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Effect of different method of irrigation and for levels of drip with suitable nitrogen doses on yield and its attributes on potato (*Solanum tuberosum* L.)

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Abstract
The investigation entitled **"**Effect of different method of irrigation and for levels of drip with suitable nitrogen doses on yield and its attributes on potato (*Solanum tuberosum* L.)" has been carried out at Research Cum Instructional Farm, College of Agriculture, IGKV, Raipur (C.G.) during rabi season 2022-23 and 2023-24. This experiment was laid out in split plot design with three replications, keeping five irrigation levels *i.e.* I_1: 75% CPE with drip, I_2: 100% CPE with drip, I_3: 125% CPE with drip, I_4: 150% CPE with drip and I_5: Furrow irrigation as a main plot and four nitrogen doses *i.e.* N_1: 90 kg N ha^{-1}, N_2: 120 kg N ha^{-1}, N_3: 150 kg N ha^{-1} and N_4: 180 kg N ha^{-1} as sub plot. The yield parameters recorded significantly higher under I_4N_4 (100% CPE with drip + 180 kg N ha^{-1}) *viz.* number of tubers $plant^{-1}$ (12.67), weight of tubers $plant^{-1}$ (350.58 g), marketable tuber yield (26.46 kg $plot^{-1}$) and total tuber yield (35.41 t ha^{-1}). However, higher unmarketable tuber yield was obtained with treatment I_3N_4 (125% CPE with drip + 180 kg N ha^{-1}) of (9.61 kg $plot^{-1}$). While minimum was recorded under combination of furrow irrigation and lowest dose of nitrogen.

Keywords: Irrigation, drip, nitrogen, potato and yield

Introduction
Potato (*Solanum tuberosum* L.) is one of the important vegetable crops belongs to the solanaceae family and popularly known as 'The king of vegetables. It is an annual herbaceous dicotyledonous plant with underground stems that give rise to tubers. These species form a polyploidy series ranging from diploid (2n=2x=24) to hexaploid (2n=6x=72). Cultivated potato are tetraploid (2n=4x=48) and origin of potato is believed to be South America (Peru). The major Potato producing states are Uttar Pradesh, West Bengal, Bihar, Gujarat, Madhya Pradesh, Punjab, Assam, Chhattisgarh, Jharkhand and Haryana. Potato is an herbaceous plant with sparse and shallow rooting system and requires light and frequent irrigations throughout cropping period (Dhaliwal, 2007) [7].
Scheduling of irrigation includes supply of water in optimum quantity at right time with appropriate application method is called irrigation scheduling (Gu *et al.*, 2020) [15]. Now a days drip irrigation, more popular among the farmers for leading good crop. Drip irrigation, it is also known as trickle irrigation which is a recent concept where small frequent irrigation applications are applied to saturate the soil and meet the plant water requirements. Thus, drip irrigation declines conventional losses like deep percolation, runoff and soil evaporation (Patel, *et al.*, 2020) [22]. Effect of drip irrigation in potato crop generally achieves better crop yield with minimum water losses (Gameh *et al.*, 2000) [13]. Nitrogen, Phosphorous and Potassium are considered as the most significant macronutrients for potato crops. Nitrogen is an integral part of purin- pyrimidins which forms RNA and DNA and also being a component of protoplasm enhances chlorophyll synthesis (El-Ghamriny and Saeed, 2007) [9]. Nitrogen is the most important primarily limiting nutrient in potato production that greatly influence crop growth and tuber yield (Kumar *et al.*, 2002) [16].

Materials and methods
The experiment was performed under All India Coordinated Research Project on Potato at Research Cum Instructional Farm, College of Agriculture, Indira Gandhi Krishi

Vishwavidyalaya, Raipur (C.G), during rabi season 2022-23 and 2023-24. This experiment was laid out in split plot design with three replications, keeping five irrigation levels *i.e.* I_1: 75% CPE with drip, I_2: 100% CPE with drip, I_3: 125% CPE with drip, I_4: 150% CPE with drip and I_5: Furrow irrigation as a main plot and four nitrogen doses *i.e.* N_1: 90 kg N ha^{-1}, N_2: 120 kg N ha^{-1}, N_3: 150 kg N ha^{-1} and N_4: 180 kg N ha^{-1} as sub plot.

Result and Discussion

The yield attributes include number of tuber plant^{-1}, weight of tuber plant^{-1} (g), marketable tuber yield (Kg plot^{-1}), unmarketable tuber yield (Kg plot^{-1}) and total tuber yield (t ha^{-1}).

Number of tuber plant^{-1}

Response of irrigation

The data indicated that significant difference in first year and pooled mean and non-significant difference in second year among the treatments of different levels and method of irrigation. In the first year, second year and pooled mean the highest number of tuber plant^{-1} (11.82, 9.50 and 10.66) were obtained under I_4 (150% CPE with drip) followed by I_3 (125% CPE with drip) of (11.45, 9.30 and 10.38) respectively. Whereas the minimum number of tuber plant^{-1} in first year (9.28), second year (8.33) and pooled mean (8.80) were recorded under I_5 (Flood irrigation) respectively. The increased number of tubers plant^{-1} under I_4 (150% CPE with drip) can be attributed to the consistent and efficient water availability through drip irrigation. Drip irrigation facilitates better root zone moisture conditions, leading to enhanced tuber initiation and development. The higher irrigation levels likely promoted cell expansion, nutrient mobility, and photosynthate translocation, which collectively contributed to higher tuber formation. Bisht *et al.* (2012) [4] suggesting that 100% CPE with drip irrigation often provides an ideal balance between water availability and oxygen supply in the root zone, thus promoting tuber initiation and development.

Response of nitrogen

The result indicated that significant difference in first year, second year and pooled mean in among different nitrogen levels. In the first year, second year and pooled mean the highest number of tuber plant^{-1} (12.30, 10.83 and 11.56) were obtained under N_4 (180 kg N ha^{-1}) followed by N_3 (150 kg N ha^{-1}) of (11.76, 9.07 and 10.41) respectively. Whereas the minimum number of tuber plant^{-1} in first year (8.83), second year (7.39) and pooled mean (8.11) were recorded under I_5 (Flood irrigation) respectively.

The enhanced number of tubers plant^{-1} under higher nitrogen levels can be attributed to the critical role of nitrogen in promoting vegetative growth, photosynthetic activity, and tuber initiation. Nitrogen is an essential nutrient involved in chlorophyll synthesis, leaf expansion, and protein formation, all of which contribute to better plant vigor and ultimately higher tuber production. Bose *et al.*, (2008) [2] reported that application of nitrogen 180 kg ha^{-1} showed the best response of yield traits viz., number of tubers.

