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Evaluation of Performance of Different Varieties of Potato (*Solanum tuberosum* L.) in Bajhang, Nepal

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Abstract

A study to Evaluate the performance of different varieties of potato was conducted in Daulichaur, Bajhang from February to June, 2021. Six commonly grown potato varieties namely Cardinal, Janakdev, Khumal rato-2, Khumal Ujjwol, MS 42.3 and Bajhang local were used for the study. An experiment was conducted in Randomized Complete Block Design (RCBD) with 6 treatments replicating 4 times each. The data on plant height, number of main stems per hill, number of leaves, and canopy diameter were taken at different days after planting (DAP) and the data on number and weight of tubers were taken after harvesting of potato. Data entry and analysis was done in MS-Excel and R-Studio. Significant variation among the varieties in terms of plant height, main stem per hill, canopy diameter and leaves number per plant was observed. Number of stems per hill was found maximum (3.88) and minimum (1.63) on Bajhang local and Janakdev respectively. Plant height is found maximum on Janakdev (42.75 cm) and minimum on Khumal rato-2 (21.45 cm). The maximum (40.90) and minimum (27.55) number of leaves per plant was recorded on Khumal Ujjwol and Cardinal while maximum and minimum canopy diameter was observed on Bajhang local (40.90 cm) and Khumal rato-2 (36.12 cm). Similarly, yield and all the yield attributing parameters was found significant at 5% level of significance. Highest number of tuber per plant was observed on Bajhang local (17.25) and lowest number of tuber per plant was observed on Khumal rato-2 (8.25) in which highest number of marketable size tuber per plant (>25g) was recorded on Khumal Ujjwol (12.05) and lowest number of marketable size tuber per plant (<25g) was recorded on Khumal rato-2 (5.75) but variation among the varieties in case of unmarketable tuber per plant was non-significant. Highest tuber weight per plant (485.50g) and lowest tuber weight per plant (306.25g) was recorded from Khumal Ujjwol and MS 42.3 respectively. The highest tuber yield was recorded from Khumal Ujjwol (40.45 t/ha) and lowest from MS 42.3 (25.52 t/ha)

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Keyword
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Introduction

Nepal is an agricultural country having 65.6 percent population of the country belonging to the farming family (CBS, 2011). Nepal's varied climatic circumstances, both within and among the different ecological zones, have created practically limitless

opportunities for growing a wide varieties of vegetables including potato throughout the year. This would result in increased exports and import substitution, as well as serve as a raw material base for future agro-industries. Furthermore, as the population is increasing geometrically and people become more aware of the nutritional benefits of vegetables, the potential for vegetable production and commercialization in Nepal has grown dramatically.
Potato (*Solanum tuberosum* L.) belongs to the family Solanaceae is the world's number one non-cereal crop that feeds more than a billion people daily (FAO, 2013). Potato ranked as second, third, and fourth position in terms of production, human consumption, and area coverage respectively in the world (FAOSTAT, 2016). Potato is one of the most important vegetables as well as a staple crop in Nepal. It occupies the fifth position in area coverage, second in total production, and first in productivity among the food crops grown in Nepal (ABPSD, 2019/20).

The different varieties of potato mostly cultivated in Nepal are Cardinal, Khumal rato-2, Janakdev, Khumal seto, Desiree, Kufri Jyoti etc. (AICC, 2018). Nepal is one of those countries where potato is used to supplement the normal human diet. The demand for potatoes is increasing as the quality of the potatoes improves, as well as the variety of ways in which they are consumed (Shrestha et al., 2020). In the Terai region, potatoes are used as a complement to vegetables, whereas in the Hill and Mountain regions, they are a staple meal too (Subedi et al., 2019). Therefore, the potato could be a decent option for enhancing the health and nutrition of rural residents. And it is more productive than major cereals and has higher economic value (Ghimire & Dhakal, 2014).

