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The Effect of Alternative Tillage Practices on Potato Growth and Yield

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted during the *rabi* seasons of 2021-22 and 2022-23 at the Research Farm, ICAR-Central Potato Research Station RS, Gwalior (M.P.). The experiment consisted of 7 treatments *viz*.; Farmer's practice (T_1), CIP Technique (T_2), Regional AICRIP/INSTITUTE recommendation/hoeing (T_3), Flat-bed planting (T_4), Flat-bed planting & mulching (T_5), Flat-bed planting & ridging (T_6) and Flat-bed planting, ridging and mulching (T_7) with 3 replications. The soil of experimental field was a sandy clay loam with uniform topography. The result showed that CIP Technique (T_2) at par with Flat-bed planting, ridging and mulching (T_7) were registered superior values of growth parameters *viz*.; plant height, number of compound leaves per plant and dry

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weight of haulm per plant (45.67 & 45.43 cm, 49.38 & 49.10 and 24.73 & 24.00 g; respectively), yield attributes *viz*.; number of tubers per plant and dry weight of tubers per plant (8.72 & 8.65 and 54.97 & 54.50 g; respectively) as well as tuber yield (299.23 & 282.44 qha^{-1}) of potato over rest of the treatments.

Keywords: Growth parameters; potato; tillage practices; yield attributes; yield.

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is an annual, herbaceous, tuber crop of Solanaceae family that contains all the essential food ingredients required for maintaining proper health (Gupta et al., 2014).

The global production of potato is around 375 mt, India ranks 2nd in area and production of potato in the world after China (Anonymous, 2022-23b). In India, it is grown on an area of 2.35 million hectares with the production of 56 mt and the productivity is 23829 kg/ha (Anonymous, 2022-23a). Madhya Pradesh covers 158.14 thousand hectares with production of 3582 thousand tonnes and the productivity is 22651 kg/ha (Anonymous, 2022-23).

Zero tillage systems such as no-tillage (NT) or direct drill, which plant directly through the mulch with minimal soil disturbance and diverse crop rotations are the practices that could maintain and improve soil quality. With the initiatives taken under International Potato Center (CIP), zero tillage potato cultivation has been fabulously adopted in various regions of the states. Farmers today can adopt the ZT potato cultivation practice as this system can give higher yield with limited labour and water use thus making the whole production system a lot more economic.

Potato is an important winter rotation and vegetable crop which provides a stable income for small holders in order to increase the knowledge and profits of farmers through the adoption of zero-tillage potato with rice straw mulch will promote climate-smart agriculture in addition to reduce environmental pollution caused by straw burning. More importantly, the use of rice straw for mulching puts nutrients back in the soil and reduces the emissions of greenhouse gases associated with the conventional practice of straw burning.

2. MATERIALS AND METHODS

An experiment was conducted during the *rabi* seasons of 2021-22 and 2022-23 at the Research Farm, ICAR-Central Potato Research Station RS, Gwalior (M.P.). The experiment consisted of 7 treatments *viz*.; Farmer's practice: Removing/Burning of straw from field, tillage, planting and irrigation afterwards (T_1), CIP (International Potato Center) Technique: Flat planting of seed tubers after FYM (Farm yard manure) & fertilizer application + covering with paddy straw mulch (T_2), Regional AICRIP/INSTITUTE recommendation/hoeing (T_3), Flat-bed planting: Direct planting of potato by opening slit and covering it with soil (Root zone tillage in 10 cm width and 15 cm depth) and no mulching or earthing (T_4), Flat-bed planting & mulching: Direct planting of potato by opening slit and covering it with soil (Root zone tillage in 10 cm width and 15 cm depth) + mulching by chopped straw and no earthing (T_5), Flat-bed planting & ridging: Direct planting of potato by opening slit and covering it with soil (Root zone tillage in 10 cm width and 15 cm depth) + earthing after 20-25 days by tilling soil between rows and no mulching (T_6) and Flat-bed planting, ridging and mulching: Direct planting of potato by opening slit and covering it with soil (Root zone tillage in 10 cm width and15 cm depth) and earthing after 20-25 days by tilling soil between rows + mulching of chopped straw after earthing (T_7) with 3 replications. The soil of experimental field was a sandy clay loam with uniform topography.

The studied for selected growth and yield attributes by using five plants in randomized manner in each plot. All other agronomic practices were adopted as per recommended package of practices. The data were statistically analysed using the F-test procedure given by Gomez & Gomez (1984). The difference between treatment means were compared with the critical differences (CD) at 5% level of probability (P=0.05).

3. RESULTS AND DISCUSSION

The value of growth parameters, yield attributes as well as tuber yield were taken as per average of both years.

