www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(10): 1738-1745

www.thepharmajournal.com
Received: 10-08-2023
Accepted: 14-09-2023

Roop Singh Dangi
Department of Agronomy, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

SP Singh
ICAR Central Potato Research Station, Patna, Bihar, India

Ekta Joshi
Department of Agronomy, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

SK Sharma
ICAR- CPRI, Central Potato Research Station, Gwalior, Madhya Pradesh, India

Murlidhar J Sadawarti
ICAR- CPRI, Central Potato Research Station, Gwalior, Madhya Pradesh, India

Reema Lautre
Department of Vegetable Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Neelam Singh
Department of Agronomy, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

Payal Patidar
Department of Horticulture (Vegetable Science), College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

Corresponding Author:
Neelam Singh
Department of Agronomy, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh, India

Effect of plastic mulching and drip irrigation on physiological parameters of potato (*Solanum tuberosum* L.) varieties under potato-based cropping system

Roop Singh Dangi, SP Singh, Ekta Joshi, SK Sharma, Murlidhar J Sadawarti, Reema Lautre, Neelam Singh and Payal Patidar

Abstract
A study was conducted at the Research Farm of ICAR-CPRI-RS, Maharajpura, Gwalior (M.P.) during *kharif, rabi* and *summer* season of 2018 and 2019 to investigate the effect of plastic mulching and drip irrigation on physiological parameters of potato (*Solanum tuberosum* L.) varieties under potato-based cropping system. The study involved eight treatment combinations replicated four times in split plot design. The treatments comprised of four mulching *viz.* DM_1: Drip irrigation with black-black plastic mulch, DM_2: Drip irrigation with silver-black plastic mulch; DM_3: Drip irrigation without mulch; FI_4: Farmer's practice (Check) and two varieties *viz.* V_1 Kufri Badshah and V_2: Kufri chipsona-3. Physiological parameter can be used to account growth in terms of functional or structural significance. With respect to root: shoot ratio, CGR, RGR and AGR, the two cultivars as well as different plastic mulching showed different trend at different growth stages of the crop. The performance of Kufri Chipsona-3 under silver black plastic mulching with drip irrigation remained superior to other treatment combinations. However, this treatment remained at par with performance of Kufri Badshah under drip irrigation with black-black plastic mulching. A non-significant interaction for SPAD meter reading was found between plastic mulching under drip irrigation and potato cultivars at all growth stages during both experimental year and on pooled basis.

Keywords: AGR, CGR, potato, physiological**,** root: shoot ratio, RGR, SPAD

1. Introduction
Potato (*Solanum tuberosum* L.) is a herbaceous annual crop that contributes substantially towards food and nutritional security in the world. It is the third most important food crop in the world after rice and wheat in terms of human consumption. More than a billion people worldwide eat potatoes. It is the most important food crop of the world and a well-balanced food with carbohydrates, proteins vitamins especially C and B_1, minerals and with negligible fats. It contains approximately 78% water, 22% dry matter (specific gravity), 2.1% protein, 0.3% fat 1.1% crude fiber and 0.9% ash. About 82% of dry matter is carbohydrate, mainly starch, with some dietary fiber and have better nutritional quality than cereals. The current global production of potato is 376 million tonnes, China being the biggest producer globally and India being the second contributes nearly 14.36% to its global production after China (FAO STAT, 2021) [1]. In the country, the crop is being cultivated on 2.20 million hectares area with production of 56.17 million tones and productivity of about 25498 kg ha^{-1} (Agricultural Statistics at a Glance, 2022) [2].
Recently, mulching and planting patterns (PPs) have gained significant attention as an effective farming practices in many countries around the world as means to effectively achieve this goal by conserving soil water during the entire crop-growth period and providing the best opportunity for an increasing crop yield. Cutting off contact between the soil's surface and the atmospheric evaporation layer is the first step in reducing the amount of soil moisture lost by direct evaporation. Thus, mulching, which refers to covering the soil surface with organic and inorganic materials, is one of the best farming practices for achieving this purpose. Mulching not only reduces soil evaporation, but also improves soil's physicochemical and biological properties, regulates soil temperature, matches water supply and demand, increases infiltration and storage of water in the root zone, restricts soil erosion, increases nutrient availability, decreases the leaching loss of fertilizers around the root zone, reduces the root-zone salinity, suppresses weed infestation, lowers the population of pathogens, and promotes carbon dioxide

(CO_2) retention in leaves (El-Hendawy *et al*. 2023) [8]**.** As a result, all the above multifaceted benefits of mulching create favorable conditions which directly and indirectly exert positive impacts on crop growth and development, not only under a limited water supply, but also under sufficient water supply conditions. Previous studies have shown that, in general, plants grown with soil mulching showed greater plant height, tiller number, leaf area index (LAI), biomass accumulation, relative growth rate (RGR), photosynthetic rate, chlorophyll content, grain yield, and WP, as well as lower days-to-emergence than those grown without mulching. Therefore, mulching has become a very important practice for the agriculture sector in arid and semiarid countries, as irrigation water resources are very limited.

