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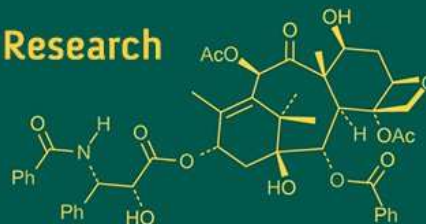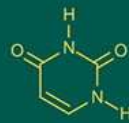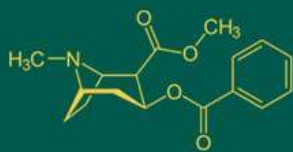
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To study on the economics of red skinned and heat tolerant hybrids of potato

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Abstract
The research work entitled "To study on the economics of red skinned and heat tolerant hybrids of potato" was carried out at Research cum Demonstration Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur. The research material consisted of sixteen genotypes of potato. The seed tubers of the genotypes were taken from the "All India Co-ordinated Research Project on Potato, Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.)". In Exp I, Pooled data revealed that the maximum gross returns (551460 Rs/ha) was obtained in P-45 followed by Kufri Khyati (530460 Rs/ha) and Kufri Lima (524440 Rs/ha). Similarly, in Exp II, maximum gross returns (658140 Rs/ha) was obtained in Kufri Khyati followed by Kufri Lima (623700 Rs/ha) and P-48 (620200 Rs/ha). In Exp I, the maximum net returns (454159.23 Rs/ha) was obtained in P-45 followed by Kufri Khyati (433159.23 Rs/ha) and Kufri Lima (427139.23 Rs/ha). While, in Exp II, The maximum net returns (560839.23 Rs/ha) was obtained in Kufri Khyati followed by Kufri Lima (526399.23 Rs ha⁻¹) and P-48 (522899.23 Rs/ha). The maximum b:c ratio (4.67) was obtained in P-45 followed by Kufri Khyati (4.45) and Kufri Lima (4.39) in Exp I. Moreover, in Exp II, maximum B:C ratio (5.76) was obtained in Kufri Khyati followed by Kufri Lima (5.10 and 5.41) and P-48 (5.37).

Keywords: Economics, red skinned, heat tolerant hybrids, potato

Introduction

Potato (*Solanum tuberosum* L.) is an important vegetable and starchy tuber belongs to the family Solanaceae which is native of the South America. It is domesticated in the area of present day Southern Peru. It is an auto-tetraploid species ($2n = 4x = 48$). It is a nutritious vegetable containing 16% carbohydrates, 2% proteins, 1% minerals, 0.6% dietary fiber and a negligible amount of fat (Gumul *et al*., 2011) [6]. In India leading potato producing states are Uttar Pradesh, West Bengal, Bihar, Gujarat, Madhya Pradesh, Punjab, Assam, Haryana, Jharkhand and Chhattisgarh. India produced 48529 thousand MT from 2151 thousand hectare with an average yield of 21.51 MT/ha (Anon, 2019) [2]. Total area under potato cultivation in Chhattisgarh is 42750 hectare with the production of 614056 MT with productivity of 15.02 MT/ha during 2020-21 (Anon, 2021) [3]. Potato color, size and shape are crucial quality aspects for consumers in buying vegetables. In India, mostly white/yellow skinned potatoes are preferred by consumers, however traditionally red skin potatoes have been in demand in eastern India (Kang and Birhman, 1993) [7] and are now being preferred in North-western and West-central plains as well (Luthra *et al.,* 2003) [9]. Red and purple potatoes are in addition contained acylated anthocyanins and pigmented potatoes display two to three times higher antioxidant potential in comparison with white-flesh potato. Red potato tubers contain glycosides of pelargonidin and peonidin, purple potatoes glycosides of malvidin and petunidin. The growth and development of potato tuber plant significantly affected by environmental temperature at all stages (sprout development, vegetative growth, tuber initiation, tuber bulking and maturation). As earth's temperature is increasing continuously due to global warming, this has undesirable impact on potato production. The ideal night temperature for tuber formation is 17 °C and night temperature beyond 22 °C reduces the tuber yield drastically. Nevertheless, temperatures ≥ 28 °C may partly or entirely suppress the stolon formation (Struik *et al.,* 1989) [10].