Table 1. Effect of tillage practices on growth parameters of potato

Treatment	Sy.	Plant height (cm)			Number of compound leaves per plant			Dry weight of haulm per plant (g)		
		2021-22	2022-23	Average	2021-22	2022-23	Average	2021-22	2022-23	Average
Farmer's practice	T_1	40.43	41.67	41.05	45.00	46.22	45.61	17.31	17.39	17.35
CIP Technique	T_2	45.30	46.03	45.67	48.80	49.97	49.38	24.68	24.77	24.73
Regional AICRIP/INSTITUTE recommendation/hoeing	T_3	44.40	45.30	44.85	48.03	49.20	48.62	23.43	23.57	23.50
Flat-bed planting	T_4	40.77	40.92	40.84	44.37	45.57	44.97	17.00	17.10	17.05
Flat-bed planting & mulching	T_5	42.97	43.53	43.25	46.90	48.10	47.50	20.41	20.66	20.53
Flat-bed planting & ridging	T_6	41.63	44.33	42.98	46.43	47.63	47.03	20.07	20.17	20.12
Flat-bed planting, ridging and mulching	T_7	44.98	45.89	45.43	48.50	49.70	49.10	23.93	24.07	24.00
SEm±		**0.63**	**0.66**	**0.32**	**0.49**	**0.56**	**0.26**	**0.47**	**0.48**	**0.24**
CD (5%)		**1.94**	**2.03**	**0.94**	**1.50**	**1.73**	**0.77**	**1.45**	**1.49**	**0.70**

Table 2. Effect of tillage practices on yield attributes and yield of potato

Treatment	Sy.	Number of tubers per plant			Dry weight of tubers per plant (g)			Tuber yield (q/ha)		
		2021-22	2022-23	Average	2021-22	2022-23	Average	2021-22	2022-23	Average
Farmer's practice	T_1	7.69	7.75	7.72	50.40	51.73	51.07	203.67	214.00	208.83
CIP Technique	T_2	8.68	8.76	8.72	54.90	55.03	54.97	295.46	303.01	299.23
Regional AICRIP/INSTITUTE recommendation/hoeing	T_3	8.51	8.54	8.53	54.17	54.27	54.22	269.00	275.33	272.17
Flat-bed planting	T_4	7.64	7.68	7.66	50.03	51.37	50.70	202.33	212.67	207.50
Flat-bed planting & mulching	T_5	8.22	8.23	8.22	52.70	53.05	52.87	240.00	246.67	243.33
Flat-bed planting & ridging	T_6	8.04	8.07	8.06	52.17	52.53	52.35	232.33	242.33	237.33
Flat-bed planting, ridging and mulching	T_7	8.63	8.67	8.65	54.47	54.53	54.50	278.35	286.53	282.44
SEm±		**0.14**	**0.14**	**0.07**	**0.62**	**0.45**	**0.27**	**9.07**	**9.10**	**4.54**
CD (5%)		**0.43**	**0.43**	**0.21**	**1.90**	**1.38**	**0.79**	**27.96**	**28.03**	**13.26**

3.1 Growth Parameters

The growth parameters were significantly varied among different treatments (Table 1). CIP Technique (T_2) at par with Flat-bed planting, ridging and mulching (T_7) registered significantly higher values of growth parameters *viz*.; plant height, number of compound leaves per plant and dry weight of haulm per plant (45.67 & 45.43 cm, 49.38 & 49.10 and 24.73 & 24.00 g; respectively) over rest of the treatments; while lowest values (40.84 cm, 44.97 and 17.05 g; respectively) were observed under Flat-bed planting (T_4). This may be due to better soil health with reduced nutrient loss. The presence of crop residue mulch at the soil atmosphere interface has a direct effect on infiltration of rainwater into the soil and evaporation from the soil leading to improved soil water supply for crops. Therefore; better cell division, cell expansion and enlargement resulted higher value of growth parameters. Msheik et al. (2019), Yaroson et al. (2019) and Rittl et al. (2023) also reported corroboratory findings in potato crop.

3.2 Yield Attributes

Different tillage practices significantly affect yield attributes (Table 2). Significantly superior values of yield attributes *viz*.; number of tubers per plant and dry weight of tubers per plant (8.72 & 8.65 and 54.97 & 54.50 g; respectively) were observed under CIP Technique (T_2) on par with Flat-bed planting, ridging and mulching (T_7) over rest of the treatments; white lower values (7.66 and 50.70 g; respectively) were noted by Flat-bed planting (T_4). This may be due to better and balanced availability of nutrients as compare to other treatments. The increase in yield attributes under these treatments may be attributed to concomitant reduction in weed dry matter that accounted for reductions in crop-weed competition, which provided congenial environment to proper utilization of growth factors *viz*., space, light, moisture and nutrient by the crop and henceforth attained superior values of yield attributes of potato. Similar results were also confined by findings of Duhlian et al. (2018) and Rittl et al. (2023).

3.3 Yield

Yield is the economic part of the crop, which is based on availability of all favorable growth conditions; which play very crucial role in enhancement of yield attributes (Table 2). CIP Technique (T_2) at par with Flat-bed planting, ridging and mulching (T_7) registered significantly maximum tuber yield (299.23 q/ha and 282.44 q/ha; respectively) over rest of the treatment; while minimum tuber yield (207.50 q/ha) was observed under Flat-bed planting (T_4). This may be due to efficient utilization of growth factors; which result in better crop growth and development during all stages owing to weed free environment. Mulch provides an important habitat for natural enemies, which are vital for pest population regulation. Reduced tillage could be improving soil quality parameters, minimizing production cost, while also sustaining higher potato yield. Such results were also confirmed by findings of Mosquera et al. (2019), Yaroson et al. (2019) and Rittl et al. (2023).

4. CONCLUSIONS

For obtaining optimum value of growth parameters, yield attributes as well as higher tuber yield of potato under semi-arid tract and sandy clay loam soils; CIP Technique (T_2) on par with Flat-bed planting, ridging and mulching (T_7) were registered superior performance over rest of the treatments.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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