Integrations of mulching with modifying PPs (IMPPs) could also be considered one of the most viable practices for efficient irrigation water use and sustainable crop production. Recently, several IMPPs have been developed and adapted to achieve this goal by designing IMPPs in a way that helps to reduce soil evaporation and preserve surface runoff, which ultimately enhances and prolongs water availability in the root zone, as well as providing adequate water at the key growth stages of the crop. In view of the above facts, the present investigation was conducted to evaluate the effect of plastic mulching and drip irrigation on physiological parameters of potato (*Solanum tuberosum* L.) varieties under potato-based cropping system.

2. Materials and Methods

The experiment was conducted at the Research Farm of ICAR-Central Potato Research Institute - RS, Gwalior (M.P.) during the *Kharif, Rabi and summer* seasons of 2018-19 and 2019-20. Gwalior is located at 26º13' North latitude and 78º14' East longitude and 206 meters above mean sea level which lies in the North tract of M.P. enjoying subtropical climate, with extreme hot up to 48 °C in summer and minimum temperature as low as 4.0 °C during winter season. The annual rainfall ranges between 750 to 800 mm, most of which received from end of June to end of September, with few showers in winter months. The experiment was conducted in split plot design (SPD) with four replications. There were 8 treatment combinations. The experimental details include (a) Main plot treatments (plastic mulching under drip irrigation) *viz.* DM_1 = Drip irrigation with black-black plastic mulch, DM_2 = Drip irrigation with silver-black plastic mulch, DM_3 = Drip irrigation without mulch, FI_4 = Farmers practice (check) and (b) Sub plot treatments (varieties) *viz*. V_1= Kufri Badshah (table purpose) V_2= Kufri Chipsona-3 (processing purpose). Under this study, different physiological parameters of potato were studied to evaluate the effect of plastic mulching and irrigation on potato (*Solanum tuberosum* L.) varieties under potato-based cropping system. The data were statistically analyzed by using the analysis of variance techniques in order to find the significance of different treatments. The analyzed data for two years including pooled data has been presented in tabular form.

Physiological parameter can be used to account growth in terms of functional or structural significance. The type of growth analysis requires measurement of plant biomass and assimilatory area (leaf area) and methods of computing certain parameters that describe growth.

2.1 Root

2.2 Shoot ratio

It is the proportion of root to shoot and was determined at 30, 60 DAP and at maturity.

2.3 Absolute growth rate (AGR)

Radford (1967) [9] suggested AGR**.** It expresses increase in the dry weight per unit time and is expressed in g/plant/day. It gives Absolute values of biomass between two intervals.

$$AGR = \frac{W2 - W1}{t2 - t1}$$

Where,

W_1 and W_2 are the total dry weight per plant at time t_1 and t_2, respectively.

2.4 Crop growth rate (CGR)

It is the dry weight gain by a unit area of crop in each time. It is expressed in g/m^2/day.

$$CGR = \frac{W2 - W1}{(t2 - t1)\ S}$$

Where,

W_1 and W_2 are the total dry weight per plant at time t_1 and t_2, respectively. S = Land area (m^2) over which dry matter recorded.

2.5 Relative growth rate (RGR)

It is the increase of material per unit weight per unit time. It is expressed in g/g/day. It was suggested by Blackman, (1919) [10].

$$RGR = \frac{InW2 - InW1}{t2 - t1}$$

Where,

W_1 and W_2 are the total dry weight per plant at time t_1 and t_2, respectively.

2.5 SPAD Reading (Estimation of total chlorophyll)

Total chlorophyll in the leaf samples were estimated using SPAD chlorophyll meter (Minolta) simply by placing the leaves in between the chlorophyll meter and pressing them slightly. Total chlorophyll was expressed in terms of SPAD values at 30, 60 DAP and maturity stage.

3. Results and Discussion

3.1 Root: Shoot of potato

The data (Table 1) with respect to root: shoot ratio of potato showed a different trend at different growth stages during both the experimental period and on pooled basis. The pooled data revealed that significantly highest root: shoot was recorded with the application of drip irrigation without mulch (0.027 and 0.033) at 60 DAP and maturity, respectively whereas at 30 DAP it was significantly highest under farmer's practice (0.049). The two potato cultivars also differed significantly in terms of root: shoot ratio of potato at all growth stages during both the years and on pooled basis. On pooled basis, Kufri Chipsona-3 recorded significantly highest

root: shoot ratio of potato (0.044 and 0.027, respectively) at 30 DAP and maturity. Whereas, it was significantly highest (0.024) in Kufri Badshah at 60 DAP. Interaction effect (Table 1.1) of cultivars and mulching was found significant at all growth stages during both the years and on pooled basis. Based on pooled analysis Kufri Badshah recorded significantly highest root: shoot ratio under farmer's practice (0.053 and 0.034) at 30 and 60 DAP, respectively. However, at maturity Kufri Chipsona-3 recorded significantly highest root: shoot ratio (0.039) with application of drip irrigation without mulch.

