Screening of Potato Clones against Wart (*Synchytrium endobioticum*) Disease under Naturally Infested Field Condition

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ABSTRACT

Field experiment was conducted at Nigale, Sindhupalchok located at 2450 masl during 2007 and 2008, with the objective of identifying potato clones resistant to wart (*Synchytrium endobioticum*). Nigale is one of the wart disease prone areas of the country. A total of 80 potato clones in 2007 and 45 clones in 2008 were planted in an augmented experimental design on a severely wart infested farmer's field. Commercially grown, locally adopted and highly wart susceptible potato cultivar 'Rosita' was used as check and crop was grown under rain fed condition. Susceptible cultivar was planted after each nine-test row. Experiment was planted during first fortnight of February in both the years and harvested in first week of July. Apparently healthy and wart infested tubers were counted and wart incidence percent was obtained at the time of harvest along with tuber yield per plot. Clones with complete absence of wart on the surface of tubers were considered as wart resistant. Thirty eight CIP accessions and five national crosses i.e C x LBr 44.14, D x LBr40.10, D x LBr43.12, D x LBr43.13, D x LBr44.6 were found resistant to wart, whereas, potato clones Kufri-Chipsona-2, 393637.10, 394007.55, 392236.6, 388572.4 and 393280.64 were found highly susceptible to wart under field conditions.

Key words: Potato clones, Rosita, *Synchytrium endobioticum*, wart screening

INTRODUCTION

Potato is one of the important food crops after rice, maize and wheat which occupy total area of 1,56,737 hectares with the productivity of 13.11 t/ha (ABPSD 2007). Share of Mountain alone for potato growing area and production is 18% and 14 % respectively as compared to National area and production. *S. endobioticum* originated from the Andean region of South-America, from which it was introduced into Europe in 1880s now almost worldwide distribution in cooler areas where potatoes are cultivated. In Nepal it was introduced probably from India via Darjiling and Sikkim to Ilam. This disease has been established in few potato growing areas of Ilam, Panchthar, Dolakha, Sindhupalchok, Dhading and Gorkha districts with the estimated yield loss ranging 20-90% (Khairgoli 1997) particularly at the high altitudes ranging 2000 to 3000 m a s l. Aerial symptoms are usually not apparent although plant vigor reduction may be observed. The fungus affects basal stems, stolons and tubers but not roots. Tubers' eyes are the main center of infection that develop into cauliflower-like warty appearance, which are initially whitish but on exposed to light changed into green and gradually darken and in advance stage get rot and disintegrate (Stuart *et al*., 2008).

This fungus causes substantial yield losses when soil gets severely infested. Ninety percent farmers of Mudhe and Nigale area grow potato variety "Rosita" which is highly susceptible to this disease with a incidence of 20-40 % (NPRP 2007) and an estimated yield loss ranging 20 to 30 percent annually. No effective fungicide has been reported against this fungus however some cultural practices can minimize the losses. The most

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effective and practical remedy of this problem is the use of resistant varieties. All the released potato varieties in Nepal are resistant to wart but farmers of that area have not been attracted to adopt these varieties. The possible cause could be either farmer are not getting their desirable characters into these varieties or lack of awareness towards this disease.

OBJECTIVES

Farmers' participatory wart screening experiment was conducted at Nigale at an altitude of 2450masl in order to identify high yielding, wart-resistant and farmers preferred potato varieties under farmer's field conditions, and to create awareness towards the nature of disease with respect to pathogen dispersal and longevity of its resting spores.

