



Evaluation of Elite Potato Cultivars on Red Ant (*Dorylus Orientalis*) Management and Tuber Yield

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ABSTRACT

On-station experiment was carried out to identify appropriate potato cultivars for red ant management and increase the tuber yield of potato at Agriculture Research Station (ARS), Jaubari, Ilam, Nepal (2900 masl) during two consecutive years 2018 and 2019. Eight different promising potato genotypes [1. BLR-20 2. PRP-296667.2 3. PRP-14267.11 4. PRP-8561.11 5. PRP-016367.7 6. PRP-16567.5 7. Khumal Seto (standard check and 8. Ilam local (Jhyale)] selected from diseased screening nursery were included in the study. Experiment was conducted in previously red ant infected potato field in Completely Randomized Block Design (RCBD) with three replications. The experimental plot size was 5.4 m² (3m x 1.8m) where planting tubers was done at 60 cm row to row and 25 cm plants to plant spacing. Fertilizers were applied at the rate of 100:100:60 kg NPK/ha and 20 t/ha compost. Well sprouted tubers with weight 30-40 g were planted during the second week of February. The cultural operations were carried out as per the recommendation of National Potato Research Program (NPRP). Harvesting was done during the last week of July. Data on yield attributing traits, late blight disease, number of red ant damaged tubers, maturity days, red ant infested yield and healthy tuber yield were recorded. The potato cultivar PRP-16567.5 produced the lowest red ant score (1.00 red ant score in 1-5 scoring scale), less (0.33 – 1.66 %) red ant incidence percentage, minimum (0.04 – 0.22 t/ha) red ant infested tuber yield and highest (31.19 – 35.22 t/ha) potato tuber yield followed by PRP-14267.11 (1.00 red ant score, 2.00 – 2.16 % red ant incidence percentage, 0.31 – 0.33 t/ha red ant infested tuber yield and 27.27 – 27.67 t/ha potato tuber yield). Therefore, planting of PRP-16567.5 as well as PRP-14267.11 potato cultivars is appropriate for higher potato tuber yield and lower down red ant incidence at Jaubari area.

Keywords: Potato, genotypes, red ant, damaged, incidence, tuber yield, infested yield.

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important and predominant tuber crop in Nepal and occupies fifth position in terms of area coverage and 2nd place in production as well as 1st position in productivity (NPRP, 2018). Potato is one of the most important vegetable crops in plains and lower hills while it is a staple food in high hills and mountains of Nepal. Nutritionally potato is rich in carbohydrates (61.5-91.5%) which is essential for energy, protein (1.6 g), dietary fiber, vitamin C (25 mg), starch (16.3 g), and minerals like phosphorous, calcium, and chlorine (Bose and Som, 1986). It is cultivated as winter crop in tropical and subtropical region and as summer crops in the temperate region of Nepal. It is one of the rare non-cereal foods that meet the nutritional requirement of the fast growing population particularly in the developing country like Nepal (CIP, 1995). It has significant role in the income generation, food production and overall poverty alleviation as it has a high cash value and short cropping duration. Potato plays an important role in food security and livelihood due to its high cash, food and nutritive value (Gautam *et al.*, 2011).

The productivity of potato in Nepal is 16.73 mt/ha (ABPSD, 2022) which is lower than its potentiality (about 30 mt/ha of released varieties) due to many biotic and abiotic factors (ARS, 2019). Several production factors are responsible for reduction of production and productivity of potato could be due to loss of valuable local genotypes; lack of improved cultivation practices; weed infestation causing potato crop loss up to 80% (Ghimire and Chaudhari, 2010), inadequate supply of quality seed; occurrence of pest (red ants, potato tuber moth and White grub) and disease especially late blight causes great damage in developing countries and low soil and nutrient management practices. Apart from other factors red ants (*Dorylus orientalis*) have been playing a significant role and have become serious to manage with some of the common chemicals and even with a single control method.