The results revealed that root: shoot ratio of potato was found significant under drip irrigation without mulch application at later stages of plant whereas, at initial stages it was highest under farmer's practice (control). Similarly, at 30 DAP and maturity, Kufri Chipsona-3 remained significantly superior over Kufri Badshah. As for interaction effect between the treatments, Kufri Badshah grown under farmer's practice recorded significantly highest root: shoot of potato at 30 and 60 DAP. The results of present investigation were in contrast with the findings of Zhao *et al.* (2014) [7] who found that full plastic mulching increased both tuber yields and rain WUE, enhanced plant height, LAI, R/S ratio and economic benefits of potato. Bhart and Kumar (2021) [4] also reported that combination of black polyethylene sheet mulch with Kufri Chipsona-3 produced maximum growth, yields and quality parameter.

3.2 Absolute growth rate (g day^{-1}) of potato, crop growth rate (g^{-1}m^{-2} day) of potato and relative growth rate (g^{-1}g^{-1} day) of potato

The data related to absolute growth rate (g day^{-1}) of potato (Table 2) reveals that different plastic mulching with drip irrigation significantly influenced absolute growth rate of plant at different growth stages recording significantly highest AGR (0.831 and 3.645 g day^{-1}) respectively, with application of drip irrigation with silver- black plastic mulch at 30 and 60 DAP based on pooled analysis. However, at maturity application of drip irrigation without mulch resulted in significantly highest AGR (2.645 g day^{-1}). Similarly, among the potato varieties, AGR of Kufri chipsona-3 was significantly highest at all growth stages during both the years and on pooled basis. The pooled analysis of two years data showed that Kufri chipsona-3 had significantly highest AGR (0.764, 3.159 and 2.144 g day^{-1}) at 30 and 60 DAP and at maturity, respectively. On the basis of pooled data of two years, it was found that drip irrigation with black-black plastic mulch application in Kufri chipsona-3 resulted in highest AGR of potato (0.934 and 3.863 g day^{-1}) respectively at 30 and 60 DAP, however at maturity it was significantly highest under drip irrigation without mulch application (3.029 g day^{-1}) in Kufri chipsona-3 (Table 2.1). At 30 and 60 DAP, Kufri Badshah and Kufri chisona-3 recorded the lowest AGR (0.378 and 1.894 gday^{-1}) under farmers practice, respectively and remained the least performing treatment combination. Whereas, application of drip irrigation in Kufri Badshah with silver-black plastic mulch resulted in lowest AGR (1.104 gday^{-1}) at maturity.

The data on crop growth rate (Table 3) was significantly influenced by application of different plastic mulch with drip irrigation at all growth stages during both the experimental period and on pooled basis. As revealed by pooled analysis, significantly highest CGR (4.26 and 20.25 g^{-1}m^{-2} day) respectively, was observed with application of drip irrigation with silver-black plastic mulch at 30 and 60 DAP. However, drip irrigation without mulch resulted in significantly highest CGR (14.70 g^{-1}m^{-2} day) at maturity. Similarly, Kufri Chipsona-3 recorded significantly highest CGR over Kufri Badshah at all growth stages during both the years and on pooled basis. The pooled data revealed that significantly highest CGR (4.65, 18.87 and 12.99 g^{-1}m^{-2} day) was observed in Kufri chipsona-3 at 30 and 60 DAP and at maturity, respectively. With respect to interaction, the pooled data revealed that CGR was significantly highest with under black-black plastic mulch application with drip irrigation in Kufri chipsona-3 (5.19 and 21.46 g^{-1}m^{-2} day) respectively, at 30 and 60 DAP. However, at maturity it was found significantly highest (16.83 g^{-1}m^{-2} day) under drip irrigation without mulch application in Kufri chipsona-3 (Table 3.1).

It is clear from the data (Table 4) that RGR was significantly highest with application of drip irrigation with silver-black plastic mulch at planting to 30 DAP and 30 to 60 DAP during 2019-20 and on pooled basis. Whereas, the treatments differed significantly at all growth stages during 2018-19. The pooled analysis of two years data showed that RGR was significantly highest (0.1071 and 0.0560, g g^{-1} day^{-1}) respectively between planting to 30 DAP and 30-60 DAP. However, at 60 DAP-maturity drip irrigation without mulch application resulted in significantly highest RGR (0.0193 g g^{-1} day^{-1}). Among the varieties, Kufri chipsona-3 performed significantly better over Kufri Badshah recording highest RGR at planting to 30 DAP and 60 DAP-maturity during 2018, 2019 and on pooled basis except at 30-60 DAP during 2018-19 and on pooled basis. Based on pooled data, RGR was significantly highest in Kufri chipsona-3 (0.1037 and 0.0151, g g^{-1} day^{-1}, respectively) during planting-30 DAP and 60 DAP-maturity. However, it was significantly highest in Kufri Badshah (0.0551 g g^{-1} day^{-1}) at 30-60 DAP. Interaction effect between potato cultivars and plastic mulching with drip irrigation with respect to RGR was significant at all growth stages of potato during 2018, 2019 and on pooled basis. Significantly, highest RGR was observed with application of drip irrigation with black-black plastic mulch in Kufri chipsona-3 at 30 DAP (0.1110 g g^{-1} day^{-1}), farmer's practice in Kufri Badshah at 60 DAP (0.0602 g g^{-1} day^{-1}) and Drip irrigation without mulch application in Kufri chipsona-3 at maturity (0.0194 g g^{-1} day^{-1}) based on pooled analysis. The farmer's practice in Kufri Badshah at 30 DAP and Kufri chispsona-3 at 60 DAP remained the least performing treatment combination (Table 4.1).