THEORETICAL FRAMEWORK

Potato wart caused by *Synchytrium endobioticum* (Schilb) Perc. is a disease of quarantine significance due to the production of persistent resting spores and lack of effective chemical control measures (Putnam and Sindermann,1994, Hehl *et al*., 1998). Wart is the most serious disease of potato particularly in the cooler region of the country. S. endobioticum an obligate parasite does not produce hyphae but forms sporangia containing 200 to 300 motile zoospores. The most favorable conditions for its development are warm temperatures (but not over 20°C) with enough humidity. Winter sporangia can remain viable for more than 40 years (Sturt *et al*., 2008) and survives at depths of 50cm in the soil. Sporangia are released into soil after the decay of host tissue and are disseminated on tuber surface, via soil movement and perhaps by wind. Once introduced into an area, the contamination can not be eradicated. Use of reistant varieties is only the best options of wart management. Six potato varieties have been released for commercial cultivation with the yield potentiality of 20-30 t/ha. None of these varieties are adopted by Nigale farmers. To enhance the adoption of new varieties and the technologies, participatory approach has been found effective in other commodities. The participatory process narrow downs the gap between research organizations and farmers' realities by ensuring direct farmer involvement at different stages of the research process (Sharma *et al*., 2007).

METHODOLOGY

Experiment was conducted on highly wart-infested soils, identified during the previous crop harvesting time. In 2007, eighty test genotypes along with previously released seven wart resistant potato varieties i.e. Kufri Jyoti, Janak Dev, Khumal Seto-1, Khumal Rato-2, NPI-106, Cardinal and Desiree were planted. Whereas in 2008, test clones were 45 and compared with wart susceptible check variety 'Rosita'. Sources of test genotypes were International Potato Center (CIP) and National Potato Research Programme (NPRP). Experiment was planted at the farmer's field at Nigale Sindhupalchok during first fortnight of February in both the years 2007 and 2008.

Susceptible check variety was planted after each 9 test entries and was made it's borderline in both the years. Experiment was in rod row augmented design (Scott and Milliken,1993, Burgueno *et al*., 2005) susceptible check was repeated 5 to 6 times depending on the size of the experimental blocks. Plot size was a row length of 2.5 m long and 0.6 m width and planted in a spacing of 25cm X 60cm. Field was prepared as furrow and ridges with a spacing of 60cm. Compost @ 10 t/ha and fertilizer @ 150:100:60 Kg N: P_2O_5: K_2O/ha were applied as basal. Intercultural operations were followed as per farmers' practice. Fungicides were not applied throughout the crop period. Wart incidence was recorded at

the time of harvesting based on the number of infected symptomatic tubers and apparently healthy tubers produced per 1.5 m^2 plots. Tuber yield including infected ones was recorded per plot.

RESULTS AND DISCUSSION

A total of eighty potato clones were exposed to wart-infested soils in 2007 and forty two clones in 2008. Thirty-two clones were repeated in both the years. A sum of 37 clones was found resistant to wart under field conditions remaining were susceptible showing wart incidence ranging 1.2 to 100 percent. Among the wart resistant, DxLBr40.10 (3.2 kg), CxLBr40.14 (2.6 kg), CIP-392661.18 (2.0 kg) and CIP-394038.105 (2.3 kg) clones were of high yielding (>2kg/1.5 m^2) clones. Some of the genotypes CIP-390347.50, CIP-394007.55 and CIP-392236.6 showed 100% wart incidence followed by CEZ-69.1 (81.8%), CIP-385556.4 (66.7%), CIP-393280.64 (65.4%) and CIP-388572.4 (65.0%). All these clones showed more susceptibility to wart than existing cultivar 'Rosita' (61.5.4%). Data are presented in Annex1. All the previously released varieties i.e Kufri Jyoti, Janak Dev, Khumal Seto-1, Khumal Rato-2, NPI 106, Cardinal and Desiree showed resistant to wart but showed poor performance with respect to tube yield (<1.0 kg/1.5 m2) even after a long period of release.

The clones such as LBr40, CIP-392657.8, CIP-393280.57, CIP-394321.15, CIP-392617.54, CIP-391058.35 and CIP-392637.10 (Annex 1) found promising with respect to late blight resistance at Khumaltar and Chitwan conditions were susceptible to wart. Clones showing wart symptoms on tubers were rejected for further evaluation and recommendation for the hills. Potato clones LBr40, CIP-392657.8 and CIP-394321.15 were the farmers preferred clones in terai and mid hills for their yield performance but found susceptible to wart. Experiment showed that these potato clones should not be recommended for commercial cultivation in the hills. Tuber yield, late blight and wart disease resistance are the major criteria of potato genotype selection especially for the high hills.