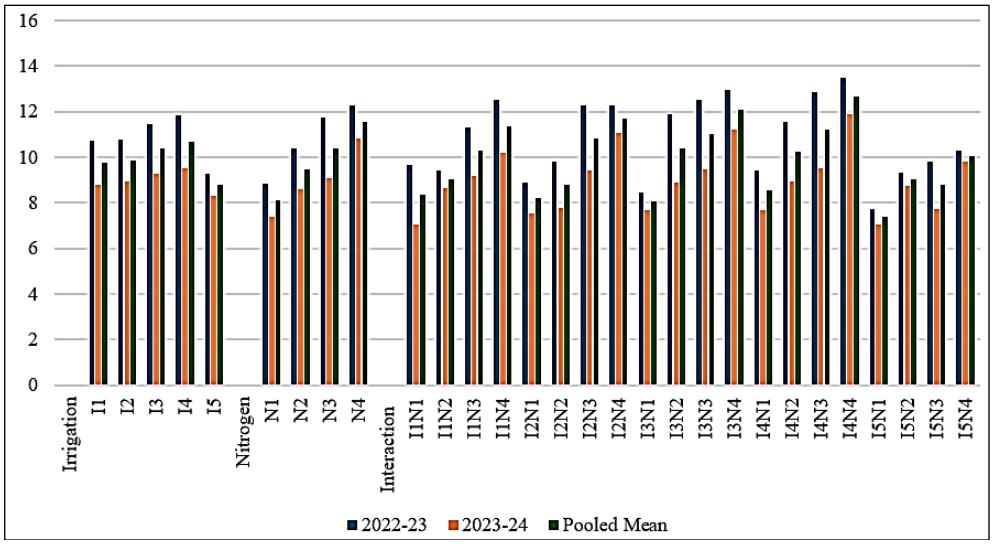

Fig 1: Number of tuber (plant^{-1}) of potato as influenced by different irrigation levels and nitrogen doses and their interactions.

Interaction (Irrigation X Nitrogen)

The results estimated that non-significant differences in first, second year and in pooled mean for interactions of irrigation levels and nitrogen doses. In the first year, second year and pooled mean the highest number of tuber plant^{-1} (13.47, 11.87 and 12.67 respectively) were obtained under I_4N_4 (150% CPE with drip + 180 kg N ha^{-1}) followed by I_3N_4 (125% CPE with drip + 180 kg N ha^{-1}) of (12.93, 11.20 and 12.07) respectively. Whereas the minimum number of tuber plant^{-1} in first year (7.73), second year (7.03) and pooled mean (7.38) were recorded under I_5N_1 (Flood irrigation + 90 kg N ha^{-1}) respectively.

The superior performance of I_4N_4 (150% CPE with drip + 180 kg N ha^{-1}) treatments can be attributed to the synergistic effect of ample soil moisture through drip irrigation and adequate nitrogen supply, which enhances vegetative growth, root development, and ultimately increases the number of tubers. Badr *et al.*, (2012) [32] reported higher number of tuber plant^{-1} and average tuber weight plant^{-1} was recorded with the application of 100% irrigation of crop ET and 340 kg ha^{-1} nitrogen application.

Weight of tuber plant^{-1} (g)

Response of irrigation

The results observed significant difference among the treatments of different levels and method of irrigation, during the first year, second year and in pooled mean. In the first year, second year and pooled mean the maximum

weight of tuber plant^{-1} (300.27 g, 313.27 g and 306.77 g) were obtained under I_4 (150% CPE with drip) followed by I_3 (125% CPE with drip) of (290.95g, 303.95g and 297.45g) respectively. Whereas the minimum weight of tuber plant^{-1} in the first year, second year and in pooled mean were recorded under I_5 (Furrow irrigation) of (270.97g, 283.97g and 277.47g respectively).

The increased weight of tuber plant^{-1} under I_4 (150% CPE with drip) can be attributed to the consistent and optimal availability of moisture in the root zone, which promotes better nutrient uptake, photosynthesis, and assimilate translocation towards tuber development. Drip irrigation ensures precise water application, maintaining favourable soil moisture conditions that are essential for enhanced tuber bulking and overall yield. Similarly, Abdelshafy *et al.*, (2021) [1] emphasized that drip irrigation systems enhance water use efficiency and yield, leading to improved tuber biomass due to uniform water application and minimal losses.

Response of nitrogen

The data indicated significant difference among different nitrogen levels during the first year, second year and pooled mean. In the first year, second year and pooled mean the maximum weight of tuber plant^{-1} (332.92 g, 345.92 g and 339.42 g) were obtained under N_4 (180 kg N ha^{-1}) followed by N_3 (150 kg N ha^{-1}) of (295g, 308.49g and 301.99g) respectively. Whereas the minimum weight of tuber plant^{-1} in the first year (245.81g), second year (258.81g) and pooled mean (252.31g) were recorded under N_1 (90 kg N ha^{-1}).

The increase in weight of tuber plant^{-1} with higher nitrogen levels, particularly under N_4 (180 kg N ha^{-1}), can be attributed to the enhanced vegetative growth, improved photosynthetic efficiency, and increased carbohydrate accumulation in tubers. Similarly, Ravikant and Chadha (2009) [24] reported maximum number of tubers plant^{-1}, average tuber weight and tuber yield plant^{-1} was recorded in the treatment of 180 kg ha^{-1} nitrogen application.

