Original Research Article

Performance Evaluation of Nutrient Dense Potato Genotypes ~~in~~ at High Hills of Karnali Province, Nepal

ABSTRACT

~~On-station varietal trial on nutrient dense potato genotypes~~The trial was carried out to identify suitable potato genotypes for high hills of Karnali province of Nepal. The genotypes were received from International Potato Centre (CIP), Lima, Peru through National Potato Research Program (NPRP) and ~~were~~ evaluated for two consecutive years 2017 and 2018 at Horticulture Research Station (HRS), Rajikot, Jumla, Nepal (2396 masl). Nine nutrient dense potato genotypes with two checks i.e. Desiree and Jumli Local in on-station trial were tested in Randomized Complete Block Design (RCBD) with three replications. ~~Each treatment was replicated three times.~~ Fertilizer was used at the rate of 100:100:60 kg NPK/ha and 20 t/ha compost. Well sprouted tubers of 25-50 g were planted with 60cm x 25cm spacing. The effects of different genotypes were recorded for both vegetative as well as yield parameters. There is ~~ested~~ ~~genotypes differed~~ a significant~~ly~~ differences among tested genotypes for vegetative (emergence percentage at 30 days after planting & 45 days after planting, uniformity, ground coverage, plant height, number of main stems) as well as yield parameters (total number of tubers and tuber yield per ha). The highest tuber yield (46.93 t/ha) was recorded from genotype T 304351.109 followed by genotype T 304368.46 (41.46 t/ha) and genotype T 302498.7 (32.69 t/ha) among the nutrient dense potato genotypes. Similarly, late blight scoring was minimum (score 1) in all these three genotypes. The results of both years showed that potato genotypes T 304351.109, T 304368.46 and T 302498.7 are promising for cultivation in high hills of Karnali province to combat the malnutrition as well as ensure nutritional security.

Key words: *Genotypes, On-station Trial, Parameters, Yield*

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important crops in Nepal. It is utilized as a major vegetable in Terai and mid- hills and used as a vegetable and staple food in high hills. In the year 2021/22 area under potato in Nepal was reported 198,788 ha and total production 33,25,231 ton with an average productivity of 16.73 t/ha which were higher than the data recorded in previous fiscal year (area: 1,88,098 ha, production: 31,31,830 tons, productivity: 16.65 t/ha [1]. It occupies the fifth position in area coverage, second in total production and first in productivity among the food crops grown in Nepal [2]. Out of the total area under potato, around 20% is in the high hills and mountains, 41.5% in the mid-hills and 38.5% in Terai [3].

Potato plays an important role in food security and livelihood due to its high cash, food and nutritive value [4]. It is grown in entire ecological region of Nepal ranging from terai to mountainous regions including Karnali zone [5, 6]. Seed potato productivity is declining in high hills and mountains of Nepal which is considered as key constraint to potato production [7].

The several factors reducing productivity could be due to loss of valuable local genotypes; lack of improved cultivation practices; weed infestation causing potato crop loss, inadequate supply of quality seed; occurrence of pest and disease especially late blight causing damage up to USD 13.5 billion per annum in developing countries [5] and low soil and nutrient management practices. Majority of farmers still use local genotypes that indicate very low seed replacement rates. The existing varieties are low yielding and highly prone to incidence of disease especially late blight and viruses as well as insect/pest.

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Till date only eleven varieties have been released along with the improved production technology which is small in number. This clarifies that there is still need for the development of new potato varieties. There is always a demand of high yielding varieties which are resistant of diseases and insect pests and even perform in the drought and dry condition too [8]. Apart to the high yielding varieties, area specific varieties and quality planting material is the other most important part for the successful cultivation of the crop. There are other more promising high yielding varieties which can be promoted for growing in the large area which have shown better yield as compared to the farmer's local ones. It is necessary to strengthen formal seed system to enhance access of quality potato seeds and needs a regular training and exposure visits to improve the adaptation of improved potato varieties in Nepal [9]. Due to the unavailability of the planting material and lack of effective ~~diffusion~~distribution mechanisms of the developed technologies, they are still within the research station and a small command area of the station [10]. Apart from the released varieties there are other most promising genotypes where there is a need for continuation of the research activities under guidance of NPRP, Khumaltar. Therefore, this study was conducted at HRS, Rajikot, Jumla with an objective to identify the high yielding genotype for the high hills condition of Karnali Province of Nepal.