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Under high-temperature conditions, tuberization is significantly inhibited and photo assimilate partitioning to tubers is greatly reduced (Lafta and Lorenzen, 1995) [8]. Tuber quality is also affected by high temperatures and some physiological disorders of potato are closely associated with heat stress and hot, dry weather (Ahmadi *et al.,* 1960) [1]. The adoption and cultivation of heat tolerant potato varieties are most feasible approaches to cope with global warming. (Frusciante *et al.,* 1999) [5]. Heat tolerance is by far the least important trait in adopted varieties, as just a few varieties present in India have heat tolerance (Willy *et al.,* 2019) [11].

Materials and Methods
The research work was carried out at Research cum Demonstration Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur; where adequate facilities for various required and necessary operations were easily available for necessary operation. The experiment was laid out in Randomized Block Design with three replications. The research material consisted of sixteen genotypes of potato. The seed tubers of the genotypes were taken from the "All India Co-ordinated Research Project on Potato, Department of Vegetable Science, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.)". The details of genotypes used in experiment are listed in Table 1.

Table 1: List of genotypes used in experiment

S. No.	Genotypes	S.No.	Genotypes
1.	AICRP- C-16	9.	AICRP-P-46
2.	AICRP-C-17 *	10.	AICRP-P-53
3.	AICRP-C-6 *	11.	AICRP-C-28 *
4.	AICRP-P-48	12.	AICRP-C-20 *
5.	AICRP-P-78	13.	AICRP-C-14*
6.	AICRP-P-75	14.	AICRP-C-15 *
7.	AICRP-P-42	15.	AICRP-P-1*
8.	AICRP-P-45	16.	AICRP-RH-2*

*AICRP-C-17(Kufri Pukhraj), AICRP-C-6(Kufri Bahar), AICRP-C-28(Kufri Lima), AICRP-C-20(Kufri Surya), AICRP-C-14(Kufri Khyati), AICRP-C-15(Kufri Lalima), AICRP-P-1(Kufri Mohan), AICRP-RH-2(Kufri Lalit)

The schedules of different pre and post-sowing cultural operations carried out timely during the crop season. The economic analysis *viz.,* gross profit, net profit and b:c ratio were calculated.

Results
The economics of potato cultivation under the present investigation were calculated using the prevailing cost of inputs and market rate of the produce during the respective years are shown in Exp-I and Exp-II in Table 2 to 7.

Gross return (Rs ha⁻¹)
In Exp I, the maximum gross returns (567140.00 Rs ha⁻¹) was obtained in P-45 followed by Kufri Lima (483840.00 Rs ha⁻¹) and C-6 (481460.00 Rs ha⁻¹) during the first year. In second year, the maximum gross returns (584920.00 Rs ha⁻¹) was obtained in Kufri Khyati followed by Kufri Lima (564900.00 Rs ha⁻¹) and P-48 (548520.00 Rs ha⁻¹). Pooled data revealed that the maximum gross returns (551460.00 Rs ha⁻¹) was obtained in P-45 followed by Kufri Khyati (530460.00 Rs ha⁻¹) and Kufri Lima (524440.00 Rs ha⁻¹). However, minimum gross return was recorded under Kufri Lalit (251860.00 Rs ha⁻¹), P-53 (352240.00 Rs ha⁻¹) and Kufri Lalit (310940.00 Rs ha⁻¹) during the first year, second year and in pooled data, respectively.

In Exp II, the maximum gross returns (651700.00 Rs ha⁻¹) was obtained in Kufri Lima followed by P-48 (650300.00 Rs ha⁻¹) and Kufri Khyati (649740.00 Rs ha⁻¹) during the first year. The maximum gross returns (666400.00 and 658140.00 Rs ha⁻¹) was obtained in Kufri Khyati followed by Kufri Lima (595700.00 and 623700.00 Rs ha⁻¹) and P-48 (590100.00 and 620200.00 Rs ha⁻¹) during the second year and in pooled data, respectively. However, minimum gross return was recorded under Kufri Lalit (292320.00 Rs ha⁻¹), P-53 (392700.00 Rs ha⁻¹) and Kufri Lalit (360780.00 Rs ha⁻¹) during the first year, second year and in pooled data, respectively.