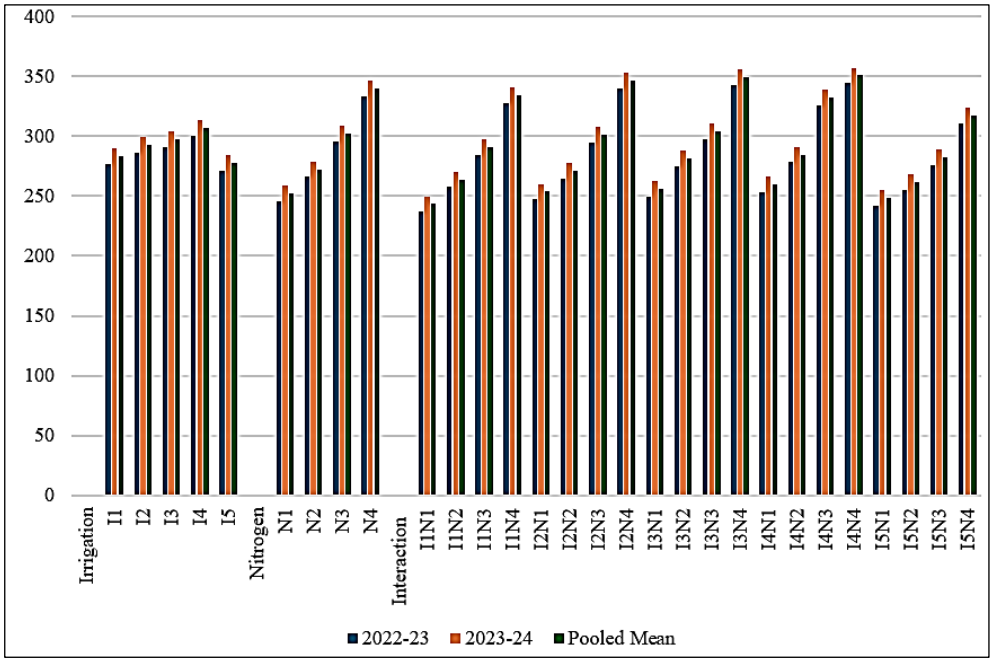

Fig 2: Weight of tuber plant^{-1} (g) of potato as influenced by different irrigation levels and nitrogen doses and their interactions.

Interaction (Irrigation X Nitrogen)

The results showed the significant difference for interactions of irrigation levels and nitrogen doses. In the first year, second year and pooled mean the maximum weight of tuber plant^{-1} (344.08 g, 357.08 g and 350.58 g) were obtained under I_4N_4 (150% CPE with drip + 180 kg N ha^{-1}) followed by I_3N_4 (125% CPE with drip + 180 kg N ha^{-1}) of (342.45g, 355.45g and 348.95g) respectively. Whereas the minimum weight of tuber plant^{-1} in the first year (242.23g), second year (255.23g) and pooled mean (248.73g) were recorded under I_5N_1 (Flood irrigation + 90 kg N ha^{-1}) respectively.

When this drip irrigation regime 150% CPE is combined with higher nitrogen doses (180 kg N ha^{-1}), it promotes enhanced vegetative growth, improved photosynthetic activity, and efficient translocation of assimilates towards the developing tubers. Consequently, this integrated approach contributes significantly to the increase in tuber weight plant^{-1}. Similarly, fandika *et al.* (2016) [11] and Sasani *et al.*, (2006) [26], the interaction of drip irrigation with well-balanced nitrogen application significantly improves water and nutrient use efficiency, resulting in greater tuber biomass and quality.

Marketable tuber yield (Kg Plot^{-1})

Response of irrigation

The results observed significant difference among the treatments of different levels and method of irrigation, during the first year, second year and in pooled mean. In first year, second year and in pooled mean highest marketable tuber yield was recorded under the treatment I_4 (150% CPE with drip) of (25.01 kg plot^{-1}, 21.44 kg plot^{-1} and 23.22 kg plot^{-1}) followed by I_3 (125% CPE with drip) of (21.90 kg plot^{-1}, 21.16 kg plot^{-1}, and 21.53 kg plot^{-1}) respectively. Whereas the minimum marketable tuber yield in the first year (11.59 kg plot^{-1}) and in pooled mean (14.89 kg plot^{-1}) were observed under treatment I_5 (Furrow irrigation), however during second year (16.67 kg plot^{-1}) was recorded with I_1 (75% CPE with drip).

The higher marketable yields recorded under the I_4 (150% CPE with drip) treatments can be primarily attributed to

improved water availability and uniform moisture distribution facilitated by the drip irrigation system. The results of the present study agree with the findings of Foti *et al.* (1995) [12] reported that increasing irrigation levels under drip systems up to 133% of ETc significantly improved both marketable and total tuber yield of potato. Nagaz *et al.* (2008) [21] evaluated the effects of drip and furrow irrigation methods on yield and its components of potato, result revealed that the maximum fresh tuber yield, number of tubers and average tuber weight was observed with drip irrigation. Similarly, Rangare *et al.*, (2021) [25] and Bhardwaj *et al.*, (2022) [5] also reported the similar findings.

Response of nitrogen

The data indicated that there was significant difference among different nitrogen levels, during the first year, second year and in pooled mean. In first year, second year and in pooled mean highest marketable tuber yield was recorded under the treatment N_4 (180 kg N ha^{-1}) of (22.71 kg plot^{-1}, 21.14 kg plot^{-1} and 21.93 kg plot^{-1}) followed by N_3 (150 kg N ha^{-1}) of (20.93 kg plot^{-1}, 19.86 kg plot^{-1} and 20.39 kg plot^{-1}) respectively. Whereas lowest marketable tuber yield in first year (17.88 kg plot^{-1}) and pooled mean (18.08 kg plot^{-1}) were found under N_1 (90 kg N ha^{-1}) however, during second year (17.95 kg plot^{-1}) recorded with N_2 (120 kg N ha^{-1}).

The significant differences in these parameters indicate that nitrogen application plays a crucial role in enhancing vegetative growth and tuber development in potato. The increase in marketable tuber yield with higher nitrogen application, particularly at 180 kg N ha^{-1}, can be attributed to improved vegetative growth and higher photosynthetic activity which enhances tuber bulking. These results are supported by the findings of Patel *et al.* (2020) [22], who reported that higher nitrogen levels significantly improve tuber yield in potato by promoting vigorous vegetative growth, chlorophyll synthesis, and enhancing photosynthetic activity. Similarly, Zelalem *et al.*, (2009) [31], Sandhu *et al.*, (2013) [27] and Parganiha *et al.*, (2022) [23] reported the similar results.

Interaction (Irrigation x Nitrogen)

The results showed the non-significant difference for interactions of irrigation levels and nitrogen doses. In first year, second year and in pooled mean the highest marketable tuber yield was recorded with treatment I_4N_4 (150% CPE with drip + 180 kg N ha^{-1}) of (29.70 kg plot^{-1}, 23.28 kg plot^{-1} and 26.46 kg plot^{-1} respectively) followed by I_4N_3 (150% CPE with drip + 150 kg N ha^{-1}) of (27.22 kg plot^{-1} and 24.38 kg plot^{-1} respectively) in first and pooled mean while during second year (22.92 kg plot^{-1}) was recorded under treatment I_3N_4 (125% CPE with drip + 180 kg N ha^{-1}). Whereas minimum marketable tuber yield in first year (10.08 kg plot^{-1}) was observed under I_5N_3 (Furrow irrigation + 150 kg N ha^{-1}) however, during second year (15.82 kg plot^{-1}) were found with I_5N_1 (Furrow irrigation + 90 kg N ha^{-1}) and pooled mean (12.69 kg plot^{-1}) was recorded with I_5N_2 (Furrow irrigation + 120 kg N ha^{-1}).