The results of present investigation revealed that AGR, CGR and RGR was significant under drip irrigation and plastic mulch treatments. Application of silver-black plastic mulch resulted in significantly highest CGR and RGR whereas, AGR was highest under black-black plastic mulch application combined with drip irrigation. Among varieties, Kufri Chipsona-3 performed best recording significantly highest values of all physiological parameters at all growth stages. With respect to interaction between the treatments, CGR and AGR were significantly highest under black-black plastic mulch application whereas, for RGR the treatments differed significantly following different trends at different growth stages. Application of black-black plastic mulch in Kufri chipsona-3 resulted in significantly highest AGR, CGR and

RGR. The significant improvement in physiological parameters of potato might be ascribed to the fact that mulching with black polyethylene significantly increased the yield per plant, dry matter percentage and total yield which ultimately contributed to the enhanced growth rate of the crop. The results are in line with those reported by Ahmed *et al.* (2009) [6] and Sadik (2009).

3.3 SPAD Values

It is evident from data (Table 5) that drip irrigation applied in silver-black plastic mulched plots resulted in significantly highest SPAD meter reading during both the years and on pooled basis at 60 DAP and maturity. However, at 30 DAP significantly highest SPAD meter reading was observed under drip irrigation without mulch application. At 30 DAP, this treatment remained at par with drip irrigation with silver-black plastic mulch and drip irrigation with black-black plastic mulch application. On the basis of pooled data, SPAD meter reading was significantly highest (47.4 and 42.7) with drip irrigation combined with silver-black plastic mulch application at 60 DAP and maturity, respectively, whereas at 30 DAP it was significantly highest under drip irrigation without mulch. Among the two varieties, Kufri Chipsona-3 recorded significantly highest SPAD meter reading at 60 DAP and maturity during both the years of experiment and on pooled basis. Kufri Chipsona-3 recorded significantly highest SPAD meter reading at 30 DAP on pooled basis, whereas it was found non- significant during 2018 and 2019. The pooled analysis clearly indicates that SPAD meter reading was significantly highest in Kufri chipsona-3 (46.1, 46.2 and 41.4) respectively at 30 and 60 DAP and at maturity. Interaction effect between different plastic mulching with drip irrigation and potato cultivars was found non- significant at all growth stages during both the years and on pooled basis with respect to SPAD meter reading except at 30 DAP (Table 5.1). The pooled data revealed that significantly highest SPAD meter reading was recorded in Kufri Chipsona-3 with application of drip irrigation with black-black plastic mulch (55.2) at 30 DAP. However, it was statistically at par with drip irrigation with silver-black plastic mulch, drip irrigation without mulch application in Kufri chipsona-3 and drip irrigation without mulch application in Kufri Badshah (54.4, 54.4 and 53.8) respectively.

The treatments with different plastic mulch and drip irrigation remained statistically similar for chlorophyll content during both years. As revealed from pooled data, significantly highest SPAD reading was recorded when silver-black plastic mulch was applied in combination with drip irrigation at later stages of plant growth. Among the varieties, Kufri Chipsons-3 had significantly higher SPAD reading on pooled basis as compared to Kufri Badshah. The two varieties did not differ significantly during the two years of experimentation. In case of interaction, the treatment combinations had no significant differences during both the years. However, pooled data showed that combined application of drip irrigation with sliver-black plastic mulch in Kufri Chipsona-3 recorded significantly highest SPAD reading followed by other treatment combinations drip irrigation without mulch in Kufri Chipsona-3 and Kufri Badshah. The improvement in SPAD reading under plastic mulch might be due to the warmer soil temperature and adequate moisture under plastic mulch which in turn hastens the emergence and development of the potato plant, resulting in better absorption of nutrients and interception of solar radiation. Our results are in conformity with finding of Cengiz *et al.* (2005) [11] and Panchal *et al.* (2001) [5]. While the results reported by Gangwar *et al.* (2017) [3] are in contrast with our finding who found that SPAD value was recorded non-significant among the plastic mulch treatments.

Table 1: Effect of plastic mulching under drip irrigation and potato varieties on root: shoot of potato under potato based cropping system