Agriculture Research Station (ARS), Jaubari is located at an altitude of 2900 masl where potato were planted during February – March. Farmers in Jaubari used the local potato genotypes susceptible to insect pests and diseases problems with low production potentialities. Where red ant insect pest is major yield reducing biotic factors (ARS, 2019). In past, several hazardous chemicals pesticides were recommended for red ant management without considering its side effect to human beings and other living creatures. Since the government organizations have been playing a significant role in creating awareness against pesticides, present situation in Nepal is favorable for the initiation of traditional methods and practices for insect pest management. While, the use of the resistance/tolerant potato varieties is more stable, sustainable and cost-effective from the technical, ecological, economic and environmental view point. So, this study and works has been proposed to find out and disseminate resistance/tolerant potato varieties against potato pests. This could be a very useful tool for the research and extension for enhancing economic return of the high hills community in the future.

2. MATERIALS AND METHODS

The experiments were conducted at Agricultural Research Station (ARS), Jaubari, Ilam, Nepal during 2018 and 2019 to identify the appropriate potato cultivars for red ant management and the tuberyield of potato at the high hill of Ilam district. Eight different promising potato genotypes [1. BLR-20 2. PRP-296667.2 3. PRP-14267.11 4. PRP-8561.11 5. PRP-016367.7 6. PRP-16567.5 7. KhumalSeto (standard check and 8. Ilam local (Jhyale)] selected from diseased screening nursery were included in the study. Experiment was conducted in previously red ant infected potato field in Completely Randomized Block Design (RCBD) with three replications. The experimental plot size was 5.4 m² (3m x 1.8m) with 60 cm row to row and 25 cm plants to plant spacing accommodating 30 seed potato tubers per plot. The plots were fertilized with 100:100:60 kg NPK/ha and 20 t/ha compost. Well sprouted tubers size of 30-40 g were planted during the second week of February. The cultural operations were carried out as per the recommendation of National Potato Research Program (NPRP). Harvesting was done during the fourth week of July. Data taken were days to 50% emergence, ground coverage (%), number of main stem/plants, number of tubers per plant, red ant damage scoring (1-5 scale), red ant incidence (%), red ant infested yield (kg/plot), number of tubers/plant and total yield (kg/plot). Ground coverage was measured 100% when all the plants cover almost all the ground, then based on the canopy of plant to cover the ground percentage was estimated. Plant uniformity was observed in 1-5 scale, where 5 was given to almost uniform plants. Late blight scoring was done in 1-9 scale where 1 was given for no infection of disease (resistant) and 9 was given when the disease was observed up to stems i.e. highly susceptible. Similarly damage of ant was measured as 1-5 scoring scale as; 1=No infestation to 5= severe infestation. The percentage of insects damaged potato tuber was calculated as follows:

$$\text{Red ant incidence \%} = \frac{\text{No. of red ant infected tuber}}{\text{Total No of tuber}} \times 100$$

The collected data were entered on MS-excel, calculated and data analysis was done using GEN-STAT software and mean separation was done by LSD at 5% level of significance.

3. RESULTS

3.1 Yield attributing traits

The effect of promising potato cultivars on yield attributing traits is presented in table 1. Days to 50% emergence was found non-significant whereas ground coverage and main stem per plant was found significant in both the year. Days to 50% emergence ranges from minimum 62.00 days in Ilam local cultivar (Jhyale) to maximum 76.00 days in cultivar BLR-20 during 2018 and in 2019 it varies from minimum 64.00 days in same Ilam local (Jhyale) cultivar to maximum 77.00 days in cultivar PRP-016367.7. The results indicate that potato cultivar Ilam local (Jhyale) takes short duration (62.00 – 64.00 days to 50 % emergence). Ground coverage and number of main stems per plant plays significant roles for the tuber yield of potato. Maximum ground coverage percentage (86.18% in 2018 and 84.76% in 2019) was observed from the cultivar PRP-16567.5 followed by the potato cultivar PRP-14267.11 (83.60 % in 2018 and 84.25 % in 2019). Number of main stems per plant was significantly highest (4.33 main stem number/plant) in the cultivar PRP-16567.5 during 2018 and 2019 followed by the potato cultivar PRP-14267.11 (3.66 main stem number /plant in 2018 and 4.33 main stem number /plant in 2019).

Table 1. Evaluation of elite potato cultivars on yield attributing traits of potato at ARS, Jaubari during 2018 and 2019.