The treatment combination of 150% CPE through drip irrigation along with a higher nitrogen dose of 180 kg N ha^{-1} significantly influenced a wide range of growth and yield-related parameters. Mokh *et al.* (2015) [10] investigated that the effect of different irrigation levels and nitrogen doses of potato on highest potato yield were observed with 100% irrigation and 300 kg ha^{-1} nitrogen doses. Similarly, Mankotia and Sharma (2022) [20] and Janani *et al.*, (2022) [16] also reported the same results.

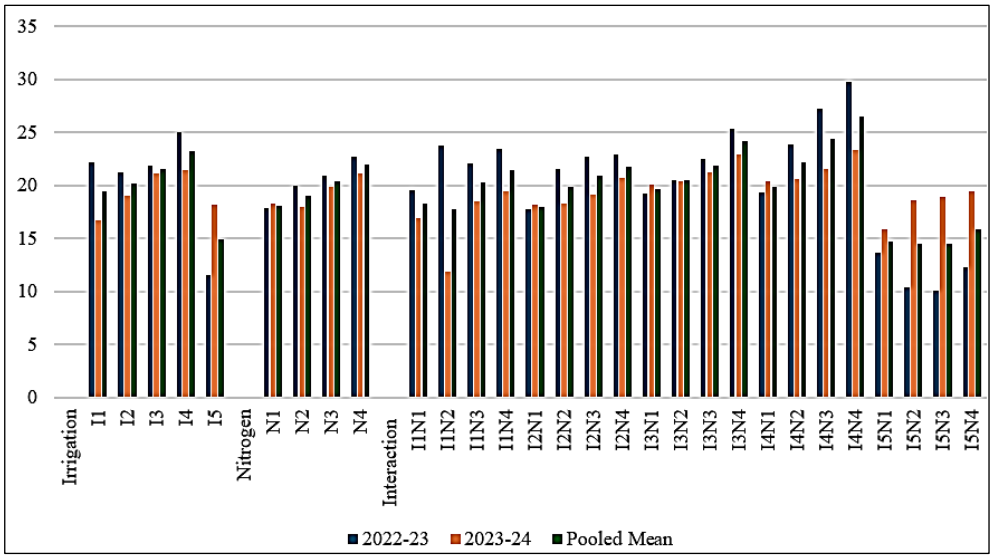

Fig 3: Marketable yield (kg plot^{-1}) of potato as influenced by different irrigation levels and nitrogen doses and their interaction

Unmarketable tuber yield (kg plot^{-1})

Response of irrigation

The data indicated significant difference in first year and in pooled mean and non-significantly differ during second year among the treatments of different levels and method of irrigation. In first year and pooled mean the maximum unmarketable tuber yield (8.51 kg plot^{-1} and 8.35 kg plot^{-1}) were recorded with the treatment I_3 (125% CPE with drip) followed by (7.96 kg plot^{-1} and 8.02 kg plot^{-1}) under 1_2 (100% CPE with drip). In the second year, the maximum unmarketable tuber yield (8.43 kg plot^{-1}) was found under I_4 (150% CPE with drip) followed by (8.19 kg plot^{-1}) with I_3 (125% CPE with drip). Whereas the minimum marketable tuber yield in the first year (5.81 kg plot^{-1}) and in pooled mean (6.96 kg plot^{-1}) were observed with I_5 (Furrow irrigation), however during second year (7.85 kg plot^{-1}) was found under I_1 (75% CPE with drip).

These results indicate that higher irrigation levels (125% CPE) through drip methods resulted in greater unmarketable tuber production, which might be attributed to excess

moisture in the soil causing physiological disorders such as tuber cracking and secondary growth. The results are matched with the findings of Janani *et al.*, (2022) [16], Bhardwaj *et al.*, (2022) [5] and Rangare *et al.*, (2021) [25].

Response of nitrogen

The data indicated that there was significant difference in first year, during second year as well as pooled mean among different nitrogen levels. In first year, second year and in pooled mean highest unmarketable tuber yield were recorded under the treatment N_4 (180 kg N ha^{-1}) of (7.85 kg plot^{-1}, 9.36 kg plot^{-1} and 8.61 kg plot^{-1}) followed by N_3 (150 kg N ha^{-1}) of (7.49 kg plot^{-1}, 8.67 kg plot^{-1} and 8.08 kg plot^{-1}) respectively. The minimum unmarketable tuber yield in the first year (7.05 kg plot^{-1}) was found with the treatment N_2 (120 kg N ha^{-1}) whereas second year (6.88 kg plot^{-1}) and pooled mean (6.97 kg plot^{-1}) were obtained under N_1 (90 kg N ha^{-1}).

These findings suggest that higher nitrogen doses (180 kg N ha^{-1}), tend to increase unmarketable tuber yield. The higher unmarketable tuber yield under the treatment might be due to the higher yield under the treatment. It might be due to the higher yield of small size tuber as well as higher rottage and damaged tubers yield were found in those treatments resulted higher unmarketable tuber yield. The results are matched with the findings of Sandhu *et al.*, (2013) [27], Parganiha *et al.*, (2022) [23] and Devi *et al.*, (2023) [8].

Interaction (Irrigation x Nitrogen)

The results showed that there is significant difference in first year and pooled mean and non-significant difference during second for interactions of irrigation levels and nitrogen doses.

In first year, second year and in pooled mean the highest unmarketable tuber yield was recorded with treatment I_3N_4 (125% CPE with drip + 180 kg N ha^{-1}) of (9.42 kg plot^{-1}, 9.80 kg plot^{-1} and 9.61 kg plot^{-1} respectively) followed by I_4N_1 (150% CPE with drip + 90 kg N ha^{-1}) in first year (9.11 kg plot^{-1}) and I_2N_4 (100% CPE with drip + 180 kg N ha^{-1}) in second year (9.45 kg plot^{-1}) and pooled mean (9.15 kg plot^{-1}). Whereas minimum marketable tuber yield in first year (3.92 kg plot^{-1}) with I_5N_2 (Furrow irrigation + 120 kg N ha^{-1}), during second year (6.48 kg plot^{-1}) and pooled mean (5.72 kg plot^{-1}) were recorded however was obtained under I_5N_1 (Furrow irrigation + 90 kg N ha^{-1}). The results are matched with the findings of Mankotia and Sharma (2022) [20].

