Screening of Rapeseed Genotypes against Alternaria Leaf Blight Resistance at Nawalpur, Sarlahi

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Abstract: Rapeseed is major oilseed crop of Nepal but its yield is limited due to various factors and one of the major limiting factors is leaf blight disease caused by *Alternaria brassicae* (Berk.). An experiment was conducted at Oilseed research Program, Nawalpur, Sarlahi, Nepal during two consecutive years viz. 2019 and 2020 to screen the rapeseed genotypes against alternaria leaf blight disease. The research was conducted in augments design with each genotype sown in two rows of 3 m length 30 cm apart and disease was allowed to develop naturally in the field. Four times scoring of disease was done starting from 49 days after sowing at seven days interval. Out of one hundred and ninety genotypes used in evaluation, there were no genotypes that were immune or completely resistant to the disease but thirty one genotypes during 2019 and eight genotypes during 2020 were found to be moderately resistant to the disease. One genotype ICT 2010-7 was found to be moderately susceptible in both the years' observations. Area under disease progress curve (AUDPC) value for three genotypes (ICT 2001-6, ICT 2001-7, and ICT 2010-9) during 2019 and six genotypes (ICT 2010-7, S R O 2, ICT 2004-1, NGRC 2798, ICT 2004-42, and ICT 2006-3) during 2020 was lower (<400) representing lower disease progress. Hence the genotypes that were moderately resistant as well as have lower AUDPC value can be utilized in future by plant breeders and plant pathologist for development of tolerant varieties as durable resource for disease management.

Keywords: Alternaria leaf blight, Genotypes, Rapeseed, Resistant, Nawalpur

Introduction

Rapeseed (*Brassica campestris* L. var. Toria, 2n=20)) and mustard (*Brassica juncea L.* Czern and Coss, 2n=4x=36) are major oilseed crops in contributing nearly 84% of total oilseed produced in Nepal (MoALD, 2021). Rapeseed and mustard oil has multiple daily uses in Nepalese family. The national production merely meets 68.7% of national requirements and huge amount of rapeseed (106599 ton) is being imported (NFTS, 2020). Although high volume of rapeseed is imported the national production could not be increased satisfactorily as there are various biotic and abiotic factors that limit rapeseed production.

Among the various factors, biotic factor leaf blight disease caused by *Alternaria brassicae* (Berk.) is the most responsible factor reporting about 32-57 percent yield losses in rapeseed in Nepal. Apart from yield the disease also reduced the produce quality by reducing seed size, oil content and impairing seed colors (Kaushik et al., 1984). Various conventional (fungicides and fertilizers application, soil dressing, seed treatments, tillage operations etc. and non-conventional (plant activators, bio-control agents, plant extracts, ionic contents comparisons through biochemical analysis etc. approaches are being utilized used for alternaria leaf spot disease management (Bhatt et al., 2009).

In chemical control measures there is need of repeated application of fungicides resulting difficulty in spraying in standing crop and sometimes being un-economical practice, so there is need of alternate approach for disease management (Chattopadhyay et al., 2005). Fungicide applied for disease control is contaminating not only soil and environment but also degrading the quality of oil at the same time so there is need of adequate, eco friendly and promising approach for quality production (Singh et al., 2015). Awareness

among the farmers on the risk involved in the use of fungicides much attention is being focused on the integrated approach pathogen management (Kumar et al., 2014) and the method of controlling the disease by using resistant varieties is to be recognized through study on resistant source (Shah et al., 2005; Prasad et al., 2003). Host plant resistance is very important approach to control much disease of various crops in many developing countries (Tengey et al., 2018). Alternaria blight severity on rapeseed-mustard differs among seasons and regions and also between individual crops within a region. This may be due to existence of variability within the isolates of *Alternaria* spp. (Meena et al., 2005; Verma et al., 2006). So identification of resistant source could be an appropriate means for addressing the problem. Sometimes plant morphology and anatomy is also related to govern the resistance of crop and protect plants from pathogen invasion (Barsa et al., 1985, Kaur and Dhillon, 1990).