Treatments	Days to 50% emergence		Ground coverage (%)		Mainstem # /plant	
	2018	2019	2018	2019	2018	2019
BLR-20	76.00	72.00	75.00	70.83	3.66	4.33
PRP-296667.2	74.00	76.00	74.73	73.15	3.33	3.66
PRP-14267.11	65.00	74.00	83.60	84.25	3.66	4.33
PRP-8561.11	65.00	66.00	73.80	74.89	3.66	3.66
PRP-016367.7	74.00	77.00	71.37	74.20	3.33	3.66
PRP-16567.5	69.00	68.00	86.18	84.76	4.33	4.33
KhumalSeto (standard check)	69.00	67.00	74.67	71.18	2.66	3.33
Ilam local (Jhyale)	62.00	64.00	60.24	62.85	2.66	2.66
GM	69.25	70.50	74.94	74.51	3.41	3.28
F-test	NS	NS	*	*	*	*
LSD 0.05	-	-	9.21	10.16	0.28	0.33
CV%	18.60	22.20	12.68	31.35	12.35	14.80

GM-Grand mean NS – Non significant * – Significant ** – Highly significant

3.2 Plant uniformity, Plant height and late blight scoring.

The effect of promising potato cultivars on vegetative parameters such as plant uniformity and plant height as well as late blight scoring is presented in table 2. Plant uniformity (1-5 scale) of the tested potato cultivars in both the experimental year was found statistically at par with each other. However, it was ranged from 2.00 to 3.00 scoring scale in both the experimental year. Plant height of the tested potato cultivars significantly varies from shortest 32.01 cm to tallest 60.72 during 2018 and 28.25 cm shortest to 56.10 cm tallest in 2019. The potato cultivar PRP-14267.11 found tallest (60.72 cm) followed by PRP-16567.5 (59.40 cm), PRP-8561.11 (58.08 cm) and BLR-20 (57.20 cm) in 2018. During in 2019 potato cultivar PRP-16567.5 was found tallest (56.10 cm) followed by PRP-14267.11 (49.32 cm). Effect of potato cultivars were found highly significant ($p=0.01$) differ in late blight disease outbreak. The potato cultivars BLR-20, PRP-14267.11, PRP-8561.11 and PRP-16567.5 were found resistance (1 scoring scale in 1-9 scale) to late blight disease in both the experimental year. The KhumalSeto (standard check) and Ilam local potato cultivars were found more (2.33 - 2.66 scoring scale in 2018 and 2.66 - 3.00 scoring scale in 2019 in 1-9 scale) susceptible to late blight disease.

Table 2. Evaluation of elite potato cultivars on plant uniformity, plant height and late blight scoring at ARS, Jaubari during 2018 and 2019.

Genotypes	Plant uniformity (1-5 scale)		Plant height (cm)		Late blight scoring (1-9 scale)	
	2018	2019	2018	2019	2018	2019
BLR-20	2.66	3.00	57.20	32.65	1.00	1.00
PRP-296667.2	2.00	2.66	43.45	32.31	1.33	1.66
PRP-14267.11	3.00	2.66	60.72	49.32	1.00	1.00
PRP-8561.11	2.00	2.00	58.08	38.19	1.00	1.00
PRP-016367.7	2.66	2.00	38.17	31.30	2.00	1.33
PRP-16567.5	3.00	2.66	59.40	56.10	1.00	1.00
KhumalSeto (standard check)	2.66	2.66	37.95	31.18	2.66	3.00
Ilam local (Jhyale)	2.00	2.66	32.01	28.25	2.33	2.66
GM	2.49	2.53	48.37	37.41	1.54	1.58
F-test	NS	NS	*	*	**	**
LSD	-	-	13.62	7.18	0.96	1.08
CV (%)	27.45	24.90	17.71	20.45	56.38	49.35

GM-grand mean *– Significant **– Highly significant

3.3 Red ant damaged and infested yield

The effect of promising potato cultivars on red ant scoring, incidence and infested yield of potato is presented in table 3. The potato cultivars had significant effects on the red ant occurrence on 2018. The elite potato cultivar PRP-16567.5 had the lowest red ant score (1.0) scale, red ant incidence (0.33%) and less infested tuber yield (0.04 t/ha) respectively followed by the cultivar PRP-14267.11 (1.00 red ant score, 2.16 % red ant incidence and 0.33 t/ha red ant infested tuber yield) whereas the Ilam local (Jhyale) potato cultivar had the highest red ant infestation score (2.00), red ant incidence (10.85%) and the highest (2.05 t/ha) infested tuber yield.