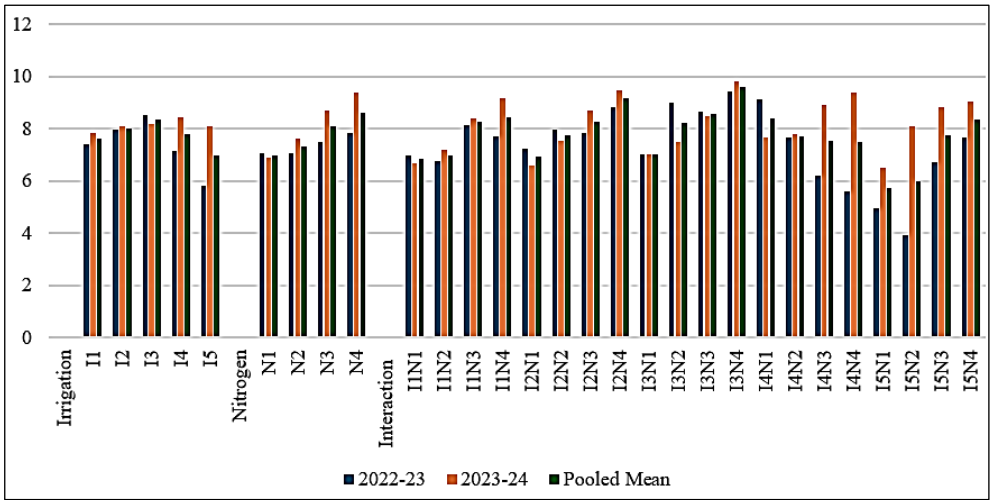

Fig 4: Unmarketable tuber yield (kg plot^{-1}) of potato as influenced by different irrigation levels and nitrogen doses and their interactions.

Total tuber yield (t ha^{-1})

Response of irrigation

The results observed significant difference among the treatments of different levels and method of irrigation, during the first year, second year and in pooled mean. In first year, second year and in pooled mean highest total tuber yield was recorded under the treatment I_4 (150% CPE with drip) of (33.48 t ha^{-1}, 31.12 t ha^{-1} and 32.30 t ha^{-1}) followed by I_3 (125% CPE with drip) of (31.68 t ha^{-1}, 30.58 t ha^{-1}, and 31.13 t ha^{-1}) respectively. Whereas minimum total tuber yield during first year (18.12 t ha^{-1}) and in pooled mean (22.76 t ha^{-1}) were observed under I_5 (Furrow irrigation) however in second year (25.54 t ha^{-1}) was found under treatment I_1 75% CPE with drip.

These parameters showed a consistent increase with increasing irrigation levels of drip irrigation, which ultimately contributed to the highest total tuber yield. The superior performance of drip irrigation at 150% CPE can be attributed to the maintenance of an optimal and uniform soil moisture regime around the root zone, leading to favourable conditions for potato growth, tuber initiation, and bulking. Drip irrigation ensures frequent but small doses of water directly to the root zone, which minimizes water stress and enhances nutrient availability and uptake efficiency (Wang *et al.* 2011) [30]. Chawla *et al.*, (2009) [6] reported that maximum plant height, number of haulms plant^{-1} and tuber yield was recorded with drip irrigation at 1.0 IW/CPE.

Response of nitrogen

The data indicated that there was significant difference among different nitrogen levels, during the first year, second year and in pooled mean. In first year, second year and in pooled mean highest total tuber yield was recorded under the treatment N_4 (180 kg N ha^{-1}) of (31.83 t ha^{-1}, 31.78 t ha^{-1} and 31.81 t ha^{-1}) followed by N_3 (150 kg N ha^{-1}) of (29.60 t ha^{-1}, 29.71 t ha^{-1}, and 29.66 t ha^{-1}) respectively. Whereas minimum total tuber yield in first year (26.05 t ha^{-1}), during second year (26.20 t ha^{-1}) and pooled mean (26.12 t ha^{-1}) was found under N_1 (90 kg N ha^{-1}).

These parameters exhibited improvement with increasing nitrogen rates, which contributed to enhanced total tuber yield. The increase in total tuber yield with higher nitrogen

application can be attributed to the enhanced vegetative growth, increased leaf area development, and improved photosynthetic efficiency, which contribute to tuber bulking. Similarly, Guler (2009) [14] also observed that adequate nitrogen supply resulted in higher tuber number and size, thereby increasing the overall yield.

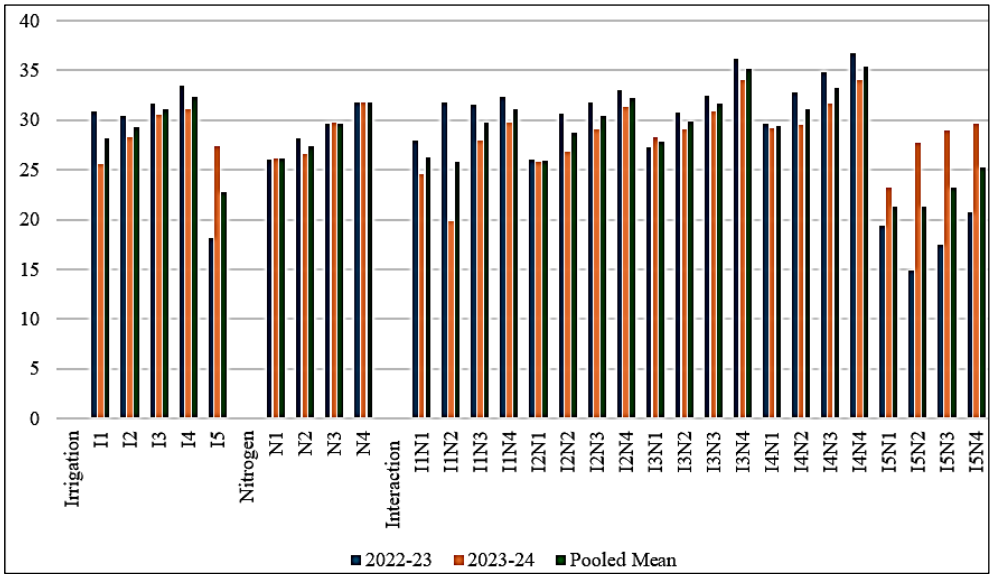

Fig 5: Total tuber yield (t ha^{-1}) of potato as influenced by different irrigation levels and nitrogen doses and their interactions.