Treatments	30 DAP			60 DAP			Maturity		
A. Main plot	**2018-19**	**2019-20**	**Pooled**	**2018-19**	**2019-20**	**Pooled**	**2018-19**	**2019-20**	**Pooled**
Drip irrigation with black-black plastic mulch	0.033	0.038	0.036	0.013	0.016	0.015	0.020	0.016	0.018
Drip irrigation with silver- black plastic mulch	0.033	0.037	0.035	0.015	0.014	0.014	0.021	0.018	0.020
Drip irrigation without mulch	0.046	0.042	0.044	0.018	0.035	0.027	0.025	0.041	0.033
Farmer's practice (Check)	0.059	0.040	0.049	0.028	0.024	0.026	0.030	0.033	0.031
S. Em±	0.0016	0.0011	0.0010	0.0010	0.0012	0.0008	0.0007	0.0015	0.0008
C.D. (at 5%)	0.0053	NS	0.0029	0.0033	0.0039	0.0024	0.0023	0.0048	0.0025
B. Sub plot									
Kufri Badshah	0.048	0.028	0.038	0.020	0.028	0.024	0.023	0.024	0.024
Kufri Chipsona-3	0.037	0.051	0.044	0.018	0.016	0.017	0.025	0.030	0.027
S. Em±	0.0017	0.0014	0.0011	0.0006	0.0008	0.0005	0.0006	0.0010	0.0006
C.D. (at 5%)	0.0053	0.0043	0.0033	0.0017	0.0024	0.0014	0.0017	0.0030	0.0016
Interaction	S	S	S	S	S	S	S	S	S

Table 1.1: Interaction effect of plastic mulching under drip irrigation and potato varieties on root: shoot of potato under potato-based cropping system

At 30 DAP					At 60 DAP					At maturity				
2018-19					2018-19					2018-19				
Factor	**M1**	**M2**	**M3**	**M4**	**Factor**	**M1**	**M2**	**M3**	**M4**	**Factor**	**M1**	**M2**	**M3**	**M4**
V1	0.038	0.029	0.051	0.074	V1	0.014	0.013	0.019	0.033	V1	0.022	0.016	0.023	0.032
V2	0.027	0.037	0.041	0.044	V2	0.012	0.017	0.018	0.024	V2	0.018	0.026	0.027	0.028
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.0035		0.0030		S. Em	0.0011		0.0013		S. Em	0.0011		0.0011	
CD 5%	0.0107		0.0092		CD 5%	0.0034		0.0041		CD 5%	0.0035		0.0034	
2019-20					**2019-20**					**2019-20**				
Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4
V1	0.028	0.025	0.026	0.033	V1	0.021	0.010	0.047	0.034	V1	0.018	0.013	0.031	0.034
V2	0.049	0.050	0.058	0.046	V2	0.011	0.017	0.022	0.014	V2	0.014	0.023	0.051	0.031
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.0028		0.0023		S. Em	0.0016		0.0016		S. Em	0.0019		0.0020	
CD 5%	0.0087		0.0070		CD 5%	0.0048		0.0052		CD 5%	0.0060		0.0064	
Pooled					**Pooled**					**Pooled**				
Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4
V1	0.033	0.027	0.038	0.053	V1	0.018	0.012	0.033	0.034	V1	0.020	0.014	0.027	0.033
V2	0.038	0.043	0.050	0.045	V2	0.012	0.017	0.020	0.019	V2	0.016	0.025	0.039	0.029
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.0022		0.0019		S. Em	0.0010		0.0010		S. Em	0.0011		0.0011	
CD 5%	0.0065		0.0054		CD 5%	0.0028		0.0031		CD 5%	0.0033		0.0034	

DM_1 = Drip irrigation with black-black plastic mulch, DM_2 = Drip irrigation with silver- black plastic mulch, DM_3 = Drip irrigation without mulch, FI_4 =Farmer's practice (Check), V_1 = Kufri Badshah, V_2 = Kufri Chipsona-3, $(M \times V)_1$ = Between two levels of variety at same level of mulch, $(M \times V)_2$= Between two levels of mulches at same level of variety

Table 2: Effect of plastic mulching under drip irrigation and potato varieties on AGR ($gday^{-1}$) of potato under potato-based cropping system

Treatments	**Planting - 30 DAP**			**30 - 60 DAP**			**60 DAP to maturity**		
A. Main plot	**2018-19**	**2019-20**	**Pooled**	**2018-19**	**2019-20**	**Pooled**	**2018-19**	**2019-20**	**Pooled**
Drip irrigation with black-black plastic mulch	0.784	0.804	0.794	2.987	3.630	3.309	2.304	1.117	1.711
Drip irrigation with silver- black plastic mulch	0.830	0.833	0.831	3.242	4.048	3.645	1.348	1.928	1.638
Drip irrigation without mulch	0.682	0.677	0.679	2.959	2.501	2.730	2.329	2.962	2.645
Farmer's practice (Check)	0.529	0.443	0.486	2.401	1.455	1.928	1.355	1.468	1.411
S. Em±	0.0085	0.0157	0.0089	0.0513	0.0638	0.0409	0.1275	0.0944	0.0793
C.D. (at 5%)	0.0273	0.0503	0.0266	0.1642	0.2041	0.1217	0.4079	0.3020	0.2357
B. Sub plot									
Kufri Badshah	0.619	0.645	0.632	2.819	2.475	2.647	1.529	1.589	1.559
Kufri Chipsona-3	0.794	0.733	0.764	2.976	3.342	3.159	2.139	2.148	2.144
S. Em±	0.0127	0.0115	0.0086	0.0446	0.0374	0.0291	0.0796	0.0582	0.0493
C.D. (at 5%)	0.0391	0.0354	0.0250	0.1374	0.1154	0.0850	0.2452	0.1795	0.1439
Interaction	S	S	S	S	S	S	S	S	S