Similarly, the potato genotypes had significant effects on the red ant occurrence on 2019. The potato cultivar PRP-16567.5 had the lowest red ant score (1.0) scale, red ant incidence (1.66 %) and less infested tuber yield (0.22 t/ha) respectively followed by the cultivar PRP-14267.11 (1.00 red ant score, 2.00 % red ant incidence and 0.31 t/ha red ant infested tuber yield) whereas Ilam local (Jhyale) potato cultivar had the highest red score (1.66), red ant incidence (10.58%) and the highest (1.98 t/ha) infested tuber yield.

Table 3. Evaluation of elite potato cultivars on red ant damage, incidence and infested yield of potato at ARS, Jaubari during 2018 and 2019.

Cultivars	Red ant scoring (1-5 scale)		Red ant incidence %		Red ant infested yield (t/ha)	
	2018	2019	2018	2019	2018	2019
BLR-20	1.33	1.66	5.56	7.00	1.25	1.49
PRP-296667.2	1.33	1.33	5.38	4.54	1.56	1.28
PRP-14267.11	1.00	1.00	2.16	2.00	0.33	0.31
PRP-8561.11	1.33	1.66	5.59	7.70	1.20	1.81
PRP-016367.7	1.33	1.33	6.90	6.86	1.54	1.43
PRP-16567.5	1.00	1.00	0.33	1.66	0.04	0.22
KhumalSeto (standard check)	1.33	1.66	5.72	6.64	1.24	1.87
Ilam local (Jhyale)	2.00	1.66	10.85	10.58	2.05	1.98
GM	1.33	1.20	5.31	5.87	1.15	1.29
F-test	**	*	**	**	**	**
LSD	0.56	0.42	1.57	1.89	0.36	0.39
CV (%)	28.16	12.57	32.30	26.18	39.0	34.10

GM-grand mean *– Significant **– Highly significant

3.4 Maturity days, tuber number and tuber yield

The tuber number and tuber yield of tested elite potato cultivars is presented in table 4. The maturity days and number of tuber per plant of tested potato cultivars were found non-significant where as significant difference was recorded in tuber yield per hectare among the potato cultivars tested. Tuber number per plant varies from 7.00 to 11.00 in 2018 and 9.00 -12.00 in 2019. Significantly, maximum tuber yield (31.19 t/ha and 35.22 t/ha, respectively in 2018 and 2019) was recorded in PRP-16567.5 potato cultivar that was followed by PRP-14267.11 (27.27 t/ha and 27.67 t/ha, respectively in 2018 and 2019), BLR-20 (23.12 t/ha and 26.78 t/ha, respectively in 2018 and 2019) and PRP-296667.2 (22.94 t/ha and 26.28 t/ha, respectively in 2018 and 2019). Significantly lower yield was found in Ilam local (Jhyale) cultivar in both the year. It was observed as 14.94 t/ha and 13.18 t/ha respectively in 2018 and 2019.

Table 4. Evaluation of elite potato cultivars on yield of potato at ARS, Jaubari during 2018 and 2019.