Performance of promising potato clones to wart disease and yield

Seventeen promising potato clones, which had been under initial evaluation trial (IET) and coordinated varietal trial (CVT) for multi location testing, were also included in the screening. Of them only three genotypes CIP-394005.115, Kufri Giriraj and CIP-393674.72 B were found to be resistant to wart under high altitude (>2450 masl) wart infested soil conditions. With respect to tuber yield, all these clones produced tuber yield less than or comparable yield with locally adopted cultivar ‘Rosita’ (Fig.1). Despite of wart susceptibility, farmers prefer this variety because of having three most desirable plant characters profuse branching, high yielding, late blight tolerant and red skinned tuber.

Hypothetically wart incidence and tuber yield should have negative correlation. Simple linear correlation coefficient (r) computed based on the data of Fig 1 showed very poor positive correlation (r = +0.17). If clones get infected by S. endobioticum at the early stage of crop generally leads to formation of wart structures on stolons instead of tuber formation and cause heavy yield loss. Later stages of infection may not affect significantly on yield, however diseases incidence percent may be higher. Clones CIP 393280.64 and Rosita have high yielding capacity along with wart susceptibility (Fig 1) which might influence to show positive relation. It may be the reason that 'Rosita' still not rejected by farmers of Nigale and Kharidhunga area despite of high wart incidence and simultaneously there is lack of new wart resistant varieties to replace the existing variety.

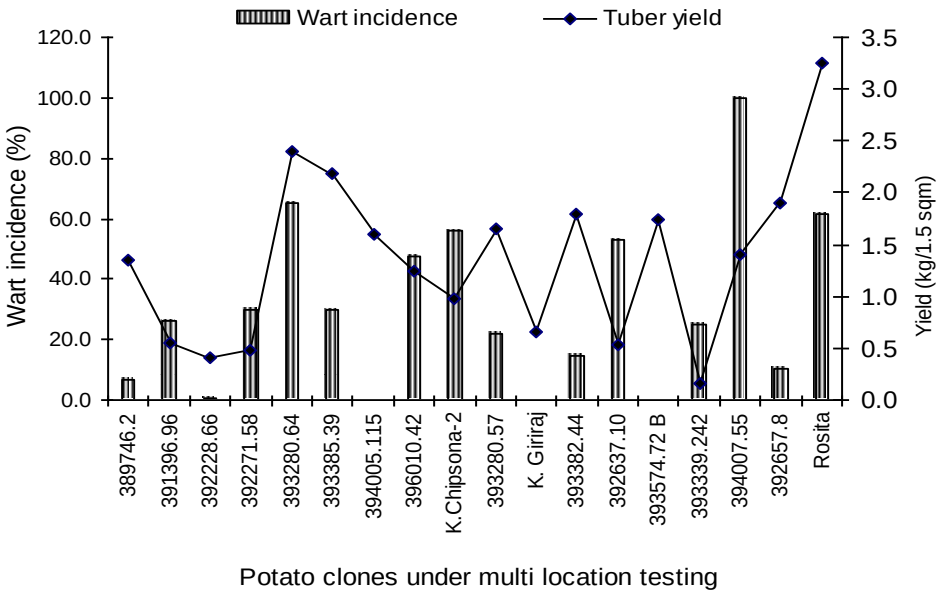

Fig.1: Performance of sixteen promising potato clones against wart incidence and tuber yield under Nigale condition in 2007 and 2008.

Performance of NPRP crosses to wart disease and yield

Among the NPRP crosses, DxLBr44.6, DxLBr40.10, DxLBr40.14, DxLBr43.13, DxLBr43.12 were found resistant to wart. However other crosses showed minimum level of wart incidence as compared to 'Rosita'. Regarding with the tuber yield, two wart resistant clone JDxLBr40.5 and CxLBr40.14 produced comparable yield with Rosita (Fig. 2). Despite of wart susceptibility, farmers prefer this variety because of having three most desirable plant characters profuse branching, high yielding, late blight tolerant and red skinned tuber.