Table 2.1: Interaction effect of plastic mulching under drip irrigation and potato varieties on AGR (g day $^{-1}$) of potato under potato-based cropping system

At 30 DAP					At 60 DAP					At maturity				
2018-19					2018-19					2018-19				
Factor	**M1**	**M2**	**M3**	**M4**	**Factor**	**M1**	**M2**	**M3**	**M4**	**Factor**	**M1**	**M2**	**M3**	**M4**
V1	0.630	0.850	0.649	0.346	V1	2.915	3.166	2.726	2.468	V1	1.878	0.724	1.656	1.859
V2	0.938	0.810	0.715	0.712	V2	3.059	3.318	3.192	2.335	V2	2.731	1.972	3.002	0.851
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.0254		0.0199		S. Em	0.0891		0.0813		S. Em	0.1592		0.1701	
CD 5%	0.0783		0.0617		CD 5%	0.2747		0.2543		CD 5%	0.4905		0.5353	
2019-20					**2019-20**					**2019-20**				
Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4
V1	0.678	0.874	0.619	0.410	V1	2.592	3.903	1.945	1.458	V1	1.318	1.484	2.868	0.686
V2	0.930	0.792	0.736	0.477	V2	4.668	4.192	3.057	1.453	V2	0.916	2.373	3.055	2.250
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.0230		0.0226		S. Em	0.0749		0.0829		S. Em	0.1165		0.1253	
CD 5%	0.0708		0.0710		CD 5%	0.2307		0.2612		CD 5%	0.3590		0.3945	
Pooled					**Pooled**					**Pooled**				
Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4
V1	0.654	0.862	0.634	0.378	V1	2.754	3.535	2.336	1.963	V1	1.598	1.104	2.262	1.273
V2	0.934	0.801	0.725	0.594	V2	3.863	3.755	3.125	1.894	V2	1.823	2.172	3.029	1.550
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.0171		0.0151		S. Em	0.0582		0.0581		S. Em	0.0986		0.1056	
CD 5%	0.0500		0.0442		CD 5%	0.1699		0.1710		CD 5%	0.2879		0.3114	

Table 3: Effect of plastic mulching under drip irrigation and potato varieties on CGR ($g^{-1}m^{-2}$ day) of potato under potato-based cropping system

Treatments	Planting - 30 DAP			30 - 60 DAP			60 DAP to maturity		
A. Main plot	**2018-19**	**2019-20**	**Pooled**	**2018-19**	**2019-20**	**Pooled**	**2018-19**	**2019-20**	**Pooled**
Drip irrigation with black-black plastic mulch	4.35	4.47	4.41	16.60	20.17	18.38	12.80	6.21	9.50
Drip irrigation with silver- black plastic mulch	4.61	4.63	4.62	18.01	22.49	20.25	7.49	10.71	9.10
Drip irrigation without mulch	3.79	3.76	3.77	16.44	13.90	15.17	12.94	16.45	14.70
Farmer's practice (Check)	4.41	3.69	4.05	20.01	12.13	16.07	11.29	12.23	11.76
S. Em±	0.053	0.102	0.058	0.317	0.364	0.241	0.793	0.580	0.491
C.D. (at 5%)	0.171	0.327	0.171	1.014	1.165	0.717	2.536	1.854	1.459
B. Sub plot									
Kufri Badshah	3.68	3.87	3.77	17.37	14.76	16.07	9.79	9.30	9.55
Kufri Chipsona-3	4.90	4.41	4.65	18.16	19.58	18.87	12.47	13.50	12.99
S. Em±	0.077	0.069	0.052	0.268	0.214	0.171	0.451	0.371	0.292
C.D. (at 5%)	0.238	0.211	0.151	NS	0.658	0.500	1.390	1.142	0.852
Interaction	S	S	S	S	S	S	S	S	S

Table 3.1: Interaction effect of plastic mulching under drip irrigation and potato varieties on CGR (g^{-1} m^{-2} day) of potato under potato-based cropping system

At 30 DAP					At 60 DAP					At maturity				
2018-19					**2018-19**					**2018-19**				
Factor	**M1**	**M2**	**M3**	**M4**	**Factor**	**M1**	**M2**	**M3**	**M4**	**Factor**	**M1**	**M2**	**M3**	**M4**
V1	3.50	4.72	3.60	2.88	V1	16.20	17.59	15.15	20.56	V1	10.43	4.02	9.20	15.50
V2	5.21	4.50	3.97	5.94	V2	17.00	18.43	17.74	19.46	V2	15.17	10.95	16.68	7.09
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.155		0.122		S. Em	0.535		0.494		S. Em	0.902		1.018	
CD 5%	0.477		0.378		CD 5%	1.649		1.545		CD 5%	2.780		3.208	
2019-20					**2019-20**					**2019-20**				
Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4
V1	3.77	4.86	3.44	3.41	V1	14.40	21.69	10.81	12.15	V1	7.32	8.24	15.94	5.71
V2	5.16	4.40	4.09	3.97	V2	25.93	23.29	16.98	12.10	V2	5.09	13.18	16.97	18.75
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.137		0.141		S. Em	0.427		0.473		S. Em	0.741		0.781	
CD 5%	0.422		0.443		CD 5%	1.317		1.491		CD 5%	2.284		2.458	
Pooled					**Pooled**					**Pooled**				
Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4
V1	3.63	4.79	3.52	3.15	V1	15.30	19.64	12.98	16.36	V1	8.88	6.13	12.57	10.60
V2	5.19	4.45	4.03	4.95	V2	21.46	20.86	17.36	15.78	V2	10.13	12.07	16.83	12.92
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.103		0.093		S. Em	0.342		0.342		S. Em	0.584		0.641	
CD 5%	0.302		0.273		CD 5%	0.999		1.007		CD 5%	1.704		1.892	