Cultivars	Maturity days		Tubers # /plant		Tuber yield (t/ha)	
	2018	2019	2018	2019	2018	2019
BLR-20	125.00	127.00	9.00	10.00	23.12	26.78
PRP-296667.2	125.00	127.00	9.00	11.00	22.94	26.28
PRP-14267.11	130.00	130.00	10.00	10.00	27.27	27.67
PRP-8561.11	129.00	130.00	7.00	9.00	20.84	24.73
PRP-016367.7	123.00	125.00	8.00	9.00	19.14	21.64
PRP-16567.5	130.00	128.00	10.00	11.00	31.19	35.22
KhumaSeto (standard check)	125.00	127.00	11.00	12.00	18.99	23.36
Ilam local (Jhyale)	123.00	125.00	10.00	9.00	14.94	13.18
GM	126.25	127.37	9.25	10.12	22.30	24.85
F-test	NS	NS	NS	NS	**	**
LSD 0.05	-	-	-	-	4.48	5.76
CV%	18.64	23.28	44.35	36.18	15.83	19.54

GM- Grand mean NS – Non significant * – Significant

4. DISCUSSION

The two year study revealed that vegetative parameters: days to 50% emergence, ground coverage %, main stem number per plant, plant uniformity (1-5 scale), maturity days as well as tuber number per plant were found statistically non-significant with each other. Ground coverage %, main stem number/plant and plant height (cm) were found significant. Late blight disease scoring (1-9 scoring scale), red ant scoring (1-5 scoring scale), red ant incidence (%), red ant infested yield and tuber yield per hectare were found statistically highly significant. The significant variation in vegetative as well as yield parameters has been reported by different researchers (Khanalet *et al.*, 2017, Pant *et al.*, 2017 and Upadhyayet *et al.*, 2017). 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 (Chapagain *et al.*, 2014, Giri *et al.*, 2016). Variation in plant uniformity (50-90%), ground coverage (50 -95%), late blight score (1 – 8 scale in 1-9 scoring scale), red ant incidence (2 – 20%) and tuber yield (9.47 – 32.80 t/ha) were found among 84 potato genotypes tested in Agriculture Research Station, Jaubari, Ilam (ARS, 2017). Damage of red ant was associated with the tuber quality and tenderness of the potato genotypes. The released potato cultivar KhumaSeto was found susceptible to late blight diseases (2.66 – 3.00 score in 1-9 scoring scale) and red ant insect pest (5.72 – 6.64 % red ant incidence) with comparatively low potato tuber yield (18.99 – 23.36 t/ha). The elite potato cultivar PRP-16567.5 had the lowest red ant score (1.00 scale), red ant incidence (0.33 – 1.66 %) and less red ant infested tuber yield (0.04 – 0.22 t/ha), respectively followed by PRP-14267.11 (1.00 red ant score, 2.00 – 2.16 % red ant incidence percentage and 0.31 – 0.33 t/ha red ant infested tuber yield). The total yield is associated with size of the tubers and the losses caused by diseases and insect pests. Significantly, maximum tuber yield (31.19 t/ha – 35.22 t/ha) was found in PRP-16567.5 potato cultivar that was followed by PRP-14267.11 (27.27 – 27.67 t/ha) and BLR-20 (23.12 – 26.78 t/ha) potato cultivars. This indicates that potato cultivars PRP-16567.5 and PRP-16567.5 were found better from the red ant management and tuber yield point of view in high hill of Ilam district of Nepal.

5. CONCLUSION

The study concluded that the potato genotypes had played an influencing role on the yield attributing traits, insect pest occurrences and tuber yield of potato. Potato genotypes significantly affected the plant height, late blight damaged, red ant occurrence and damaged as well as the potato tuber yield. The potato cultivar PRP-16567.5 produced the lowest red ant score (1.00 red ant score in 1-5 scoring scale), less (0.33 – 1.66 %) red ant incidence percentage, minimum (0.04 – 0.22 t/ha) red ant infected tuber yield and highest (31.19 – 35.22 t/ha) potato tuber yield followed by PRP-14267.11 (1.00 red ant score, 2.00 – 2.16 % red ant incidence percentage, 0.31 – 0.33 t/ha red ant infected tuber yield and 27.27 – 27.67 t/ha potato tuber yield). Therefore, planting of PRP-16567.5 as well as PRP-14267.11 potato cultivars is appropriate for higher potato tuber yield and lower down red ant incidence at Jaubari area of Ilam district.

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CONFLICTING INTERESTS

Authors declare that there is no conflict of interest related to the publication of this manuscript.

Authors' Contributions

This trial was carried out in close collaboration with author. All the authors reviewed the first draft paper, commented, suggested and approved the final paper for submission.

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