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2. MATERIALS AND METHODS

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On-station trial was conducted at Horticulture Research Station (HRS), Rajikot, Jumla. The ~~E~~experimental area is situated at 29°16'50"N to 29°12'20"N and 82°12'20"E to 82°12'40"E with the altitude of 2398 meters above mean sea level. Its climate is a temperate. March-April is the main planting season of potato in Jumla. Soil is sandy loam in nature. Maximum & minimum average ~~temperature of growing season in 2017 were~~temperature of growing season in 2017 was 20^0C to 27^0C and 3^0C to 17^0C. Total rainfall during this year was 591mm [11]. Similarly, during 2018 maximum & minimum average temperature were 21^0C to 25^0C and 4^0C to 16^0C and total rainfall was 692mm [12].

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Nine different nutrient dense potato genotypes (T 302498.7, T 303381.3, T 304347.6,T 304351.109, T 304366.46, T 304368.46, T 391058.175, T 393371.58 and T 304405.47) were introduced from International Potato Centre (CIP), Lima, Peru through National Potato Research Program (NPRP) to Horticultural Research Station (HRS), Rajikot, Jumla and tested as on-station trial at the station during 2017 and 2018. Desiree and Jumli local were used as check for on-station trial. The experimental plot size was 5.4 m^2 (3m x 1.8m). The plots were fertilized with 100:100:60 kg NPK/ha and 20 t/ha compost.

Well sprouted tubers of 25-50 g were planted with 60cm x 25cm spacing. The experiment was designed as RCBD with three replications. Planting and harvesting were done on the 3rd week of March and 3rd week of September respectively. All the management practices were followed as per the NPRP recommendation. Observation on ground coverage was recorded as percentage covered by plant canopy in each plot at six weeks after planting. Late blight scoring was done in 1-9 scale where 1 was considered as no infection of disease (resistant) and 9 was given when the disease was observed up to stems i.e. highly susceptible. Similarly plant uniformity was observed in 1-5 scale, where 5 was given to almost uniform plats. The number of tubers and total yield was recorded from experimental plot and converted as per hectare. The data for growth, yield and yield parameters were recorded and analyzed by using Genstat (15th edition).

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3. RESULTS

3.1 Vegetative Parameters

Among different parameters recorded, vegetative as well as yield and yield attributing parameters were found significant among each other whereas emergence at 45 Days After Planting (DAP) during 2017, number of main stems/plant during 2018, insect damage during 2018 were found non-significant. Emergence at 30 DAP was found highly significant. Maximum emergence percentage (72.78 %) was observed in genotype T 304351.109 which was followed by Desiree (66.67 %), T 304368.46 (65.56 %) and Jumli Local (58.89 %) whereas the lowest (23.89 %) was recorded in genotype T 302498.7 that was followed by T 391058.175 (32.78 %). AT 45 DAP, genotype T 304368.46 showed the maximum (98.89 %) emergence followed by Desiree (98.33%), T 304351.109 (97.22%) and T 302498.7 (97.22%) whereas the lowest (81.11%) was observed in T 304347.6 (Table 1). The plant height was found significant among tested genotypes. The plant height was found highest (79.67 cm) in genotype T 303381.3 which was followed by genotypes T 304405.47 (79.5 cm), T 304351.109 (75.93 cm) whereas it was recorded minimum (40.2 cm) in check variety Desiree followed by Jumli Local (50.7 cm). The highest number of main stems per plant (5.13) were observed in genotype T 304351.109 followed by T 391058.175 (4.55) and T 304347.6 (4.17), whereas the lowest (2.91) was recorded in Jumli Local and Desiree (3.5) (Table 2).

Table 1: Effect of different potato genotypes on emergence (%) at 30 and 45 days after planting in On-Station Varietal Trial at Horticulture Research Station, Rajikot, Jumla during 2017 and 2018