Interaction (Irrigation x Nitrogen)

The results showed the significant difference for interactions of irrigation levels and nitrogen doses in first year, second year and pooled mean. The highest total tuber yield in first year (36.78 t ha^{-1}) and pooled mean (35.41 t ha^{-1}) were found under treatment I_4N_4 (150% CPE with drip + 180 kg N ha^{-1}) followed by I_3N_4 (125% CPE with drip + 180 kg N ha^{-1}) of (36.19 t ha^{-1} and 35.14 t ha^{-1} respectively). In second year, maximum total tuber yield (34.08 t ha^{-1}) was observed with treatment I_3N_4 (125% CPE with drip + 180 kg N ha^{-1}) followed by I_4N_4 (150% CPE with drip + 180 kg N ha^{-1}) of (34.03 t ha^{-1}). Whereas minimum total tuber yield in first year (14.88 t ha^{-1}) was recorded with treatment I_5N_2 (Furrow irrigation + 120 kg N ha^{-1}), while during second year (19.86 t ha^{-1}) was found under I_1N_2 (75% CPE with drip + 120 kg N ha^{-1}) and in pooled mean (21.29 t ha^{-1}) was obtained under treatment I_5N_1 (Furrow irrigation + 90 kg N ha^{-1}).

The interaction effect indicated that combining higher irrigation levels (150% CPE) with higher nitrogen doses (180 kg N ha^{-1}) under drip irrigation, substantially enhanced total tuber yield. The positive response may be attributed to the synergistic effect of adequate moisture and nutrient availability, that improved tuber bulking. These observations agree with the findings of Sharma *et al.* (2012) [28] and Singh *et al.* (2024) [29], who reported that appropriate combinations of water and nitrogen management under drip systems significantly increased crop productivity and resource use efficiency. In contrast, lower yields under furrow irrigation combined with lower nitrogen doses may be due to uneven water distribution, moisture stress, along with limited nutrient availability, which negatively affected growth and tuber formation (Maan *et al.*, (2018) [19]; Kumar *et al.*, (2006) [18].

Table 1: Number of tubers plant^{-1} and weight of tuber plant^{-1} (g) of potato as influenced by different irrigation levels and nitrogen doses.

Treatments	Number of tubers plant^{-1}			Weight of tubers plant^{-1} (g)		
	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean
Irrigation levels						
I1- 75% CPE with drip	10.73	8.78	9.76	276.58	289.58	283.08
12- 100% CPE with drip	10.80	8.95	9.88	286.31	299.31	292.81
I3- 125% CPE with drip	11.45	9.30	10.38	290.95	303.95	297.45
I4- 150% CPE with drip	11.82	9.50	10.66	300.27	313.27	306.77
I5- Furrow irrigation	9.28	8.33	8.80	270.97	283.97	277.47
SE (m) +	0.44	0.39	0.28	0.42	0.80	0.55
CD at 5%	1.42	NS	0.93	1.43	2.65	1.84
Nitrogen doses						
N1- 90 kg N ha^{-1}	8.83	7.39	8.11	245.81	258.81	252.31
N2- 120 kg N ha^{-1}	10.39	8.60	9.49	265.85	278.85	272.35
N3- 150 kg N ha^{-1}	11.76	9.07	10.41	295.49	308.49	301.99
N4- 180 kg N ha^{-1}	12.30	10.83	11.56	332.92	345.92	339.42
SE (m)	0.40	0.34	0.26	0.40	0.70	0.49
CD at 5%	1.16	0.93	0.75	1.18	2.03	1.43
Interaction: (Irrigation levels X Nitrogen doses)						
I1N1- 75% CPE with drip + 90 kg N ha^{-1}	9.67	7.07	8.37	236.80	249.80	243.30
I1N2- 75% CPE with drip + 120 kg N ha^{-1}	9.40	8.67	9.03	257.41	270.41	263.91
I1N3- 75% CPE with drip + 150 kg N ha^{-1}	11.33	9.20	10.27	284.35	297.35	290.85

I1N4- 75% CPE with drip + 180 kg N ha^{-1}	12.53	10.20	11.36	327.76	340.76	334.26
I2N1- 100% CPE with drip + 90 kg N ha^{-1}	8.87	7.53	8.20	247.14	260.14	253.64
I2N2- 100% CPE with drip + 120 kg N ha^{-1}	9.80	7.80	8.80	264.32	277.32	270.82
I2N3- 100% CPE with drip + 150 kg N ha^{-1}	12.27	9.40	10.83	294.33	307.33	300.83
I2N4- 100% CPE with drip + 180 kg N ha^{-1}	12.28	11.07	11.68	339.47	352.47	345.97
I3N1- 125% CPE with drip + 90 kg N ha^{-1}	8.47	7.67	8.07	249.34	262.34	255.84
I3N2- 125% CPE with drip + 120 kg N ha^{-1}	11.87	8.87	10.37	274.72	287.72	281.22
I3N3- 125% CPE with drip + 150 kg N ha^{-1}	12.53	9.47	11.00	297.28	310.28	303.78
I3N4- 125% CPE with drip + 180 kg N ha^{-1}	12.93	11.20	12.07	342.45	355.45	348.95
I4N1- 150% CPE with drip + 90 kg N ha^{-1}	9.40	7.67	8.53	253.52	266.52	260.02
I4N2- 150% CPE with drip + 120 kg N ha^{-1}	11.53	8.93	10.23	278.10	291.10	284.60
I4N3- 150% CPE with drip + 150 kg N ha^{-1}	12.87	9.53	11.20	325.37	338.37	331.87
I4N4- 150% CPE with drip + 180 kg N ha^{-1}	13.47	11.87	12.67	344.08	357.08	350.58
I5N1- Furrow irrigation + 90 kg N ha^{-1}	7.73	7.03	7.38	242.23	255.23	248.73
I5N2- Furrow irrigation + 120 kg N ha^{-1}	9.33	8.73	9.03	254.72	267.72	261.22
I5N3- Furrow irrigation + 150 kg N ha^{-1}	9.80	7.73	8.77	276.11	289.11	282.61
I5N4- Furrow irrigation + 180 kg N ha^{-1}	10.27	9.80	10.03	310.82	323.82	317.32
SE (m) + Factor (B) at the same level of A	0.87	0.77	0.56	0.86	1.60	1.12
CD at 5% Factor (B) at the same level of A	NS	NS	NS	2.73	4.71	3.32
SE (m) + Factor (A) at the same level of B	0.89	0.73	0.57	0.89	1.57	1.11
CD at 5% Factor (A) at the same level of B	NS	NS	NS	2.68	4.74	2.33

Table 2: Marketable yield, Unmarketable yield and Total tuber yield of potato as influenced by different irrigation levels and nitrogen doses.