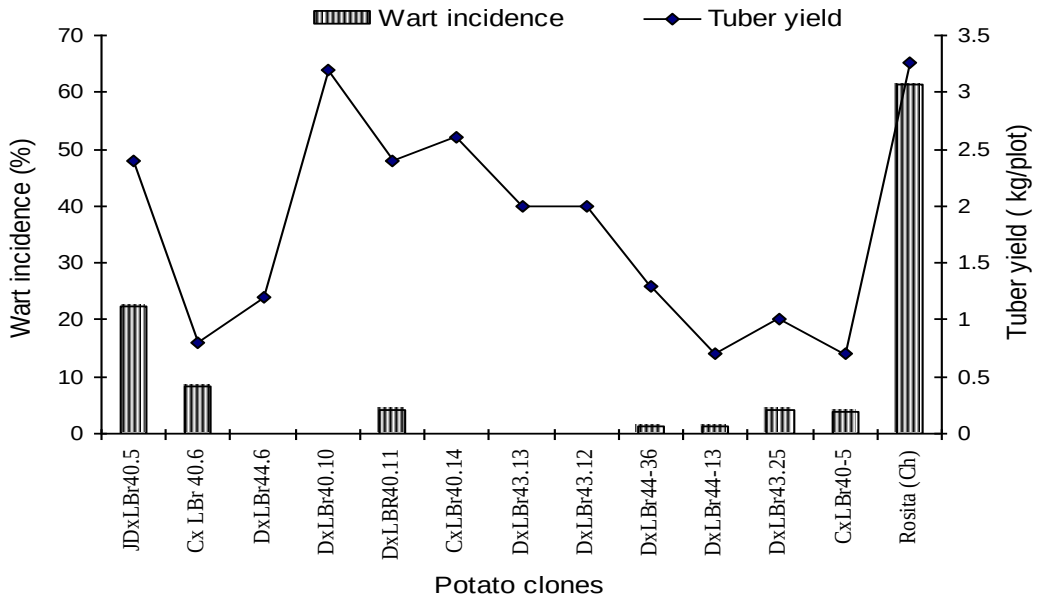

Fig.2: Performance of NPRP crosses potato clones against wart infested field conditions of Nigale in 2007 and 2008.

All of these high yielding genotypes were found to be susceptible to wart indicating that there was no significant effect of wart incidence on tuber yield. But it does not exactly hold true, when wart infection starts early during the tuber formation stage there will be no tuber development and that lead to formation of wart instead of tuber. Under such circumstances yield loss reaches maximum. Tuber yield per plot includes both infected and healthy. When warty structures are removed, total produce can be marketed. On use of warty tubers as seed material for succeeding crop season would enhance severity of wart under favorable soil and weather conditions.

CONCLUSION

In addition to released potato varieties, three potato genotypes DxLBr40.10, CxLBR40.14 and CIP-394038.105 were found to be resistant to wart with considerable tuber yield ranging 15 to 21 t/ha. Out of these three clones, participating farmers selected DxLBr40.10 because of red skin tuber and comparable tuber yield with their existing cultivar 'Rosita'. Screening of potato clones against wart and late blight diseases should be continued in order to get at least 50% more yield than the existing cultivar under high altitude conditions.

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Annex 1. Performance of potato clones against wart disease at Nigale during 2007-08