Net return (Rs ha⁻¹)
In Exp I, the maximum net returns (470174.00 Rs ha⁻¹) was obtained in P-45 followed by Kufri Lima (386874.00 Rs ha⁻¹) and C-6 (384494.00 Rs ha⁻¹) during the first year. In second year, the maximum net returns (487284.45 Rs ha⁻¹) was obtained in Kufri Khyati followed by Kufri Lima (467264.45 Rs ha⁻¹) and P-48 (450884.45 Rs ha⁻¹). Pooled data revealed that the maximum net returns (454159.23 Rs ha⁻¹) was obtained in P-45 followed by Kufri Khyati (433159.23 Rs ha⁻¹) and Kufri Lima (427139.23 Rs ha⁻¹). However, minimum net return was recorded under Kufri Lalit (154894.00 Rs ha⁻¹), P-53 (254604.45 Rs ha⁻¹) and Kufri Lalit (213639.23 Rs ha⁻¹) during the first year, second year and in pooled data, respectively.

In Exp II, the maximum net returns (554734.00 Rs ha⁻¹) was obtained in Kufri Lima followed by P-48 (553334.00 Rs ha⁻¹) and Kufri Khyati (552774.00 Rs ha⁻¹) during the first year. The maximum net returns (568764.45 and 560839.23 Rs ha⁻¹) was obtained in Kufri Khyati followed by Kufri Lima (498064.45 and 526399.23 Rs ha⁻¹) and P-48 (492464.45 and 522899.23 Rs ha⁻¹) during the second year and in pooled data, respectively. However, minimum net return was recorded under Kufri Lalit (195354.00 Rs ha⁻¹), P-53 (295964.45 Rs ha⁻¹) and Kufri Lalit (263479.23 Rs ha⁻¹) during the first year, second year and in pooled data, respectively.

B:C Ratio
In Exp I, the maximum b:c ratio (4.85) was obtained in P-45 followed by Kufri Lima (3.99) and C-6 (3.97) during the first year. In second year, the maximum b:c ratio (4.99) was obtained in Kufri Khyati followed by Kufri Lima (4.79) and P-48 (4.62). Pooled data revealed that the maximum b:c ratio (4.67) was obtained in P-45 followed by Kufri Khyati (4.45) and Kufri Lima (4.39). However, minimum net return was recorded under Kufri Lalit (1.60), P-53 (2.61) and Kufri Lalit (2.20) during the first year, second year and in pooled data, respectively.

In Exp II, the maximum b:c ratio (5.72) was obtained in Kufri Lima followed by P-48 (5.71) and Kufri Khyati (5.70) during the first year. The maximum b:c ratio (5.83 and 5.76) was obtained in Kufri Khyati followed by Kufri Lima (5.10 and 5.41) and P-48 (5.04 and 5.37) during the second year and in pooled data, respectively. However, minimum net return was recorded under Kufri Lalit (2.01), P-53 (3.02) and Kufri Lalit (2.71) during the first year, second year and in pooled data, respectively.

Table 2: Evolution of different genotypes of potato on economics (during the year 2020-21) in Exp-I