Treatments	Marketable yield (kg plot^{-1})			Unmarketable yield (kg plot^{-1})			Total tuber yield (t ha^{-1})		
	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean	2022-23	2023-24	Pooled Mean
Irrigation levels									
I1- 75% CPE with drip	22.18	16.67	19.43	7.40	7.85	7.62	30.90	25.54	28.22
12- 100% CPE with drip	21.20	19.06	20.13	7.96	8.07	8.02	30.38	28.26	29.32
I3- 125% CPE with drip	21.90	21.16	21.53	8.51	8.19	8.35	31.68	30.58	31.13
I4- 150% CPE with drip	25.01	21.44	23.22	7.14	8.43	7.78	33.48	31.12	32.30
I5- Furrow irrigation	11.59	18.20	14.89	5.81	8.10	6.96	18.12	27.39	22.76
SE (m) +	0.63	0.83	0.43	0.41	0.07	0.19	0.37	0.24	0.18
CD at 5%	2.09	1.96	1.44	1.36	0.26	0.64	1.24	0.82	0.64
Nitrogen doses									
N1- 90 kg N ha^{-1}	17.88	18.27	18.08	7.06	6.88	6.97	26.05	26.20	26.12
N2- 120 kg N ha^{-1}	19.98	17.95	18.96	7.05	7.61	7.33	28.16	26.62	27.39
N3- 150 kg N ha^{-1}	20.93	19.86	20.39	7.49	8.67	8.08	29.60	29.71	29.66
N4- 180 kg N ha^{-1}	22.71	21.14	21.93	7.85	9.36	8.61	31.83	31.78	31.81
SE (m)	0.42	0.59	0.32	0.21	0.14	0.13	0.48	0.30	0.17
CD at 5%	1.24	1.22	0.97	0.61	0.43	0.38	1.41	0.88	0.50
Interaction: (Irrigation levels X Nitrogen doses)									
I1N1- 75% CPE with drip + 90 kg N ha^{-1}	19.55	16.93	18.24	6.97	6.66	6.82	27.97	24.58	26.27
I1N2- 75% CPE with drip + 120 kg N ha^{-1}	23.70	11.88	17.79	6.76	7.18	6.97	31.73	19.86	25.79
I1N3- 75% CPE with drip + 150 kg N ha^{-1}	22.11	18.46	20.29	8.14	8.40	8.27	31.51	27.98	29.75
I1N4- 75% CPE with drip + 180 kg N ha^{-1}	23.38	19.40	21.39	7.71	9.16	8.43	32.39	29.75	31.07
I2N1- 100% CPE with drip + 90 kg N ha^{-1}	17.72	18.17	17.95	7.23	6.58	6.91	25.99	25.79	25.89
I2N2- 100% CPE with drip + 120 kg N ha^{-1}	21.50	18.24	19.87	7.98	7.53	7.75	30.70	26.85	28.77
I2N3- 100% CPE with drip + 150 kg N ha^{-1}	22.70	19.16	20.93	7.81	8.70	8.26	31.78	29.03	30.40
I2N4- 100% CPE with drip + 180 kg N ha^{-1}	22.87	20.66	21.76	8.84	9.45	9.15	33.03	31.36	32.20
I3N1- 125% CPE with drip + 90 kg N ha^{-1}	19.20	20.10	19.65	7.02	7.03	7.02	27.31	28.26	27.79
I3N2- 125% CPE with drip + 120 kg N ha^{-1}	20.53	20.42	20.48	8.98	7.47	8.22	30.74	29.05	29.89
I3N3- 125% CPE with drip + 150 kg N ha^{-1}	22.53	21.20	21.87	8.63	8.49	8.56	32.46	30.93	31.69
I3N4- 125% CPE with drip + 180 kg N ha^{-1}	25.32	22.92	24.12	9.42	9.80	9.61	36.19	34.08	35.14
I4N1- 150% CPE with drip + 90 kg N ha^{-1}	19.31	20.35	19.83	9.11	7.64	8.38	29.60	29.15	29.38
I4N2- 150% CPE with drip + 120 kg N ha^{-1}	23.80	20.61	22.21	7.64	7.77	7.71	32.75	29.57	31.16
I4N3- 150% CPE with drip + 150 kg N ha^{-1}	27.22	21.53	24.38	6.19	8.92	7.55	34.80	31.72	33.26
I4N4- 150% CPE with drip + 180 kg N ha^{-1}	29.70	23.28	26.49	5.61	9.39	7.50	36.78	34.03	35.41
I5N1- Furrow irrigation + 90 kg N ha^{-1}	13.61	15.82	14.72	4.97	6.48	5.72	19.35	23.23	21.29
I5N2- Furrow irrigation + 120 kg N ha^{-1}	10.37	18.57	14.47	3.92	8.08	6.00	14.88	27.76	21.32
I5N3- Furrow irrigation + 150 kg N ha^{-1}	10.08	18.93	14.50	6.70	8.82	7.76	17.48	28.91	23.19
I5N4- Furrow irrigation + 180 kg N ha^{-1}	12.29	19.45	15.87	7.66	9.02	8.34	20.78	29.66	25.22
SE (m) + Factor (B) at the same level of A	1.26	1.33	0.87	0.82	0.15	0.38	0.74	0.49	0.39
CD at 5% Factor (B) at the same level of A	2.92	2.87	NS	1.46	NS	0.91	3.23	2.01	1.15
SE (m) + Factor (A) at the same level of B	1.04	1.42	0.78	0.57	0.29	0.32	1.01	0.63	0.38
CD at 5% Factor (A) at the same level of B	3.18	3.07	NS	1.80	NS	0.99	3.01	1.89	1.16

Conclusion

The following conclusion were presented based on this study, the yield parameters like maximum number of tubers plant^{-1}, weight of tubers plant^{-1}, marketable tuber yield (kg plot^{-1}) and total tuber yield (t ha^{-1}) were observed higher under treatment I_4N_4 (150% CPE with drip + 180 kg N ha^{-1}) as comparison to other treatments. So, this combination of drip irrigation and nitrogen doses were performed better yield and its attributes.