Bajhang is one of those districts in the country having highest potential for potato production which is also declared as the potato zone in 2019. The main occupation of the people of the Bajhang is agriculture. Rice, wheat, finger millet, potato, and barley are the major crops grown here. The total area of potato cultivation in the Bajhang district is 1,063 hectares and total production is 17,155 mt with the productivity of 16.14 tons/hectare (ABPSD, 2019/20).

Materials and Methods

A field experiment was conducted in a farmer's field at Surma Rural Municipality-1, Daulichaur, Bajhang, Nepal from February 2021 to June 2021. The study site is located at 29.69°N latitude and 81.16°E longitude in the sub-humid sub-tropical zone with an elevation of 1,867 masl. Experiment was conducted in a randomized complete block design (RCBD) with six treatments. Each treatment was replicated four times. Altogether there were 24 individual plots. Individual experimental plot area was $3m^2$, having plot-plot spacing 30 cm, block-block spacing 50cm and 20 cm border, thus the total area for research was 109.81 m^2. Six commonly grown varieties of potato viz. Cardinal, Janakdev, Khumal rato-2, Khumal Ujjwol, MS 42.3 and Bajhang local were used. Well decomposed FYM at the rate of 30 ton/ha was thoroughly mixed during field preparation. Recommended dose of fertilizer i.e 40g urea, 65g DAP and 30g MOP per plot was applied. Half dose of urea, full dose of DAP and MOP was applied as basal dose. Split dose of urea was applied on 45 DAP. Hand weeding at 40 DAP and single earthing up was done at 65 DAP. By using furrow method of irrigation, field was irrigated thrice at 45, 60 and 75 DAP. Data on growth parameters were recorded on the field at 45, 60 and 75 DAP. The recorded data entry and analysis were done using MS-Excel and software package R-Studio.

Results and Discussion

Growth Parameter

Number of main stems per hill

The effect of different varieties on number of main stems per hill was significant among the treatment (Table 5). At 45 DAP, maximum number of stems were recorded on Bajhang Local (2.95) and minimum number of stems were recorded on MS 42.3 (1.30). At 60 DAP, maximum number of stems were recorded on Bajhang local (3.80) and minimum number of stems were recorded on Janakdev (1.50). Similarly at 75 DAP, maximum number of stems were recorded on Bajhang local (3.88) and minimum number of stems were recorded on Janakdev (1.63). Quality of tuber used and presence of number of buds on the tuber might be the factors that influence the number of main stems per hill.

Table 1. Number of stems per hill of different potato varieties at different days of observations

Treatments	No of stem per hill		
	45 DAP	60 DAP	75 DAP
Cardinal	1.85^{bc}	2.05^{b}	2.27^{b}
Janakdev	1.45^{c}	1.50^{b}	1.63^{b}
Khumal rato-2	1.70^{bc}	2.00^{b}	2.23^{b}
Khumal ujjwol	2.30^{ab}	3.15^{a}	3.3^{a}
MS 42.3	1.30^{c}	1.70^{b}	1.85^{b}
Bajhang local	2.95^{a}	3.80^{a}	3.88^{a}
SEm (±)	0.106	0.116	0.094
F probability	<0.01	<0.001	<0.001
LSD (=0.05)	0.786**	0.863***	0.6977***
CV, %	27.109	24.21	18.27
Grand mean	1.92	2.36	2.53

Mean followed by common letter(s) within columns are non-significantly different based on DMRT P=0.05, **Significant at 0.01 P level, ***Significant at 0.001 P level, DAP: Days After Planting

Plant height

Significant variation of plant height was observed among different potato varieties at different days of observations (Table 6). At 45 DAP maximum average height of plant was recorded in Janakdev (6.06 cm) and minimum average height of plant was recorded in Khumal rato-2 (3.15 cm) which was at par with MS 42.3 (3.32 cm). At 60 DAP, Janakdev (19.60 cm) was recorded with maximum height and Cardinal (9.55 cm) was recorded with minimum height. At 75 DAP, maximum plant height was recorded in Janakdev (42.75 cm) and that of minimum was recorded in Khumal rato-2 (21.45 cm). Lower temperature during earlier months of growing might be the cause of slower earlier growth of potato (Banjade, 2019). Plant genetics and the quality of plant materials might be the cause for differences in plant height between the varieties (Touria, 2017). These results are similar to those reported by S. Banjade et.al. Janakdev was the variety having highest plant height (Banjade, 2019).