Therefore, the field experiments were designed and conducted at Oilseed Research Program (ORP), Nawalpur, Sarlahi during 2019 and 2020 to find the resistant genotypes which can be included in the breeding program and develop resistant cultivars.

Material and Methods

Experimental Site

The field experiment was conducted at field of ORP, Nawalpur, Sarlahi, Nepal in 2019 and 2020. The collection of indigenous and exotic rapeseed genotypes at ORP was used for the experiment.

Experimental Materials, Design and Setup

A total of one hundred ninety genotypes of rapeseed received from national as well as international institution including check were evaluated against alternaria leaf spot during 2019 and 2020 respectively. Trial was conducted during winter season under natural epiphytotic condition in augmented design in a single replication with single genotype sown in 2-rows of 1m 3m length having spacing line to line 30 cm and plant to continuous. The nursery was surrounded by 2-rows of susceptible border mixture to produce sufficient inoculums to infect the test entries. Chemical fertilizer was applied @ 60:40: 20; N: P_2O_5: K_2O kg/ha in which phosphatic and potassium fertilizer used as a basal dose while nitrogenous fertilizer in a split dose. All the agronomic practices were provided for excellent growth of the crop and disease development.

Disease Assessment

Alternaria blight disease scoring was done four times in 7 days interval on (0-9) scale suggested by Ghosh et al. 2009, after completion of flowering of the crop (49 days after sowing) and maximum score was considered for the evaluation of test entries. For visual estimation of severity, 0-9 point scale (No infection – 0; 0-10% leaf area infected – 1; 10-20% leaf area infected – 2; 20-30% leaf area infected – 3; 30-40% leaf area infected – 4; 40-50% leaf area infected – 5; 50-60% leaf area infected – 6; 60-70% leaf area infected – 7; 70-80% leaf area infected – 8; 80-90% or more leaf area infected – 9) were used for rating of all foliar diseases studied. Similarly, area under disease progress curve (AUDPC) was calculated and total AUDPC value was considered for evaluation.

Results and Discussion

Meteorological Information

Weather data on average minimum temperature, average maximum temperature and relative humidity during crop period of year 2019 and year 2020 at ORP, Nawalpur, Sarlahi were found to be favorable for disease development (Table 1). In February, the weather became congenial to disease development. Severity of alternaria blight on leaves (Meena et al., 2002) and pods (Sandhu et al., 1985) were higher in late sown crops. The coincidence of the vulnerable growth stage of plants with favorable (maximum temperature: 18-26^{0}C; minimum temperature: 8-12^{0}C) and humid (mean RH > 70%) results in disease severity. Most of the genotypes found susceptible to alternaria blight because of conducive weather condition during the crop season and none of the genotypes were found completely resistant to alternaria blight disease (Singh et al., 2022; Chakrabarty et al., 2018).

Table 1: Weather data on average minimum temperature, average maximum temperature and relative humidity during crop period of year 2019 and year 2020 at ORP, Nawalpur, Sarlahi

Year	2019			2020		
Month	Average temperature, ^{o}C		Relative humidity	Average temperature, ^{o}C		Relative humidity
	Minimum	Maximum		Minimum	Maximum	

September	24.24	35.8	82.7	23.72	36.2	84.44
October	17.6	31.2	73.3	18.64	30.51	68.9
November	11.3	29.21	65.6	10.94	33.48	55.42
December	9.31	27.76	76.2	6.09	28.95	72.17
January	6.22	25.98	90.6	4.98	26.12	91.2
February	6.12	27.56	82.3	4.68	29.33	75.07

Disease Severity

During 2019, out of 190 genotypes were screened, none of the genotypes were found resistant or disease free; 21 genotypes were found moderately resistant (3 score in 0-9 scoring scale); 128 genotypes were moderately susceptible (4 or 5 score in 0-9 scoring scale) and 41 genotypes were found to be susceptible (6 or 7 score in 0-9 scoring scale) against alternaria blight disease (Figure 1 and Table 2). Based on total AUDPC value ICT 2004-1 was found to be mostly disease affected genotype with AUDPC value 1322 whereas the lowest AUDPC value 272 was calculated in genotype ICT 2006-6 followed by genotypes ICT 2001-7 and ICT 2010-9 with AUDPC value 350 (Table 3).