SN	Genotypes	Emergence % at 30 DAP			Emergence % at 45DAP		
		2017	2018	Average	2017	2018	Average
1	T 302498.7	5.56 d	42.22 bc	23.89 e	95.56	98.89 a	97.22 a
2	T 303381.3	51.11 abc	51.11 b	51.11 bcd	96.67	76.67 bc	86.67 bc
3	T 304347.6	74.44 a	25.56 c	50 bcd	97.78	64.44 c	81.11 c
4	T 304351.109	58.89 abc	86.67 a	72.78 a	95.56	98.89 a	97.22 a
5	T 304366.46	53.33 abc	58.89 b	56.11 abc	95.56	92.22 ab	92.89 ab
6	T 304368.46	64.44 abc	66.67 ab	65.56 abc	100	97.78 a	98.89 a
7	T 391058.175	43.33 bc	22.22 c	32.78 de	96.67	83.33 ab	90 abc
8	T 393371.58	37.78 c	52.22 b	45 cd	95.56	94.44 ab	95 ab
9	T 304405.47	62.22 abc	52.22 b	57.22 abc	94.44	85.56 ab	90 abc
10	Jumli local	54.44 abc	63.33 ab	58.89 abc	93.33	95.56 ab	94.44 ab
11	Desiree	70 ab	63.33 ab	66.67 ab	97.78	98.89 a	98.33 a
	Mean	52.3	53.1	52.7	96.26	89.7	92.98
	F test	**	**	**	NS	**	*
	CV (%)	29.5	26.1	20.3	3.6	11.2	5.8
	LSD (0.05)	26.25	23.61	18.24		17.12	9.16

Note: NS=Non Significant *= Significant at p<0.05 **=Significant at p<0.001 LSD=Least Significant Difference CV= Coefficient of Variation

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Table 2: Effect of different potato genotypes on Plant height (cm) and number of main stems/plant in On-Station Varietal Trial at Horticulture Research Station, Rajikot, Jumla during 2017 and 2018

SN	Genotypes	Plant height (cm)			No. of main stem		
		2017	2018	Average	2017	2018	Average
1	T 302498.7	54.8 b	75.6 ab	65.2 b	3.67 cde	4.33	4 bc
2	T 303381.3	66.07 a	93.27 ab	79.67 a	3.47 de	3.67	3.57 cd
3	T 304347.6	49.8 bc	77.33 ab	63.57 b	4.13 bc	4.2	4.17 bc
4	T 304351.109	56.2 b	95.67 a	75.93 a	5.2 a	5.07	5.13 a
5	T 304366.46	51.93 bc	76 ab	63.97 b	3.4 e	3.67	3.53 cd
6	T 304368.46	50.6 bc	76.2 ab	63.4 b	3.2 ef	4.13	3.67 c
7	T 391058.175	51.2 bc	77.67 ab	64.43 b	4.4 b	4.7	4.55 ab
8	T 393371.58	49.87 bc	72.4 bc	61.13 b	3.53 de	4.13	3.83 c
9	T 304405.47	65.6 a	93.4 ab	79.5 a	3.93 bcd	4	3.96 bc
10	Jumli local	46.93 c	54.47 cd	50.7 c	2.9 f	2.93	2.91 d
11	Desiree	40.2 d	40.2 d	40.2 d	3.53 de	3.47	3.5 cd
	Mean	53.02	75.7	64.3	3.76	4.03	3.89
	F test	**	**	**	**	NS	**
	CV (%)	7.4	15	9.4	7.3	18.6	9.3
	LSD (0.05)	6.69	19.39	10.28	0.47		0.61

Note: NS=Non Significant *= Significant at p<0.05 **=Significant at p<0.001 LSD=Least Significant Difference CV= Coefficient of Variation

Percentage ground coverage of different potato genotypes found significantly differed among each other. Maximum ground coverage (59.17%) was recorded in T 304368.46 followed by T 304351.109 (58.33%) and T 302498.7 (56.67%) whereas the lowest (36.67%) was recorded in T 304405.47 followed by Desiree (38.33%) and Jumli Local (39.17%). Uniformity among the genotypes was found statistically significant. The uniformity was recorded the highest (5) in genotypes T 303381.3, T 304351.109, and T 304368.46 which was followed by T 302498.7 and T 304405.47 as score 4.67 whereas the lowest (2.33) in Jumli Local (Table 3).

