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Prospects of true potato seed on productivity and profitability of potato cultivation in northern hill zone of Chhattisgarh

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Abstract
The field experiment was conducted at Research-cum-Instructional Farm of Potato & Temperate Fruit' Research Station Mainpat, (Surguja) Chhattisgarh during the *Rabi* season in 2020-21. The experiment was laid out in a Randomized Block Designs (RBD) with 3 replications and 9 treatments. The treatment consists of Eight TPS crosses genotypes and one tuber potato genotype Kufri Pukhraj. The result revealed that the TPS crosses genotype PS 8/97-1 x D-150 (F_1C_1) (T_8) significantly superior performance observed as compare to other tested TPS crosses genotypes and tuber potato genotype with represent to growth attributes, yield attributing characters and economics *viz.*, plant emergence (94.87%), Plant height (78.69 cm), number of shoots plant^{-1} (8.27), number of compound leaves plant^{-1} (64.42), number of tuber plant^{-1} (13.87), fresh weight of tuber plant^{-1} (427.08 g), tuberization efficiency (2.25), tuber yield (24.08 t ha^{-1}), gross returns (₹ 433356 ha^{-1}), net returns (₹ 340967 ha^{-1}), B:C ratio (3.69), economic efficiency (₹ 3247.30 ha^{-1} day^{-1}) and production efficiency (229.29 Kg ha^{-1} day^{-1}). The TPS crosses genotype PS 8/97-1 x D-150 (T_8) and TPS crosses genotype PT/14-01 x D-150 x D-150 (T_7) both are similar to each other but TPS crosses genotype PS 8/97-1 x D-150 (T_8) was most suitable for the northern hill zone of Chhattisgarh.

Keywords: Productivity, profitability, (TPS) crosses genotypes and tuber potato genotype

Introduction
Potato (*Solanum tuberosum* L.) is ones of the world's most important food and vegetable crops in the Solanaceae family. The annual production of potato in the world is greater than all other vegetable crops. Potato has emerged as the 4th most important food crop tin India after Rice, Wheat and Maize. India is the world's second largest potato producer country after China. It is cultivated on an average 2.16 million hectares with a production of 51.30 million tonnes with productivity of 23.75 tonnes ha^{-1} (Anonymous, 2020a) [1]. In Chhattisgarh, on an average potato occupies about 42750 hectares with a production of 614056 tones and a productivity of 14.36 tonnes per hectare. The highest area (6742 ha) and production (93065 tonnes) was recorded in Surguja districts followed by Balrampur, Bilaspur and Raigarh district of Chhattisgarh (Anonymous, 2020b) [2]. Potato is a poor man's food crop and such a crop is very important for countries with higher population density like India. Potato tubers are also rich source of carbohydrates 20.6%, protein 2.1%, fat 0.3%, crude fibre 1.1%, ash 0.9% and they also contains a good amount of vitamin B, C and essential amino acids like leucine, tryptophan and isoleucine (Paul and Naik, 2003) [7].

Potato propagated through both seed tubers and true botanical seed. TPS technology has replaced the use of seed tubers and this method has reduced the production cost of potato cultivation by 25 to 50 percent. TPS would also helpsin expanding potato cultivation into farming areas previously unable to produce potato due to lack of good quality seed tubers. TPS technology may serve as a potential alternative to mitigate the problem of non-availability of quality seeds (Sinha *et al*., 2018) [11]. The true potato seed (TPS) technology has an advantage overt conventional potato seed for minimum transmission of viruses and other pathogens. True potato seed has been found to be tolerant to the most common Late blight (*Phytophthora infestans*) disease. Hence, to maintain a high yield level, recommended potato varieties to time could be supplied through a well-developed & disease-free seed production programme and this is a big advantage as a healthy crop would give up to 30 q ha^{-1} more yields depending upon the extent of infestation of the seed tuber. Potato is a highly weather sensitive crop,

different genotypes respond differently to varying agro-climatic conditions. The performance of any potato genotype is largely dependent on different agro-climatic conditions besides their genetic potential for adaptability.