Acc. No.	Infected tubers (No.)		Healthy tubers (N0)		Wart incidence %			Tuber yield (kg/plot)		
	2007	2008	2007	2008	2007	2008	Mean	2007	2008	Mean
378711.7	0	0	9	50	0.0	0.0	0.0	0.1	1.2	0.6
383178.22	0	0	29	38	0.0	0.0	0.0	0.3	1.0	0.7
384321.15	2	6	22	73	8.3	7.6	8.0	1.0	2.5	1.7
384329.21	0	0	26	22	0.0	0.0	0.0	0.6	0.6	0.6
385021.12	1	2	4	8	20.0	20.0	20.0	0.1	0.6	0.4
388576.3	3	11	10	4	23.1	73.3	48.2	0.3	0.8	0.5
389746.2	1	2	17	24	5.6	7.7	6.6	1.1	1.6	1.4
391002.6	2	7	13	24	13.3	22.6	18.0	0.3	0.8	0.5
391046.2	1	10	4	17	20.0	37.0	28.5	0.1	0.5	0.3
391396.96	1	11	3	10	25.0	52.4	38.7	0.1	1.0	0.6
391617.54	6	13	18	28	25.0	31.7	28.4	1.4	1.4	1.4
392228.66	0	0	9	54	0.0	0.0	0.0	0.1	0.7	0.4
392243.17	0	0	21	10	0.0	0.0	0.0	1.1	0.4	0.7
392243.52	0	0	33	36	0.0	0.0	0.0	1.0	1.5	1.3
392271.58	4	5	10	11	28.6	31.3	29.9	0.4	0.6	0.5
392637.10	1	12	16	0	5.9	100.0	52.9	0.6	0.5	0.5
392657.8	7	2	26	11	21.2	15.4	18.3	2.0	1.85	1.9
392661.18	0	0	54	51	0.0	0.0	0.0	2.1	1.9	2.0
393077.54	7	5	17	39	29.2	11.4	20.3	0.8	2.5	1.6
393280.64	25	53	56	0	30.9	100.0	65.4	2.8	2.0	2.4
393385.39	41	11	54	55	43.2	16.7	29.9	2.3	2.1	2.2
394005.115	0	0	50	44	0.0	0.0	0.0	1.5	1.7	1.6
394051.4	3	2	32	20	8.6	9.1	8.8	0.8	0.4	0.6
396010.42	14	25	15	28	48.3	47.2	47.7	0.9	1.6	1.3
393574.72 B	0	0	30	45	0.0	0.0	0.0	1.6	1.9	1.8
K.Chipsona-2	6	29	19	4	24.0	87.9	55.9	0.7	1.3	1.0
RW-8201.19	9	9	15	24	37.5	27.3	32.4	0.3	1.1	0.7
LBr-40	40	4	16	35	71.4	10.3	40.8	3.4	3.1	3.2
392227.15	15	2	20	5	42.9	28.6	35.7	1.0	0.1	0.6
394038.105	0	0	38	33	0.0	0.0	0.0	2.4	2.2	2.3
388572.4	3	68	7	0	30.0	100.0	65.0	0.1	1.7	0.9
BR 63/65	8	17	65	20	11.0	45.9	28.5	0.7	1.4	1.0
396233.38	0	-	7	-	0.0	-	0.0	0.1	-	0.1
800982	0	-	18	-	0.0	-	0.0	0.8	-	0.8
384331.10 LB	1	-	11	-	8.3	-	8.3	0.1	-	0.1
388572.1	0	-	15	-	0.0	-	0.0	0.1	-	0.1
388574.6D	0	-	71	-	0.0	-	0.0	0.7	-	0.7
388578.2 D	1	-	19	-	5.0	-	5.0	0.2	-	0.2
AKK-69.1	11	-	27	-	28.9	-	28.9	0.6	-	0.6
CEZ-69.1	18	-	4	-	81.8	-	81.8	1.6	-	1.6
Curza-27	2	-	18	-	10.0	-	10.0	0.6	-	0.6
K.Chipsona-1	5	-	16	-	23.8	-	23.8	0.9	-	0.9
Kinga	3	-	8	-	27.3	-	27.3	0.1	-	0.1
390347.50	11	-	0	-	100.0	-	100.0	0.2	-	0.2
T-55X TPS-67	3	-	38	-	7.3	-	7.3	0.5	-	0.5
388580.6	0	-	18	-	0.0	-	0.0	0.6	-	0.6
LBr-20	7	-	46	-	13.2	-	13.2	1.2	-	1.2
LBr-43	7	-	25	-	21.9	-	21.9	1.2	-	1.2
LBr-44	17	-	30	-	36.2	-	36.2	2.0	-	2.0
NPI-106	0	-	54	-	0.0	-	0.0	1.7	-	1.7
Mineara	0	-	35	-	0.0	-	0.0	0.6	-	0.6
388764.26 LB	23	-	31	-	42.6	-	42.6	1.4	-	1.4
Andinita	0	-	35	-	0.0	-	0.0	0.1	-	0.1
DxLBr44-36	1	-	79	-	1.3	-	1.3	1.3	-	1.3