During 2020, out of 190 genotypes were screened, none of the genotypes were found resistant or disease free; 8 genotypes (viz. SRO 2, ICT 2004-1, ICT 2010-7, NGRC 2798, ICT 2004-42, ICT 2006-3, Morang-2, and ICT 2003-10) were found moderately resistant (3 score in 0-9 scoring scale); 104 genotypes were moderately susceptible (4 or 5 score in 0-9 scoring scale) and 68 genotypes were found to be susceptible (6 or 7 score in 0-9 scoring scale) and 10 genotypes were found to be highly susceptible (8 or 9 score in 0-9 scoring scale) against alternaria blight disease (Figure 1 and Table 2). Based on total AUDPC value ICT 2004-44, ICT 2001-13, ICT 2002-11 and ICT 2012-81 were found to be mostly disease affected genotype with AUDPC value 933 whereas the lowest AUDPC value 311 was calculated in genotype SRO 2 and ICT 2004-1 followed by genotypes ICT 2010-7and NGRC 2798 with AUDPC value 350 (Table 3).

During both years observation, none of the evaluated genotypes were found to be totally resistant to disease. Similar observation was made by Srivastva et al., (2001) when fifty-four lines/varieties were tested in an alternaria sick plot and none of the varieties were found to be resistant to alternaria blight. None of the variety was found disease free when 81 Indian mustard lines were screened in Faizabad, India Singh et al., (2009). The genotype ICT 2010-7 was found to be moderately resistant in both years observations whereas genotypes NGRC 2752, ICT 2012-98, ICT 2012-82, ICT 2012-61, ICT 2012-6, ICT 2012-59, ICT 2012-58, ICT 2012-27, ICT 2010-9, ICT 2010-7, ICT 2009-2, ICT 2006-4, ICT 2002-9, ICT 2001-7, ICT 2001-6, ICT 2001-44, ICT 2001-44, ICT 2001-40, ICT 2001-11, NGRC 2798, ICT 2003-10, SRO 2, ICT 2006-3, ICT 2004-42 and ICT 2004-1 were found moderately resistant to alternaria blight either in 2019 or in 2020 observations (Table 2). When AUDPC value was observed the genotypes ICT 2001-6, ICT 2001-7, ICT 2010-9 showed comparatively lower disease severity (AUDPC < 400) during 2019 whereas genotypes ICT 2010-7, S R O 2, ICT 2004-1, NGRC 2798, ICT 2004-42, and ICT 2006-3 have lower AUDPC value (AUDPC < 400) during 2020 observations (Table 3). The moderately resistant varieties could be utilized for development disease tolerant varieties in future by breeder and pathologist.