Materials and Methods

The field experiment was conducted during the *Rabi* season of 2020-21 at Research-cum-Instructional Farm of Potato & Temperate Fruit Research Station, Mainpat, (Surguja) Chhattisgarh. The experimental site is geographically situated at 22.83 'N latitude and 83.31' E longitude and 1085 meters above mean sea level. The soil of the experimental site was sandy clay loam (*Inceptisol*) in texture with acidic in nature and low organic carbon. The soil have available nitrogen is low, available phosphorus and potassium is medium. The experiment was laid out in Randomized Block Design, (RBD) with 3 replications and 9 treatments. The experiment material consisting of Eight TPS crosses genotypes *viz.*, PS 5/41-1 x 15 KPC2+D-150 (F_1C_1) (T_1), KP 15 C2 x PS 8/63-5 (F_1C_1) (T_2), PS 6/ 78-1 x P23-CP2419 (F_1C_1) (T_3), PRT -17 x D-150 (F_1C_1) (T_4), PRT-17 x PS 6/78-4 (F_1C_1) (T_5), PS 6/7-29 x 2015P-17 (F_1C_1) (T_6), PT/14-01 x D-150 x D-150 (F_1C_1) (T_7), PS 8/97-1 x D-150 (F_1C_1) (T_8) and one tuber potato genotype Kufri Pukhraj (T_9) used as check for study. The gross plot size is 4 m x 4 m and net plot size 4 m x 2.4 m. Well sprouted seed tubers are treated with fungicide, tuber of true potato seed (TPS) tuber lets @ 20 q ha^{-1} and tuber potato 25 q ha^{-1} were planted on ridges 60 cm apart with at a distance 15 cm in true potato seed (TPS) tuber lets and 20 cm spacing in tuber potato with the recommended dose of fertilizer 180:100:100, N:P:K kg ha^{-1} respectively.

Result and Discussion

Growth attributes

The growth attributing characters of potato were significantly affected due to TPS crosses genotypes and tuber potato genotype. Among TPS crosses genotype PS 8/97-1 x D -150 (T_8) was recorded on significantly maximum plant emergence per cent (94.87), plant height (78.69 cm), number of shoots plant^{-1} (8.27), number of compound leaves plant^{-1}(64.42) but it was found statically similar with TPS crosses genotype PT/14-01 x D-150 x D-150 (T_7) as compared to other TPS crosses genotypes and tuber potato genotype Kufri Pukhraj (check). But minimum growth attributing characters were recorded with TPS crosses genotype KP 15 C2 x PS 8/63-52 (T_2). TPS crosses genotype PS 8/97-1 x D -150 (T_8) exhibited better plant growth attributes. This may be due to differences in the genetic make-up of genotypes which are expressed in differently under varying agro climatic condition and favorable climatic conditions *i.e.*, soil moisture and better nutrient availability. Similar results were also reported by Jamro *et al*. (2015) [5], Rojoni *et al.* (2014)) [9] and Vishwas *et al.* (2020) [12].

Yield attributes and yield

Yield attributing characters and Yields of potato were significantly influenced by different TPS crosses genotypes and tuber potato genotype. Among the TPS cross genotype PS 8/97-1 x D -150 (T_8) was recorded significantly maximum number of tuber plant^{-1} (13.87), fresh weight of tubers plant^{-1} (427.08 g), tuberization efficiency (2.25) tuber yield (24.08 t ha^{-1}) as compare to other TPS crosses genotypes and tuber potato genotype Kufri Pukhraj (check). On other hand, lowest yield attributing and yield characters were recorded with TPS crosses genotype KP 15 C2 x PS 8/63-5 (T_2). There is significant variation in number of tuber plant^{-1}, fresh weight of tubers plant^{-1} and tuber yield of different TPS crosses and tuber potato genotype. This may be due to the growth habits of the genotype which have also produced higher number of tuber plant^{-1}, fresh weight of tubers plant^{-1}, and tuber yield t ha^{-1} was recorded in TPS crosses genotype PS 8/97-1 x D -150 (T_8). Similar finding was also reported by Nizamuddin *et al.* (2010) [6], Chaurasiya *et al.* (2016) [3], Dash *et al*. (2018) [4] and Vishwas *et al.* (2020) [12].

Economic

The cost of cultivation was similar for all TPS crosses genotypes but there was a significant difference for the tuber potato genotype. The lowest cost of cultivation was recorded under TPS crosses genotypes (₹ 92389 ha^{-1}) as compare to tuber potato genotype (₹ 102389 ha^{-1}). Among the TPS crosses genotype PS 8/97-1 x D -150 (T_8) recorded maximum gross return (₹ 433356 ha^{-1}), net return (₹ 340967 ha^{-1}), B:C ratio (3.69), economic efficiency (₹ 3247.30 ha^{-1} day^{-1}) and production efficiency (229.29 kg ha $^{-1}$ day $^{-1}$) as compare to other (TPS) crosses genotypes and tuber potato genotype Kufri Pukhraj (check) but minimum gross return (₹ 196002 ha^{-1}), net return (₹ 103613 ha^{-1}), B:C ratio (1.12), economic efficiency (₹ 986.79 ha^{-1} day^{-1}) and production efficiency (103.70 kg ha^{-1} day^{-1}) recorded under TPS crosses genotype KP 15 C2 x PS 8/63-5 (T_2). Significantly maximum gross return (₹ ha^{-1}), net profit (₹ ha^{-1}) and B:C ratio, economic efficiency (₹ ha^{-1} day^{-1}) and production efficiency (kg ha $^{-1}$ day $^{-1}$) were recorded under TPS crosses genotype PS 8/97-1 x D -150 (T_8), which might be due to higher tuber yield production potential and a more remunerative price of the potato. Similar trend were found by Roy *et al.* (2009) [10], Sinha *et al.* (2018) [11] and Rathiya *et al* (2020).