Acc. No.	Infected tubers (No.)		Healthy tubers (N0)		Wart incidence %			Tuber yield (kg/plot)		
	2007	2008	2007	2008	2007	2008	Mean	2007	2008	Mean
DxLBr44-13	1	-	70	-	1.4	-	1.4	0.7	-	0.7
DxLBr44.6	0	-	46	-	0.0	-	0.0	1.2	-	1.2
DxLBr40.10	0	-	72	-	0.0	-	0.0	3.2	-	3.2
DxLBR40-11	3	-	69	-	4.2	-	4.2	2.4	-	2.4
DxLBr43.13	0	-	82	-	0.0	-	0.0	2.0	-	2.0
DxLBr43.12	0	-	84	-	0.0	-	0.0	2.0	-	2.0
DxLBr43.25	2	-	46	-	4.2	-	4.2	1.0	-	1.0
CxLBr40-5	1	-	25	-	3.8	-	3.8	0.7	-	0.7
Cx LBr 40.6	2	-	22	-	8.3	-	8.3	0.8	-	0.8
CxLBr40.14	0	-	73	-	0.0	-	0.0	2.6	-	2.6
JDxLBr40-5	13	-	45	-	22.4	-	22.4	2.4	-	2.4
386201.3	0	-	8	-	0.0	-	0.0	0.2	-	0.2
391058.35	8	-	16	-	33.3	-	33.3	0.7	-	0.7
392240.29	3	-	12	-	20.0	-	20.0	0.2	-	0.2
392258.11	4	-	7	-	36.4	-	36.4	0.1	-	0.1
393280.57	8	-	28	-	22.2	-	22.2	1.7	-	1.7
393339.242	2	-	6	-	25.0	-	25.0	0.2	-	0.2
395014.97	2	-	12	-	14.3	-	14.3	0.5	-	0.5
396082.7	-	0	-	43	-	0.0	0.0	-	0.83	0.83
394007.55	-	28	-	0	-	100.0	100.0	-	1.40	1.40
392270.32	-	0	-	37	-	0.0	0.0	-	0.85	0.85
385556.4	-	20	-	10	-	66.7	66.7	-	1.15	1.15
Panauti	-	0	-	22	-	0.0	0.0	-	2.05	2.05
392236.6	-	51	-	0	-	100.0	100.0	-	1.73	1.73
BSUPO-3	-	33	-	38	-	46.5	46.5	-	2.19	2.19
K. Giriraj	-	0	-	25	-	0.0	0.0	-	0.66	0.66
394005.12	-	4	-	39	-	9.3	9.3	-	2.02	2.02
388764.26	-	0	-	41	-	0.0	0.0	-	1.60	1.60
393077.16	-	4	-	31	-	11.4	11.4	-	2.30	2.30
393382.44	-	5	-	29	-	14.7	14.7	-	1.80	1.80
392206.35	-	0	-	67	-	0.0	0.0	-	1.90	1.90
Khumal- Seto-1 (Ch)	0	-	51	-	0.0	-	0.0	0.2	-	0.2
Kufri Jyoti (Ch)	0	-	43	-	0.0	-	0.0	0.6	-	0.6
Janak Dev (Ch)	0	-	45	-	0.0	-	0.0	2.6	-	2.6
Kufri Jyoti (Ch)	0	-	36	-	0.0	-	0.0	0.8	-	0.8
Khumal Rato-2 (Ch)	0	-	30	-	0.0	-	0.0	0.9	-	0.9
Cardinal (Ch)	0	-	54	-	0.0	-	0.0	0.8	-	0.8
Desiree (Ch)	0	-	37	-	0.0	-	0.0	0.8	-	0.8
Rosita (Ch)	55	48	40	26	57.9	64.9	61.4	3.0	3.51	3.26

Total test entries in 2007 were 80 and 45 in 2008. Plot size 1.5 m^2