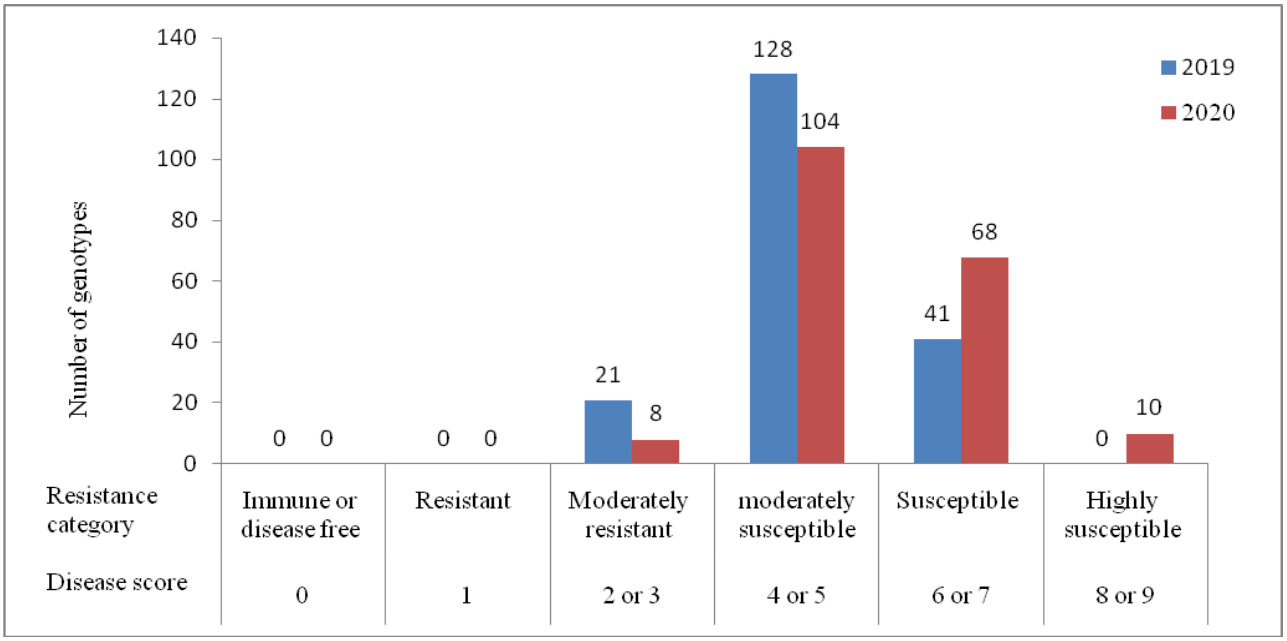

Figure 1: Rapeseed genotypes showing different level of resistance to alternaria leaf blight during 2019 and 2020 at ORP, Nawalpur, Sarlahi

Table 2: Resistance reaction of rapeseed genotypes to alternaria leaf blight, 2019 and 2020 at ORP, Nawalpur, Sarlahi.

Disease score	Resistance category	Year	Genotypes
0	Immune or disease free	2019	
		2020	
1	Resistant	2019	
		2020	
2 and 3	Moderately resistant	2019	NGRC 2752, Morang-2, ICT 2012-98, ICT 2012-82, ICT 2012-61, ICT 2012-6, ICT 2012-59, ICT 2012-58, ICT 2012-27, ICT 2010-9, ICT 2010-7, ICT 2009-2, ICT 2006-4, ICT 2002-9, ICT 2001-7, ICT 2001-6, ICT 2001-44, ICT 2001-44, ICT 2001-40, ICT 2001-11, Bikash
		2020	ICT 2010-7, NGRC 2798, Morang-2, ICT 2003-10, SRO 2, ICT 2006-3, ICT 2004-42, ICT 2004-1