Genotypes	Yield (t ha⁻¹)	Cost of cultivation (Rs ha⁻¹)			Cost (Rs ha⁻¹)		Sale price (Rs t⁻¹)	Net returns (Rs ha⁻¹)	B:C ratio
		Seed	Fertilizers	Cultivation	Inputs	Produce			
C-16	33.56	40000	9192	47774	96966	469840.00	14000	372874.00	3.85
C-17	33.45	40000	9192	47774	96966	468300.00	14000	371334.00	3.83
C-6	34.39	40000	9192	47774	96966	481460.00	14000	384494.00	3.97
P-48	34.16	40000	9192	47774	96966	478240.00	14000	381274.00	3.93
P-78	27.66	40000	9192	47774	96966	387240.00	14000	290274.00	2.99
P-75	23.42	40000	9192	47774	96966	327880.00	14000	230914.00	2.38
P-42	26.96	40000	9192	47774	96966	377440.00	14000	280474.00	2.89
P-45	40.51	40000	9192	47774	96966	567140.00	14000	470174.00	4.85
P-46	22.41	40000	9192	47774	96966	313740.00	14000	216774.00	2.24
P-53	24.53	40000	9192	47774	96966	343420.00	14000	246454.00	2.54
K.Lima	34.56	40000	9192	47774	96966	483840.00	14000	386874.00	3.99
K.Surya	24.89	40000	9192	47774	96966	348460.00	14000	251494.00	2.59
K.Khyati	33.99	40000	9192	47774	96966	475860.00	14000	378894.00	3.91
K.Lalima	28.49	40000	9192	47774	96966	398860.00	14000	301894.00	3.11
K.Mohan	21.27	40000	9192	47774	96966	297780.00	14000	200814.00	2.07
K.Lalit	17.99	40000	9192	47774	96966	251860.00	14000	154894.00	1.60

Table 3: Evolution of different genotypes of potato on economics (during the year 2021-22) in Exp-I

Genotypes	Yield (t ha⁻¹)	Cost of cultivation (Rs ha⁻¹)			Cost (Rs ha⁻¹)		Sale price (Rs t⁻¹)	Net returns (Rs ha⁻¹)	B:C ratio
		Seed	Fertilizers	Cultivation	Inputs	Produce			
C-16	35.60	40000	9191.55	48444	97635.55	498400.00	14000	400764.45	4.10
C-17	35.12	40000	9191.55	48444	97635.55	491680.00	14000	394044.45	4.04
C-6	36.16	40000	9191.55	48444	97635.55	506240.00	14000	408604.45	4.18
P-48	39.18	40000	9191.55	48444	97635.55	548520.00	14000	450884.45	4.62
P-78	35.10	40000	9191.55	48444	97635.55	491400.00	14000	393764.45	4.03
P-75	27.32	40000	9191.55	48444	97635.55	382480.00	14000	284844.45	2.92
P-42	36.50	40000	9191.55	48444	97635.55	511000.00	14000	413364.45	4.23
P-45	38.26	40000	9191.55	48444	97635.55	535640.00	14000	438004.45	4.49
P-46	27.55	40000	9191.55	48444	97635.55	385700.00	14000	288064.45	2.95
P-53	25.16	40000	9191.55	48444	97635.55	352240.00	14000	254604.45	2.61
K.Lima	40.35	40000	9191.55	48444	97635.55	564900.00	14000	467264.45	4.79
K.Surya	32.45	40000	9191.55	48444	97635.55	454300.00	14000	356664.45	3.65
K.Khyati	41.78	40000	9191.55	48444	97635.55	584920.00	14000	487284.45	4.99
K.Lalima	29.05	40000	9191.55	48444	97635.55	406700.00	14000	309064.45	3.17
K.Mohan	28.36	40000	9191.55	48444	97635.55	397040.00	14000	299404.45	3.07
K.Lalit	26.42	40000	9191.55	48444	97635.55	369880.00	14000	272244.45	2.79

Table 4: Evolution of different genotypes of potato on economics (pooled mean basis) in Exp-I