References

1. Abdelshafy AA, Abd El-Latif KhM, Abdelhalim AKH. Irrigation scheduling of potato using Class A pan under drip and surface irrigation systems. Alexandria Journal of Soil and Water Sciences. 2021;5(1):1-9.
2. Bose US, Bisen A, Nayak S. Effect of different levels of nitrogen and potassium on growth and yield of potato (*Solanum tuberosum* L.). Green Farming. 2008;2(1):16-17.
3. Badr MA, Taalab AS, El-Tohamy WA. Nitrogen application rate and fertigation frequency for drip-irrigated potato (*Solanum tuberosum*). Australian Journal of Basic and Applied Sciences. 2011;5(7):817-825.
4. Bisht P, Manoj R, Singh VK. Effect of different irrigation schedules on the growth and yield of drip irrigated potato. Potato Journal. 2012;39(2):202-204.
5. Bhardwaj LP, Sharma PK, Shukla N, Das GK, Chandrakar DK, Sahu DK, *et al*. Effect of water stress and different varieties/hybrids of potato (*Solanum tuberosum* L.) on yield and its attributes under Chhattisgarh plain. The Pharma Innovation Journal. 2022;11(8):725-731.
6. Chawla AK, Singh KG, Singh A. Effect of mulch and drip irrigation on soil hydrothermal regime and potato yield (*Solanum tuberosum* L.). Journal of Research Punjab Agricultural University. 2009;46(1&2):66-71.
7. Dhaliwal MS. Handbook of Vegetable Crops. New Delhi: Kalyani Publishers; 2007. ISBN: 978-93-272-2553-2.
8. Devi S, Sharma PK, Trivedi J, Shrivastava LK, Agrawal S, Gupta P, *et al*. Effect of NPK fertilizer on quality parameters of potato (*Solanum tuberosum* L.). The Pharma Innovation Journal. 2023;12(3):5028-5032.
9. El-Ghamriny EA, Saeed MNA. Effect of irrigation intervals, mineral fertilizers and biofertilizers on potato plants grown under sandy soil conditions. Egypt J Appl Sci. 2007;22:480-511.
10. El Mokh F, Nagaz K, Masmoudi MM, Mechlia NB. Yield and water productivity of drip-irrigated potato under different nitrogen levels and irrigation regime with saline water in arid Tunisia. American Journal of Plant Sciences. 2015;6:501-510.
11. Fandika IR, Kemp PD, Millner JP, Horne D, Roskruge N. Irrigation and nitrogen effects on tuber yield and water use efficiency of heritage and modern potato cultivars. Agricultural Water Management. 2016;170:148-157.
12. Foti S, Mauromicale G, Ierna A. Influence of irrigation regimes on growth and yield of potato cv. Spunta. Potato Research. 1995;38:307-318.
13. Gameh MA, Abd Alla MMA, Aboul-Nasr MH. Improving water use efficiency in the New Valley. J Agric Sci Mansoura Univ. 2000;25(1):541-554.
14. Guler S. Effects of nitrogen on yield and chlorophyll of potato (*Solanum tuberosum* L.) cultivars. Bangladesh J Bot. 2009;38(2):163-169.
15. Gu Z, Qi Z, Burghate R, Yuan S, Jiao X, Xu JJ. Irrigation scheduling approaches and applications: a review. Journal of Irrigation and Drainage Engineering. 2020;146(6):04020007.
16. Janani P, Kumar M, Das B, Sailo N, Challam C. Response of potato (*Solanum tuberosum* L.) varieties to different levels of nitrogen under agroclimatic conditions of Meghalaya. Indian Journal of Ecology. 2022;49(6):2184-2188.
17. Kumar V, Singh N, Malik YS, Bhatia AK, Nehra BK. Effect of nitrogen and crop duration on bulking behaviour of potato cv. Kufri Sutlej. Haryana Journal of Horticultural Sciences. 2002;31(3-4):259-261.
18. Kumar S, Mandal G, Asrey R, Singh R. Influence of irrigation and fertigation on yield, production efficiency and economic returns of drip irrigated potato under semi-arid environment. Potato Journal. 2006;33(3-4):126-130.
19. Maan D, Bhatia AK, Duhan A. Response of nitrogen rates and irrigation methods on nutrients uptake, nitrogen and water use efficiency on potato. International Journal of Current Microbiology and Applied Sciences. 2018;7(11):1969-1976.
20. Mankotia S, Sharma SK. Effect of micro-irrigation and nutrient management on yield and quality of potato in acid Alfisol of Himachal Pradesh. Indian Journal of Ecology. 2022;49(5):1732-1735.
21. Nagaz K, Toumi I, Masmoudi MM, Mechlia NB. Comparative effects of drip and furrow irrigation with saline water on the yield and water use efficiency of potato (*Solanum tuberosum* L.) in arid conditions of Tunisia. Agricultural Journal. 2008;3(4):272-277.
22. Patel N, Rajput TBS, Singh M. Effect of drip irrigation and nitrogen fertigation on growth, yield, water use efficiency and nutrient uptake of potato. International Journal of Agricultural Sciences. 2020;12(2):45-51.
23. Parganiha S, Sharma PK, Yadav V, Samadhiya VK, Parganiha S. Effect of NPK on growth, yield and quality of potato (*Solanum tuberosum* L.) under Chhattisgarh plain. The Pharma Innovation Journal. 2022;11(8):2214-2217.
24. Ravikant, Chadha S. Effect of planting season and fertility regimes on different potato cultivars. Potato Journal. 2009;36(1-2):68-71.
25. Rangare SB, Sharma PK, Trivedi J, Rangare NR. Effect of different irrigation regimes and genotypes on growth and yield of potato (*Solanum tuberosum* L.) under Chhattisgarh plain. The Pharma Innovation Journal. 2021;10(6):530-533.
26. Sasani GV, Patel CK, Patel RN, Patel NH, Patel SH. Efficient use of water and fertilizers through drip fertigation in potato. Potato Journal. 2006;33(3-4):131-133.
27. Sandhu AS, Sharma SP, Bhutani RD, Khurana SC. Potato (*Solanum tuberosum* L.) tuber yield as affected by planting times and fertilizer doses under sandy loam soils. Indian Journal of Agricultural Research. 2013;47(6):496-502.
28. Sharma V, Sharma IP, Spehia RS, Kumar P. Influence of irrigation methods and fertilizer levels on

productivity of potato (*Solanum tuberosum* L). Indian Journal of Agricultural Science. 2012;82(2):117-121.
29. Singh SP, Sadawarti MJ, Sharma SK, Singh RK, Rawal S, Kumar M, *et al*. Effect of irrigation methods and nutrient management practices on production and economics of potato under different preceding crop sequences in central India. Potato Journal. 2024;51(1):49-56.
30. Wang FX, Wu XX, Shock CC, Chu LY, Gu XX, Xue X. Effect of drip irrigation regimes on potato tuber yield and quality under plastic mulch in arid northwestern China. Field Crops Research. 2011;122:78-88.
31. Zelalem A, Tekalign T, Nigussie D. Response of potato (*Solanum tuberosum* L.) to different rates of nitrogen and phosphorus fertilization on vertisols at Debre Berhan, in the central highlands of Ethiopia. African Journal of Plant Science. 2009;3(2):16-24.
32. Badr N, Fawzy M, Al-Qahtani KM. Phytoremediation: An ecological solution to heavy-metal-polluted soil and evaluation of plant removal ability. World Applied Sciences Journal. 2012 Jun 6;16(9):1292-301.