Table 4: Effect of plastic mulching under drip irrigation and potato varieties on RGR ($g^{-1}g^{-1}$ day) of potato under potato-based cropping system

Treatments	Planting to 30 DAP			30 - 60 DAP			60 DAP to maturity		
A. Main plot	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Drip irrigation with black-black plastic mulch	0.1046	0.1056	0.1051	0.0529	0.0562	0.0545	0.0158	0.0082	0.0120
Drip irrigation with silver- black plastic mulch	0.1071	0.1072	0.1071	0.0531	0.0590	0.0560	0.0093	0.0110	0.0101
Drip irrigation without mulch	0.1005	0.1003	0.1004	0.0559	0.0510	0.0534	0.0162	0.0224	0.0193
Farmer's practice (Check)	0.0900	0.0860	0.0880	0.0592	0.0487	0.0539	0.0126	0.0180	0.0153
S. Em±	0.00038	0.00082	0.00045	0.00068	0.00105	0.00063	0.00086	0.00085	0.00061
C.D. (at 5%)	0.00121	0.00262	0.00134	0.00218	0.00336	0.00186	0.00275	0.00273	0.00180
B. Sub plot									
Kufri Badshah	0.0957	0.0976	0.0966	0.0586	0.0517	0.0551	0.0125	0.0139	0.0132
Kufri Chipsona-3	0.1054	0.1020	0.1037	0.0519	0.0557	0.0538	0.0144	0.0159	0.0151
S. Em±	0.00060	0.00051	0.00040	0.00070	0.00065	0.00048	0.00056	0.00058	0.00040
C.D. (at 5%)	0.00186	0.00158	0.00115	0.00216	0.00201	NS	0.00173	0.00178	0.00117
Interaction	S	S	S	S		S	S	S	S

Table 4.1: Interaction effect of plastic mulching under drip irrigation and potato varieties on RGR (g $^{-1}$ g $^{-1}$ day) of potato under potato-based cropping system

At 30 DAP					At 60 DAP					At maturity				
2018-19					2018-19					2018-19				
Factor	**M1**	**M2**	**M3**	**M4**	**Factor**	**M1**	**M2**	**M3**	**M4**	**Factor**	**M1**	**M2**	**M3**	**M4**
V1	0.0980	0.1079	0.0988	0.0780	V1	0.0576	0.0518	0.0551	0.0699	V1	0.0142	0.0055	0.0133	0.0169
V2	0.1112	0.1062	0.1021	0.1020	V2	0.0483	0.0543	0.0566	0.0485	V2	0.0173	0.0130	0.0190	0.0082
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.0012		0.0009		S. Em	0.00140		0.00120		S. Em	0.00112		0.00117	
CD 5%	0.0037		0.0029		CD 5%	0.00433		0.00376		CD 5%	0.00345		0.00368	
2019-20					2019-20					2019-20				
Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4
V1	0.1004	0.1089	0.0974	0.0836	V1	0.0524	0.0566	0.0473	0.0506	V1	0.0113	0.0090	0.0251	0.0103
V2	0.1108	0.1055	0.1031	0.0885	V2	0.0599	0.0614	0.0546	0.0468	V2	0.0051	0.0130	0.0197	0.0258
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.00102		0.00109		S. Em	0.00131		0.00140		S. Em	0.00116		0.00118	
CD 5%	0.00315		0.00344		CD 5%	0.00402		0.00440		CD 5%	0.00356		0.00372	
Pooled					Pooled					Pooled				
Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4	Factor	M1	M2	M3	M4
V1	0.0992	0.1084	0.0981	0.0808	V1	0.0550	0.0542	0.0512	0.0602	V1	0.0128	0.0073	0.0192	0.0136
V2	0.1110	0.1059	0.1026	0.0953	V2	0.0541	0.0579	0.0556	0.0476	V2	0.0112	0.0130	0.0194	0.0170
	(M×V)1		(M×V)2			(M×V)1		(M×V)2			(M×V)1		(M×V)2	
S. Em	0.00079		0.00072		S. Em	0.00096		0.00092		S. Em	0.00080		0.00083	
CD 5%	0.00231		0.00211		CD 5%	0.00280		0.00272		CD 5%	0.00235		0.00245	

Table 5: Effect of plastic mulching under drip irrigation and potato varieties on SPAD meter reading of potato under potato-based cropping system