Table 1: Growth parameters of potato as affected by different true potato seed (TPS) crosses genotypes and tuber potato genotype

Treatment	Plant emergence (%) at 20 DAP	Plant height (cm)	Number of Shoots plant^{-1}	Number of Compound leaves plant^{-1}
T_1 - PS 5/41-1 x 15 KPC2 + D-150	87.18	48.67	3.90	37.46
T_2 - KP 15 C2 x PS 8/63-5	84.61	41.83	3.23	29.83
T_3 - PS 6/78-1 x P23-CP 2419	89.74	60.22	5.50	42.52
T_4 - PRT -17 x D- 150	87.18	54.37	4.83	37.45
T_5 - PRT - 17 x PS 6/78-4	92.30	68.59	6.97	57.73
T_6 - PS 6/7-29 x 2015P-17	91.02	67.04	6.37	49.25
T_7 - PT/14-01 x D-150 x D-150	93.58	73.16	7.63	59.93
T_8 - PS 8/97-1 x D -150	94.87	78.69	8.27	64.42
T_9 - Kufri Pukhraj (Check)	90.06	64.56	6.30	47.54
S.Em±	1.35	2.05	0.42	1.91
CD (P=0.05%)	4.05	6.14	1.25	5.72

Table 2: Yield attributes, and tuber yield (t ha^{-1}) of potato as affected by different true potato seed (TPS) crosses genotypes and tuber potato genotype

Treatment	Number of tuber plant^{-1}	Fresh Weight of tuber plant^{-1} (g)	Tuberization efficiency (Tuber: Haulm)	Tuber yield t ha^{-1}
T_1 - PS 5/41-1 x 15 KPC2 + D-150	8.90	238.04	1.66	12.35
T_2 - KP 15 C2 x PS 8/63-5	7.57	223.86	1.53	10.89
T_3 - PS 6/78-1 x P23-CP 2419	10.93	283.60	1.86	15.67
T_4 - PRT -17 x D- 150	10.03	257.27	1.73	13.74
T_5 - PRT - 17 x PS 6/78-4	11.90	325.81	2.07	18.12
T_6 - PS 6/7-29 x 2015P-17	11.17	296.35	1.93	16.51
T_7 - PT/14-01 x D-150 x D-150	12.63	373.19	2.10	21.73
T_8 - PS 8/97-1 x D -150	13.87	427.08	2.25	24.08
T_9 - Kufri Pukhraj (Check)	11.13	283.93	1.92	16.49
S.Em±	0.75	6.86	0.02	1.40
CD(P=0.05%)	2.25	20.55	0.05	4.18

Table 3: Economics of potato as affected by different true potato seed (TPS) crosses genotypes and tuber potato genotype

Treatment	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio	Economic efficiency (₹ ha-1 day^{-1})	Production efficiency (kg ha^{-1} day^{-1})
T_1 - PS 5/41-1 x 15 KPC2 + D-150	92389	222228	129839	1.41	1236.56	117.58
T_2 - KP 15 C2 x PS 8/63-5	92389	196002	103613	1.12	986.79	103.70
T_3 - PS 6/78-1 x P23-CP 2419	92389	282069	189680	2.05	1806.48	149.24
T_4 - PRT -17 x D- 150	92389	247260	154871	1.68	1474.96	130.83
T_5 - PRT - 17 x PS 6/78-4	92389	326184	233795	2.53	2226.62	172.58
T_6 - PS 6/7-29 x 2015P-17	92389	297189	204800	2.22	1950.48	157.24
T_7 - PT/14-01 x D-150 x D-150	92389	391122	298733	3.23	2845.08	206.94
T_8 - PS 8/97-1 x D -150	92389	433356	340967	3.69	3247.30	229.29
T_9 - Kufri Pukhraj (Check)	102389	296733	194344	1.90	1850.90	157.00
S.Em±		25117.43	25117.43	0.27	239.21	13.29
CD(P=0.05%)		75301.85	75301.85	0.80	717.16	39.84

Conclusion

From these results it can be concluded that the TPS crosses genotype PS 8/97-1 x D-150 (T_8) is most suitable for the northern hill zone of Chhattisgarh which recorded highest value for growth and yield parameters as well as highest productivity (24.08 t ha^{-1}), maximum net return (340967 ₹ ha^{-1}) and profitability (3.69%) over other tested TPS crosses genotypes and tuber potato genotype.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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