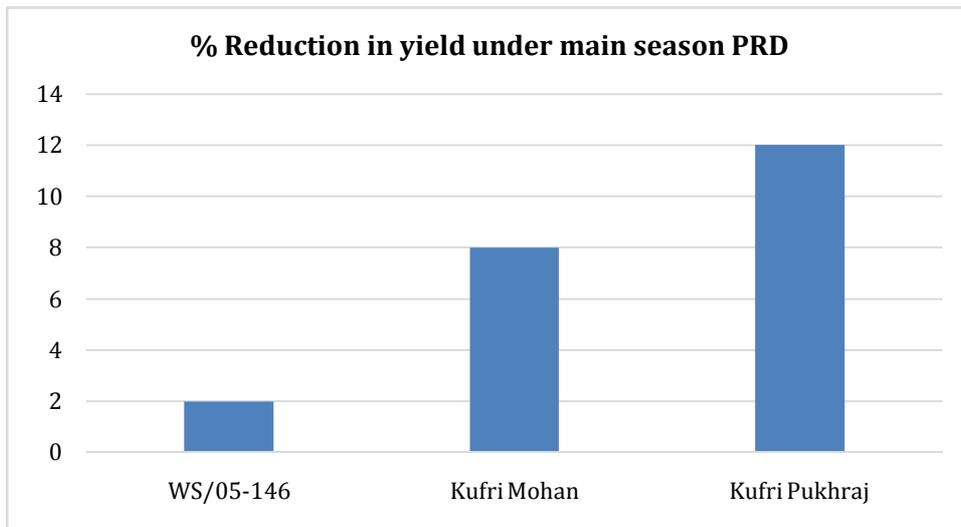
In all, a total of five irrigation events occurred, out of which the last four were executed as prescribed in PRD. Total water used (including 84 mm winter rain on three occasions) in PRD was 27% lesser (184 ha mm) than in control (251 ha mm). Results at 90 days harvest suggest only about 8% reduction in tuber yield, indicating role of PRD in sustaining potato yields. However, estimation of tuber dry matter content was enhanced by 0.9% under PRD (Fig. 2 Fig. 2), indicating suitability of all the varieties for low moisture situations. However, genotypic variability in response to PRD was also observed and advanced hybrid WS/05-146 showed least reduction in yield (2%) as compared to Kufri Mohan (8%) and Kufri Pukhraj (12%) under PRD (Fig. 3). Increase in tuber dry matter content of potatoes under water deficit regime has been reported earlier as well [7].



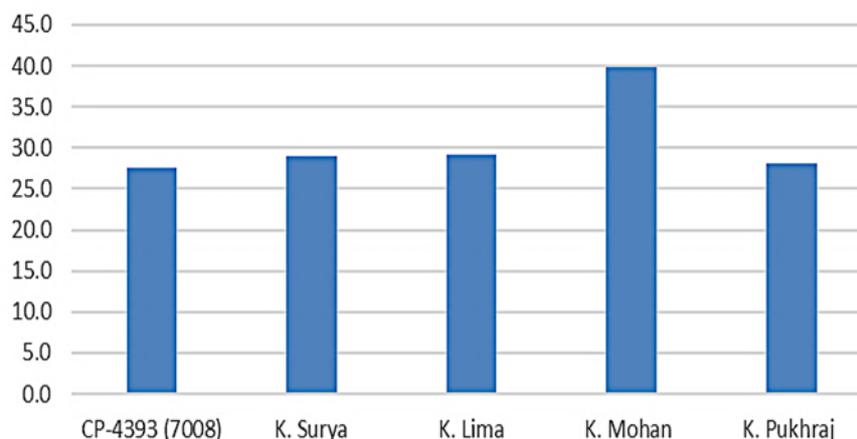
**Fig. 1. Percent reduction in yield of potato varieties Kufri Surya and KufriBahar under early season partial root zone drying (PRD) trial**



**Fig. 2. Tuber yield and tuber dry matter content in main season potato under PRD**



**Fig. 3. Percent reduction in yield of potato varieties/ entries Kufri Mohan, KufriPukhraj and WS/05-146 under main season partial root zone drying (PRD) trial**



**Fig. 4. Average yield (Mt/ha) of potato clones/ varieties in early plantation trial at PTC, Karnal**

The present findings suggest that use of PRD in early crop grown under heat stress may be further evaluated only in those genotypes which possess heat tolerance. Evaluation in main season crop also needs confirmatory experiments. Partial root-zone drying technique has been shown to increase water use efficiency, yield and quality under water scarce situations by earlier workers [4, 6].

#### **Early Plantation Trial**

The total yield of Kufri Surya was 29 Mt/Ha, Kufri Lima 29.1 Mt/Ha, Kufri Mohan 39.8 Mt/Ha, KufriPukhraj 28.2 Mt/Ha and that of CIP clone CP-4393 (7008) was 27.5 Mt/Ha (Fig. 4). It was found that Kufri Mohan could be grown as the early variety without much loss in the yield under Karnal conditions. Thus, the farmer could take one extra crop mid-January onwards after harvest of potato.

#### **CONCLUSION**

Potato variety Kufri Surya was found performing better under water scarce conditions in early season PRD. Under main season conditions, sustainable yields of potato (only 8% reduction in yield) were obtained under PRD, indicating role of PRD under water deficit conditions. The advance hybrid WS/05-146 showed least reduction in yield (2%), however Kufri Mohan (8%) and KufriPukhraj (12%) also performed well. Kufri Mohan could be grown as the early variety under hot weather conditions, thus giving window to farmers to take one additional crop after potato harvest. Growing of these climate smart varieties with PRD could help farmers achieve higher economic returns.

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