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Table 3: Effect of different potato genotypes on ground coverage (%) and Plant uniformity (1-5 scale) in On- Station Varietal Trial at Horticulture Research Station, Rajikot, Jumla during 2017 and 2018

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SN	Genotypes	Ground coverage (%) at six weeks of planting			Uniformity (1-5 scale)		
		2017	2018	Average	2017	2018	Average
1	T 302498.7	58.33 abc	55 a	56.67 ab	4.67 abc	4.67 abc	4.67 ab
2	T 303381.3	46.67 cd	48.33 ab	47.5 abc	5 a	5 a	5 a
3	T 304347.6	50 abcd	45 ab	47.5 abc	4 e	4 e	4 c
4	T 304351.109	60 ab	56.67 a	58.33 ab	5 ab	5 ab	5 a
5	T 304366.46	48.33 bcd	48.33 ab	48.33 abc	4.33 acde	4.33 acde	4.33 bc
6	T 304368.46	61.67 a	56.67 a	59.17 a	5 ab	5 ab	5 a
7	T 391058.175	43.33 d	48.33 ab	45.83 bc	4 e	4 e	4 c
8	T 393371.58	40 d	43.33 ab	41.67 c	4 ce	4 ce	4 c
9	T 304405.47	38.33 d	35 b	36.67 c	4.67 abcd	4.67 abcd	4.67 ab
10	Jumli local	40 d	38.33 b	39.17 c	2.33 f	2.33 f	2.33 d
11	Desiree	38.33 d	38.33 b	38.33 c	4 cde	4 cde	4 c
	Mean	47.7	46.7	47.2	4.27	4.27	4.27
	F test	**	*	**	**	**	**
	CV (%)	13.6	17.3	14.4	8.2	8.2	7.5
	LSD (0.05)	11.06	13.76	11.6	0.6	0.6	0.54

Note: NS=Non Significant *= Significant at p<0.05 **=Significant at p<0.001 LSD=Least Significant Difference CV= Coefficient of Variation

3.2 Insect pest damage and late blight scoring

Damage caused by insect (Blister beetle, Leaf minor) was minimum in all the genotypes. Insect damage percentage was maximum (3.83%) in genotype Jumli local followed by Desiree (3.5%), and T 304366.46 (3%) whereas minimum in genotype T 304405.47 (2%). Similarly, occurrence of late blight was maximum (4.17) in Jumli Local followed by Desiree (3), T 304366.46 (2.5) whereas minimum (1) in genotype T 302498.7, T 303381.3, T 304347.6, T 304351.109, T 304368.46, T 391058.175 and T 304405.47 (Table 4).

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Table 4: Effect of different potato genotypes on insect damage (%) and late blight infection (scale 1-9) in On-Station Varietal Trial at Horticulture Research Station, Rajikot, Jumla during 2017 and 2018

SN	Genotypes	Insect damage (%)			Late blight reading (1-9 scale)		
		2017	2018	Average	2017	2018	Average
1	T 302498.7	2.67 b	2.67 a	2.67 bc	1 d	1 d	1 e
2	T 303381.3	2.67 b	2.33 a	2.5 bc	1 d	1 d	1 e
3	T 304347.6	2.67 b	2.67 a	2.67 bc	1 d	1 d	1 e
4	T 304351.109	2.33 b	3 a	2.67 bc	1 d	1 d	1 e
5	T 304366.46	2.67 b	3.33 a	3 abc	2.67 c	2.33 c	2.5 c
6	T 304368.46	2.33 b	2.33 a	2.33 c	1 d	1 d	1 e
7	T 391058.175	2 b	2.33 a	2.17 c	1 d	1 d	1 e
8	T 393371.58	2 b	2.67 a	2.33 c	1 d	2 c	1.5 d
9	T 304405.47	2 b	2 a	2 c	1 d	1 d	1 e
10	Jumli local	4.33 a	2.67 a	3.83 a	4 a	4.33 a	4.17 a
11	Desiree	4.33 a	3.33 a	3.5 ab	3 b	3 b	3 b
	Mean	2.73	2.67	2.7	1.6	1.69	1.65
	F test	**	NS	*	**	**	**
	CV (%)	24.1	31.1	20.8	10.8	14.9	10.9
	LSD (0.05)	1.12		0.96	0.29	0.43	0.31

Note: NS=Non Significant *= Significant at p<0.05 **=Significant at p<0.001 LSD=Least Significant Difference CV= Coefficient of Variation