Treatments	At 30 DAP			At 60 DAP			At maturity		
A. Main plot	**2018-19**	**2019-20**	**Pooled**	**2018-19**	**2019-20**	**Pooled**	**2018-19**	**2019-20**	**Pooled**
Drip irrigation with black-black plastic mulch	52.5	52.4	52.4	44.5	44.6	44.6	38.8	38.4	38.6
Drip irrigation with silver- black plastic mulch	53.3	53.4	53.4	47.3	47.5	47.4	42.7	42.7	42.7
Drip irrigation without mulch	54.1	54.1	54.1	42.7	42.9	42.8	40.7	41.0	40.9
Farmer's practice (Check)	47.1	47.4	47.2	44.4	44.5	44.5	37.1	38.1	37.6
S. Em±	0.91	0.91	0.64	0.63	0.60	0.44	0.61	0.73	0.48
C.D. (at 5%)	2.90	2.92	1.91	2.02	1.92	1.29	1.94	2.35	1.41
B. Sub plot									
Kufri Badshah	50.9	50.9	50.9	43.4	43.5	43.4	38.2	38.8	38.5
Kufri Chipsona-3	52.6	52.7	52.7	46.1	46.2	46.2	41.4	41.3	41.4
S. Em±	0.63	0.63	0.45	0.49	0.50	0.35	0.65	0.69	0.47
C.D. (at 5%)	NS	NS	1.30	1.51	1.55	1.03	2.02	2.12	1.39
Interaction	NS	NS	S	NS	NS	NS	NS	NS	NS

Table 5.1: Interaction effect of plastic mulching under drip irrigation and potato varieties on SPAD meter reading of potato at 30 DAP under potato-based cropping system

Treatments	Pooled			
	DM_1	**DM_2**	**DM_3**	**FI_4**
V_1	49.7	52.4	53.8	47.8
V_2	55.2	54.4	54.4	46.7
	$(M×V)_1$			
S. Em±	0.89			
C.D. (at 5%)	2.60			
	$(M×V)_2$			
S. Em±	0.90			
C.D. (at 5%)	2.65			

4. Conclusion

With respect to root shoot ratio, CGR, RGR and AGR, the two cultivars as well as different plastic mulching showed different trend at different growth stages of the crop. However, performance of Kufri Chipsona-3 under drip irrigation with silver black plastic mulching remained superior to other treatment combinations. This treatment remained at par with performance of Kufri Badshah under drip irrigation with black-black plastic mulching. A non-significant interaction for SPAD meter reading was found between plastic mulching under drip irrigation and potato cultivars at all growth stages during both experimental year and on pooled basis. Since these results are based on two years of experimentation, for reaching to any rigid conclusion and recommendation, further conduction of the same experiment is required for at least three successive years in different environments.

5. References

1. Food and Agriculture Organization; c2021. http://www.global potato statistics.org
2. Agricultural Statistics at a Glance; c2022. https://agricoop.nic.in/Documents/CWWG DATA/Agricultural_Statistics_at_a_Glance_2022_0.pdf
3. Suchi G, Arpna B, Rao KVR, Lavesh C, Kumar S. Effect of Duration of Plastic Mulch on Potato (*Solanum tuberosum* L.) Growth and Yield Under Drip Irrigation. The Bioscan. 2017;12(1):527-530.
4. Bhart, Kumar R. Effect of various types of mulching on growth, yield and quality of different processable cultivars of potato (*Solanum tuberosum* L.). International Journal of Chemical Studies. 2021;9(3):166-169.

5. Panchal SC, Bhatnagar R, Momin RA, Chauhan NP. Influence of cultural practices on quality of green and red chilli (*Capsicum annum* L.) fruit. Indian Journal of Agricultura. Biochemistry. 2001;14:21-24.
6. Ahmed SM, Sadik SK, Muslah OH. Effect of manures and mulching on yield of potato (*Solanum tuberosum* L.) Desiree. Al-Anbar. Journal of Agricultural. Science. 2009;2(7):104-115.
7. Zhao H, Wang RY, Ma BL, Xiong YC, Qiang SC, Wang CL, *et al*. Ridge-furrow with full plastic film mulching improves water use efficiency and tuber yields of potato in a semiarid rainfed ecosystem. Field Crop Research. 2014;161:137-148.
8. El-Hendawy, Salah, Alsamin B, Nabil M, Refay Y. Improving Morpho-Physiological Indicators, Yield, and Water Productivity of Wheat through an Optimal Combination of Mulching and Planting Patterns in Arid Farming Systems. Agronomy. 2023;13(6):1660. 1-23. https://doi.org/10.3390/agronomy13061660.
9. Radford PJ. Growth analysis formulae-their use and abuse. Crop Science. 1967;7:171-175.
10. Blackman VN. The compound interest law and plant growth. Annals of Botany. 1919;33:353-360.
11. Cengiz K, David H, Halil K. Influence of Polyethylene Mulch, Irrigation Regime, and Potassium Rates on Field Cucumber Yield and Related Traits. Journal of Plant Nutrition - J PLANT NUTR. 2005;28:1739-1753. 10.1080/01904160500250797.