Genotypes	Yield (t ha⁻¹)	Cost of cultivation (Rs ha⁻¹)			Cost (Rs ha⁻¹)		Sale price (Rs t⁻¹)	Net returns (Rs ha⁻¹)	B:C ratio
		Seed	Fertilizers	Cultivation	Inputs	Produce			
C-16	34.58	40000	9191.775	48109	97300.78	484120.00	14000	386819.23	3.98
C-17	34.29	40000	9191.775	48109	97300.78	480060.00	14000	382759.23	3.93
C-6	35.27	40000	9191.775	48109	97300.78	493780.00	14000	396479.23	4.07
P-48	36.67	40000	9191.775	48109	97300.78	513380.00	14000	416079.23	4.28
P-78	31.38	40000	9191.775	48109	97300.78	439320.00	14000	342019.23	3.52
P-75	25.37	40000	9191.775	48109	97300.78	355180.00	14000	257879.23	2.65
P-42	31.73	40000	9191.775	48109	97300.78	444220.00	14000	346919.23	3.57
P-45	39.39	40000	9191.775	48109	97300.78	551460.00	14000	454159.23	4.67
P-46	24.98	40000	9191.775	48109	97300.78	349720.00	14000	252419.23	2.59
P-53	24.85	40000	9191.775	48109	97300.78	347900.00	14000	250599.23	2.58
K.Lima	37.46	40000	9191.775	48109	97300.78	524440.00	14000	427139.23	4.39
K.Surya	28.67	40000	9191.775	48109	97300.78	401380.00	14000	304079.23	3.13
K.Khyati	37.89	40000	9191.775	48109	97300.78	530460.00	14000	433159.23	4.45
K.Lalima	28.77	40000	9191.775	48109	97300.78	402780.00	14000	305479.23	3.14
K.Mohan	24.82	40000	9191.775	48109	97300.78	347480.00	14000	250179.23	2.57
K.Lalit	22.21	40000	9191.775	48109	97300.78	310940.00	14000	213639.23	2.20

Table 5: Evolution of different genotypes of potato on economics during the year 2020-21) in Exp-II

Genotypes	Yield (t ha⁻¹)	Cost of cultivation (Rs ha⁻¹)			Cost (Rs ha⁻¹)		Sale price (Rs t⁻¹)	Net returns (Rs ha⁻¹)	B:C ratio
		Seed	Fertilizers	Cultivation	Inputs	Produce			
C-16	26.14	40000	9192	47774	96966	365960.00	14000	268994.00	2.77
C-17	45.88	40000	9192	47774	96966	642320.00	14000	545354.00	5.62
C-6	36.47	40000	9192	47774	96966	510580.00	14000	413614.00	4.27
P-48	46.45	40000	9192	47774	96966	650300.00	14000	553334.00	5.71
P-78	42.20	40000	9192	47774	96966	590800.00	14000	493834.00	5.09
P-75	26.50	40000	9192	47774	96966	371000.00	14000	274034.00	2.83
P-42	39.31	40000	9192	47774	96966	550340.00	14000	453374.00	4.68
P-45	46.28	40000	9192	47774	96966	647920.00	14000	550954.00	5.68
P-46	27.05	40000	9192	47774	96966	378700.00	14000	281734.00	2.91
P-53	31.00	40000	9192	47774	96966	434000.00	14000	337034.00	3.48
K.Lima	46.55	40000	9192	47774	96966	651700.00	14000	554734.00	5.72
K.Surya	37.54	40000	9192	47774	96966	525560.00	14000	428594.00	4.42
K.Khyati	46.41	40000	9192	47774	96966	649740.00	14000	552774.00	5.70
K.Lalima	34.57	40000	9192	47774	96966	483980.00	14000	387014.00	3.99
K.Mohan	26.07	40000	9192	47774	96966	364980.00	14000	268014.00	2.76
K.Lalit	20.88	40000	9192	47774	96966	292320.00	14000	195354.00	2.01

Table 6: Evolution of different genotypes of potato on economics (during the year 2021-22) in Exp-II