Table 2. Plant height of different potato varieties at different days of observations

Treatments	Plant height (cm)		
	45 DAP	60 DAP	75 DAP
Cardinal	4.05^{bc}	9.55^{d}	23.90^{cd}
Janakdev	6.06^{a}	19.60^{a}	42.75^{a}
Khumal rato-2	3.15^{c}	11.27^{cd}	21.45^{d}
Khumal ujjwol	5.22^{ab}	15.20^{bc}	38.15^{ab}
MS 42.3	3.32^{c}	13.25^{bcd}	27.50^{cd}
Bajhang local	4.25^{bc}	16.20^{ab}	32.30^{bc}
SEm (±)	0.181	0.542	1.125
F probability	<0.01	<0.01	<0.001
LSD (=0.05)	1.337**	4.005**	8.31***
CV, %	20.42	18.74	17.78
Grand mean	4.34	14.17	31.008

Mean followed by common letter(s) within columns are non-significantly different based on DMRT P=0.05, **Significant at 0.01 P level, ***Significant at 0.001 P level, DAP: Days After Planting

Number of leaves per plant

The statistical analysis result shows that the number of leaves per plant is significantly different among the varieties at different days of observations (Table 7). At 45 DAP, maximum number of leaves per plant was recorded on Bajhang local (15.05) and minimum number of leaves per plant was recorded on Khumal rato-2 (8.95). Similar results were observed at 60 DAP where, leaves per plant was recorded maximum on Bajhang local (30.75) which was at par with Khumal Ujjwol (29.50) and minimum on Khumal rato-2 (16.98) which was at par with Janakdev (17.85), MS 42.3 (18.20) and Cardinal (18.70). At 75 DAP, maximum number of leaves per plant was recorded on Khumal Ujjwol (40.90) which was at par with Bajhang local (39.50) and minimum number of leaves per plant was recorded on Cardinal (27.55). Temperature and light intensity may interact to influence the number of leaves that grow. Plant genetic differences among the varieties may be the cause that contributes to the significant differences in number of leaves that grow per plant.

Table 3. Number of leaves of different potato varieties at different days of observations

Treatments	No. of leaves		
	45 DAP	60 DAP	75 DAP
Cardinal	10.90^{b}	18.70^{b}	27.55^{c}
Janakdev	9.70^{b}	17.85^{b}	35.05^{abc}
Khumal rato-2	8.95^{b}	16.98^{b}	30.55^{bc}
Khumal ujjwol	11.85^{ab}	29.50^{a}	40.90^{a}
MS 42.3	10.57^{b}	18.20^{b}	30.97^{bc}
Bajhang local	15.05^{a}	30.75^{a}	39.50^{ab}
SEm (±)	0.435*	1.0009**	1.213*
F probability	<0.05	<0.01	<0.05
LSD (=0.05)	3.213	7.390	8.958
CV, %	19.08	22.29	17.43
Grand mean	11.17	21.99	34.08

Mean followed by common letter(s) within columns are non-significantly different based on DMRT P=0.05, **Significant at 0.01 P level, ***Significant at 0.001 P level, DAP: Days After Planting