3.3 Yield and yield attributing parameters

Most of tested potato genotypes were late in maturity whereas Desiree was early in maturity. Highly significant difference was recorded in tuber number per hectare among the potato genotypes tested. Maximum number (686235) of tubers per hectare was recorded in Jumli local which was followed by T 304368.46 (598642), T 304351.109 (518457) and it was recorded as 334630 and 365802 per hectare in genotypes Desiree and T 391058.175 respectively. Similarly, tuber yield was also found highly significant among each other. Maximum tuber yield (46.93 t/ha) was recorded in genotype T 304351.109 that was followed by T 304368.46 (41.61 t/ha), T 302498.7 (32.69 t/ha), T 303381.3 (31.64 t/ha) and T 304347.6 (31.05 t/ha) whereas the lowest (12.59 t/ha) in Jumli local (Table 5). Tuber characteristics (tuber shape and tuber color) differed among potato genotypes. T 302498.7, T 303381.3, T 304347.6, T 304366.46, T 304368.46 and T 391058.175 were round; T 304351.109 and T 304368.46 Oblong whereas Jumli Local and Desiree were round in shape. T 302498.7, T 304368.46, T 391058.175, T 393371.58, T 304405.47 and Jumli Local were white, T 304366.46 was light red and remaining genotypes were red in tuber color.

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Table 5: Effect of different potato genotypes on number of tuber/ha and tuber yield (t/ha) in On-Station Varietal Trial at Horticulture Research Station, Rajikot, Jumla during 2017 and 2018

SN	Genotypes	Tuber number per ha			Tuber yield (t/ha)		
		2017	2018	Average	2017	2018	Average
1	T 302498.7	419259 cd	401235 bc	410247 d	31.99 bc	33.4 c	32.69 b
2	T 303381.3	430370 cd	406173 bc	418272 cd	31.03 bc	32.26 c	31.64 b
3	T 304347.6	407407 cd	333333 c	370370 d	36.44 ab	25.67 cd	31.05 bc
4	T 304351.109	499259 cd	537654 ab	518457 bc	42.74 a	51.11 a	46.93 a
5	T 304366.46	480000 bcd	391358 bc	435679 cd	29.75 bc	28.69 cd	29.22 bc
6	T 304368.46	589630 ab	587654 a	598642 b	40.3 a	42.93 b	41.61 a
7	T 391058.175	382222 cd	399383 c	365802 d	29.15 bc	26.08 cd	27.61 bc
8	T 393371.58	454815 cd	404938 bc	429877 cd	30.96 bc	26.35 cd	28.56 bc
9	T 304405.47	393333 cd	274691 c	334012 d	31.15 bc	25.86 cd	28.5 bc
10	Jumli local	697778 a	674691 a	686235 a	12.77 d	12.42 e	12.59 d
11	Desiree	360000 d	309259 c	334630 d	27.72 c	22.49 d	25.11 c
	Mean	464916	424579	444747	31.27	29.75	30.51
	F test	**	**	**	**	**	**
	CV (%)	13.8	19.3	12.4	13	15.7	11
	LSD (0.05)	108968	139772	93919	6.93	7.94	5.7

Note: NS=Non Significant *= Significant at p<0.05 **=Significant at p<0.001 LSD=Least Significant Difference CV= Coefficient of Variation

4. DISCUSSION

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Based on the results of two years experiments, vegetative parameters: emergence at 30 & 45 DAP, Plant uniformity, ground coverage, number of stems per plant and plant height (cm) as well as yield parameters: total number of tubers per ha and tuber yield per ha all were found significant among each other. The significant variation in vegetative as well as yield parameters has been reported by different researchers [13, 14 and 15]. Significant differences for almost all the vegetative as well as yield parameters show the wider genetic diversity as well as variability and potentiality among the tested potato genotypes [16, 17]. Significantly higher tuber yield (46.93 t/ha, 41.46 t/ha and 32.69 t/ha) were obtained from T 304351.109, T 304368.46 and T 302498.7 respectively at research block of Horticulture Research Station, Rajikot, Jumla, Nepal. Productivity of these genotypes ranged from 32.69 t/ha to 46.93 t/ha in two consecutive years. This indicates that these genotypes have genetic potentiality to perform better under Jumla condition of Nepal.

5. CONCLUSION

The results of the experiment during 2017 and 2018 at the station showed that potato genotypes T 304351.109, T 304368.46 and T 302498.7 performed better. Productivity of these genotypes ranged from 32.69 t/ha to 46.93 t/ha during two years whereas the national productivity of potato is 16.73 t/ha. Therefore, these potato genotypes are suitable for food security point to the farmers in Jumla and high hills of Karnali Province of Nepal for commercial cultivation.

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