Genotypes	Yield (t ha⁻¹)	Cost of cultivation (Rs ha⁻¹)			Cost (Rs ha⁻¹)		Sale price (Rs t⁻¹)	Net returns (Rs ha⁻¹)	B:C ratio
		Seed	Fertilizers	Cultivation	Inputs	Produce			
C-16	34.05	40000	9191.55	48444	97635.55	476700.00	14000	379064.45	3.88
C-17	40.06	40000	9191.55	48444	97635.55	560840.00	14000	463204.45	4.74
C-6	38.01	40000	9191.55	48444	97635.55	532140.00	14000	434504.45	4.45
P-48	42.15	40000	9191.55	48444	97635.55	590100.00	14000	492464.45	5.04
P-78	36.74	40000	9191.55	48444	97635.55	514360.00	14000	416724.45	4.27
P-75	34.15	40000	9191.55	48444	97635.55	478100.00	14000	380464.45	3.90
P-42	39.85	40000	9191.55	48444	97635.55	557900.00	14000	460264.45	4.71
P-45	39.65	40000	9191.55	48444	97635.55	555100.00	14000	457464.45	4.69
P-46	29.48	40000	9191.55	48444	97635.55	412720.00	14000	315084.45	3.23
P-53	28.05	40000	9191.55	48444	97635.55	392700.00	14000	295064.45	3.02
K.Lima	42.55	40000	9191.55	48444	97635.55	595700.00	14000	498064.45	5.10
K.Surya	38.93	40000	9191.55	48444	97635.55	545020.00	14000	447384.45	4.58
K.Khyati	47.60	40000	9191.55	48444	97635.55	666400.00	14000	568764.45	5.83
K.Lalima	32.20	40000	9191.55	48444	97635.55	450800.00	14000	353164.45	3.62
K.Mohan	29.86	40000	9191.55	48444	97635.55	418040.00	14000	320404.45	3.28
K.Lalit	30.66	40000	9191.55	48444	97635.55	429240.00	14000	331604.45	3.40

Table 7: Evolution of different genotypes of potato on economics (pooled mean basis) in Exp-II

Genotypes	Yield (t ha⁻¹)	Cost of cultivation (Rs ha⁻¹)			Cost (Rs ha⁻¹)		Sale price (Rs t⁻¹)	Net returns (Rs ha⁻¹)	B:C ratio
		Seed	Fertilizers	Cultivation	Inputs	Produce			
C-16	30.09	40000	9191.775	48109	97300.78	421260.00	14000	323959.23	3.33
C-17	42.97	40000	9191.775	48109	97300.78	601580.00	14000	504279.23	5.18
C-6	37.24	40000	9191.775	48109	97300.78	521360.00	14000	424059.23	4.36
P-48	44.30	40000	9191.775	48109	97300.78	620200.00	14000	522899.23	5.37
P-78	39.47	40000	9191.775	48109	97300.78	552580.00	14000	455279.23	4.68
P-75	30.33	40000	9191.775	48109	97300.78	424620.00	14000	327319.23	3.36
P-42	39.58	40000	9191.775	48109	97300.78	554120.00	14000	456819.23	4.69
P-45	42.97	40000	9191.775	48109	97300.78	601580.00	14000	504279.23	5.18
P-46	28.26	40000	9191.775	48109	97300.78	395640.00	14000	298339.23	3.07
P-53	29.53	40000	9191.775	48109	97300.78	413420.00	14000	316119.23	3.25
K.Lima	44.55	40000	9191.775	48109	97300.78	623700.00	14000	526399.23	5.41
K.Surya	38.24	40000	9191.775	48109	97300.78	535360.00	14000	438059.23	4.50
K.Khyati	47.01	40000	9191.775	48109	97300.78	658140.00	14000	560839.23	5.76
K.Lalima	33.39	40000	9191.775	48109	97300.78	467460.00	14000	370159.23	3.80
K.Mohan	27.97	40000	9191.775	48109	97300.78	391580.00	14000	294279.23	3.02
K.Lalit	25.77	40000	9191.775	48109	97300.78	360780.00	14000	263479.23	2.71

Conclusion

In conclusion, the economic analysis of potato cultivation, as depicted in Exp-I and Exp-II, unveils notable variations in gross returns, net returns, and benefit-cost ratios across different potato varieties. Across both experiments, distinct trends emerge regarding the profitability of potato varieties, with certain varieties consistently outperforming others in terms of gross returns, net returns, and benefit-cost ratios. Notably, varieties such as P-45, Kufri Khyati, and Kufri Lima exhibit superior economic performance, boasting higher gross returns, net returns, and benefit-cost ratios compared to others. Conversely, varieties like Kufri Lalit

and P-53 demonstrate comparatively lower economic viability. These findings underscore the significance of varietal selection in maximizing economic returns in potato cultivation. Moreover, the analysis underscores the importance of considering both gross and net returns, along with benefit-cost ratios, for a comprehensive assessment of the economic feasibility of potato cultivation. Moving forward, informed decision-making regarding varietal selection can significantly enhance the profitability and sustainability of potato farming practices.

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