Canopy diameter

Significant variation for canopy diameter was observed among potato varieties (Table 8). From the combined analysis of variance, at 45 DAP maximum canopy diameter was recorded from Janakdev (18.65 cm) and minimum canopy diameter was recorded from MS 42.3 (7.15 cm). At 60 DAP, widest canopy diameter was recorded on Khumal Ujjwol (32.40 cm) and narrowest canopy diameter was recorded on MS 42.3 (23.37 cm) which was at par with Khumal rato-2 (23.52 cm). Similarly, at 75 DAP, maximum canopy diameter was observed from Bajhang local (47.90 cm) which was at par with Khumal Ujjwol (47.65 cm) and Janakdev (45.20 cm) and minimum canopy diameter was observed from Khumal rato-2 (36.12 cm) which was at par with MS 42.3 (37.32 cm). Leaf area index (LAI) of the plants determines rates of energy and material exchange between plant canopies and the atmosphere (Vose et al., 1994). Genetic factors as well as environmental factors could be the causes of difference in canopy diameter among the varieties.

Table 4. Canopy diameter (cm) of different Potato varieties at different days of observations

Treatments	Canopy diameter (cm)		
	45 DAP	60 DAP	75 DAP
Cardinal	11.15^{bc}	29.80^{a}	42.25^{ab}
Janakdev	18.65^{a}	31.30^{a}	45.20^{ab}
Khumal rato-2	8.77^{cd}	23.52^{b}	36.12^{b}
Khumal ujjwol	14.52^{b}	32.40^{a}	47.65^{a}
MS 42.3	7.15^{d}	23.37^{b}	37.32^{b}
Bajhang local	13.85^{b}	30.55^{a}	47.90^{a}
SEm (±)	0.504	0.410	1.203
F probability	<0.001	<0.001	<0.05
LSD (=0.05)	3.72***	3.034***	8.88*
CV, %	20.008	7.066	13.79
Grand mean	12.35	28.49	42.74

Mean followed by common letter(s) within columns are non-significantly different based on DMRT P=0.05, **Significant at 0.01 P level, ***Significant at 0.001 P level, DAP: Days After Planting

Yield and yield attributing parameter

Number of tubers per plant by grade basis

The analysis of variance for the average number of tubers per plant shows varieties to be significantly different for both marketable tuber and unmarketable tuber (Table 9). Highest number of marketable size tuber (>25g) was recorded from Khumal Ujjwol (12.05) which was at par with Bajhang local (11.70) and lowest number of marketable size tuber (>25g) was recorded from Khumal rato-2 (5.75) which was at par with Janakdev (6.05). On the other hand, highest number of unmarketable size tuber (<25g) was recorded from Bajhang local (5.55) and lowest number of unmarketable size tuber (<25g) was recorded from both Cardinal and Khumal rato-2(2.5). These differences in the numbers of tubers of different grades among varieties could be related to the variety's tolerance to the trial site's climatic circumstances, its genetics, or the quality of the potato seed (Touria, 2017).

Table 5. Number of tubers per plant by grade basis of different potato varieties

Treatments	Number of tubers per plant	
	MTN (>25g)	UMTN (<25g)
Cardinal	8.40[b]	2.5[b]
Janakdev	6.05[c]	3.8[ab]
Khumal rato-2	5.75[c]	2.5[b]
Khumal ujjwol	12.05[a]	4.3[ab]
MS 42.3	8.50[b]	3.7[ab]
Bajhang local	11.70[a]	5.55[a]
SEm (±)	0.234	0.305
F probability	<0.001	<0.1
LSD (=0.05)	1.73***	2.25[NS]
CV, %	13.15	40.21
Grand mean	8.74	3.72

Mean followed by common letter(s) within columns are non-significantly different based on DMRT P=0.05, **Significant at 0.01 P level, ***Significant at 0.001 P level, MTN: marketable tuber number, UMTN; unmarketable tuber number

Tuber weight per plant by grade basis

The effect of potato varieties on tuber weight by grade basis is presented (Table 10). There was significant effect of varieties on marketable and unmarketable tuber weight per plant was observed. Highest weight of marketable size tuber (>25g) was recorded from Khumal Ujjwol (443g) and lowest weight of marketable size tuber (>25g) was recorded from MS 42.3 (281.75g). And, highest weight of unmarketable size tuber (<25g) was recorded from Bajhang local (52.25g) and lowest weight of unmarketable size tuber (<25g) was recorded from Khumal rato-2 (21.25g) which was at par with Cardinal and MS 42.3 (24.5g) and Janakdev (25.75g).

Table 6. Tuber weight per plant (g) by grade basis of different potato varieties

Treatments	Tuber weight per plant (g)	
	MTW (>25g)	UMTW (<25g)
Cardinal	384.25[ab]	24.50[b]
Janakdev	347.25[bc]	25.75[b]
Khumal rato-2	384.50[ab]	21.25[b]
Khumal ujjwol	443.00[a]	42.50[a]
MS 42.3	281.75[c]	24.50[b]
Bajhang local	405.00[ab]	52.25[a]
SEm (±)	10.291	1.893
F probability	<0.01	<0.01
LSD (=0.05)	75.98**	13.97**
CV, %	13.47	29.17
Grand mean	374.29	31.79

Mean followed by common letter(s) within columns are non-significantly different based on DMRT P=0.05, **Significant at 0.01 P level, ***Significant at 0.001 P level, MTN: marketable tuber number, UMTN; unmarketable tuber number

Number and weight of tuber per plant

The analysis of variance for number and weight of tuber per plant shows varieties to be significantly different (Table 11). The highest number of tuber per plant was observed on Bajhang local (17.25) and lowest number of tuber per plant was observed on Khumal rato-2 (8.25). The highest tuber weight per plant (485.50g) was recorded from Khumal Ujjwol and lowest tuber weight per plant (306.25g) was recorded from MS 42.3.

Table 7. Number of tuber and weight of tuber per plant of different potato varieties

Treatments	Number and Weight of tuber	
	Number of tubers per plant	Weight of tubers per plant (g)
Cardinal	10.9^{b}	408.75^{ab}
Janakdev	8.35^{c}	373.00^{bc}
Khumal rato-2	8.25^{c}	405.75^{ab}
Khumal ujjwol	16.35^{a}	485.50^{a}
MS 42.3	12.20^{b}	306.25^{c}
Bajhang local	17.25^{a}	457.25^{a}
SEm (±)	0.332	10.17
F probability	<0.001	<0.01
LSD (=0.05)	2.45***	75.09**
CV, %	13.34	12.27
Grand mean	12.21	406.08

Mean followed by common letter(s) within columns are non-significantly different based on DMRT P=0.05, **Significant at 0.01 P level, ***Significant at 0.001 P level

Tuber yield (t/ha)

The effect of different potato varieties on tuber yield (t/ha) was found to be significant. The highest tuber yield was recorded from Khumal Ujjwol (40.45 t/ha) which was statistically similar with Bajhang local (38.10 t/ha) and lowest tuber yield was recorded from MS 42.3 (25.52 t/ha). The tuber yield is affected by environmental factors such as soil temperature, moisture, light intensity, fertilizer delivery, and disease and pest control (Struik & Wiersema, 1999).

Differences in yield among varieties might be genetically determined, the quality of potato seed, or the variety's adaptive responses to the experimental site's climatic conditions were also might be the factors for this result. Higher yield in the local cultivar; Bajhang local is consistent with (Khatri, 2004) and (Shrestha et al., 2020)'s findings.

Table 8. Yield (t/ha) of different potato varieties

Treatments	Yield (t/ha)
Cardinal	34.06[ab]
Janakdev	31.08[bc]
Khumal rato-2	33.81[ab]
Khumal ujjwol	40.45[a]
MS 42.3	25.52[c]
Bajhang local	38.10[a]
SEm (±)	0.847
F probability	<0.01
LSD (=0.05)	6.25**
CV, %	12.27
Grand mean	33.84

Conclusions

According to the study's findings, some varieties, such as Khumal Ujjwol and Bajhang local, have great yield potential in the agro-climatic conditions of Nepal's western hills. Potato yields can be improved by cultivating either of these varieties.

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