4 and 5	Moderately susceptible	2019	S R O 98, S R 0 8, S R 0 5, NGRC 2798, NGRC 2797, NGRC 2791, NGRC 2790, NGRC 2777, NGRC 2767, NGRC 2763, NGRC 2761, NGRC 2753, NGRC 2295, Mustang Local, Morang-2 (5), INGRC 2775, ICT 2025-1, ICT 2012-97, ICT 2012-96, ICT 2012-94, ICT 2012-81, ICT 2012-7, ICT 2012-62, ICT 2012-36, ICT 2012-16, ICT 2010-4, ICT 2010-3, ICT 2010-19, ICT 2010-10, ICT 2010-1, ICT 2006-3, ICT 2004-52, ICT 2003-10, ICT 2002-10, ICT 2001-36, ICT 2001-23, ICT 2001-12, Doti Local, Bikash (5) , BC 08-7, ACC# 9109, Unnati (7), SRO 15, SR 06, S R O 7, S R 0 4, Preeti (6), NGRC 2793, NGRC 2785, NGRC 2783, NGRC 2776, NGRC 2775, NGRC 2766, NGRC 2760, NGRC 2759, NGRC 2757, NGRC 2756,NGRC 2751, NGRC 2750, NGRC 2749, ICT 2015-2, ICT 2012-92, ICT 2012-90, ICT 2012-87, ICT 2012-86, ICT 2012-78, ICT 2012-76, ICT 2012-74, ICT 2012-67, ICT 2012-38, ICT 2012-38, ICT 2012-35, ICT 2012-26, ICT 2012-242, ICT 2012-22, ICT 2012-15, ICT 2012-13, ICT 2012-120, ICT 2012-110, ICT 2012-103, ICT 2012-10, ICT 2012.101, ICT 2010-24, ICT 2010-17, ICT 2010-14, ICT 2010-12, ICT 2010-11, ICT 2009-3, ICT 2009-1, ICT 2006-4, ICT 2006-2, ICT 2004-1, ICT 2003-5, ICT 2003-24, ICT 2003-12, ICT 2002-8, ICT 2002-5, ICT 2002-16, ICT 2002-11, ICT 2001-41,ICT 2001-4, ICT 2001-20, ICT 2001-2, ICT 2001-19, Gopi Tori, Goldee Tori, Bal tori, ACC#9118, ACC # 5738
		2020	NGRC 2752, ICT 2009-2, ICT 2001-11, NGRC 2295, ICT 2012-94, ICT 2010-4, ICT 2001-12, Bikash , Preeti (5), NGRC 2766, NGRC 2756, ICT 2012-26, ICT 2012-110, ICT 2006-2, ICT 2003-5, ICT 2001-20, ICT 2012-60, ICT 2012-202, ICT 2010-6, ICT 2010-2, ICT 2006-1, ICT 2010-11, ICT 2001-35, ICT 2012-82, ICT 2012-6, ICT 2012-27, ICT 2001-7, ICT 2001-44, ICT 2001-40, Unnati (2),S R 0 5, NGRC 2797, NGRC 2790, NGRC 2777, NGRC 2767, NGRC 2763, NGRC 2761, NGRC 2753, Morang-2 (5), ICT 2025-1, ICT 2012-96, ICT 2012-7, ICT 2012-36, ICT 2012-16, ICT 2010-3, ICT 2004-52, ICT 2002-10, ICT 2001-36, ICT 2001-23, ACC# 9109, S R O 7, S R 0 4, NGRC 2793, NGRC 2776, NGRC 2760, NGRC 2759, NGRC 2757, NGRC 2751, NGRC 2750, NGRC 2749, ICT 2015-2, ICT 2012-92, ICT 2012-90, ICT 2012-87, ICT 2012-76, ICT 2012-74, ICT 2012-67, ICT 2012-38, ICT 2012-35, ICT 2012-242, ICT 2012-22, ICT 2012-120, ICT 2012-103, ICT 2012.101, ICT 2010-14, ICT 2009-3, ICT 2006-4, ICT 2004-1, ICT 2003-24, ICT 2003-12, ICT 2002-5, ICT 2002-16, ACC # 5738, Uttara, S R 0 3, NGRC 2800, NGRC 2762, ICT 2012-41, ICT 2001-34, ICT 2001-25, ICT 2012-1, ICT 2002-10, ICT 2001-20
6 and 7	Susceptible	2019	Uttara, S R O 2, S R 0 3, Preeti (2), NGRC 2800, NGRC 2765, NGRC 2762, Morang-2 (2), ICT 2012-85, ICT 2012-60, ICT 2012-47, ICT 2012-41, ICT 2012-37, ICT 2012-202, ICT 2012-157, ICT 2010-6, ICT 2010-2, ICT 2006-3, ICT 2006-3, ICT 2006-1, ICT 2004-42, ICT 2003-9, ICT 2003-3, ICT 2002-24, ICT 2001-34, ICT 2001-25, ICT 2001-25, ICT 2001-13, Chitwan local, Unnati, ICT 2012-1, ICT 2010-11, ICT 2004-44, ICT 2004-1, ICT 2002-4, ICT 2002-10, ICT 2001-35, ICT 2001-20, Bikash
		2020	ACC#9118, Bal tori, BC 08-7, Bikash (3), , Chitwan local, Doti Local, Goldee Tori, Gopi Tori, ICT 2001-19, ICT 2001-2, ICT 2001-25, ICT 2001-4, ICT 2001-41, ICT 2001-44, ICT 2001-6, ICT 2002-24, ICT 2002-4, ICT 2002-8, ICT 2002-9, ICT 2003-3, ICT 2003-9, ICT 2006-3, ICT 2006-3, ICT 2006-4, ICT 2009-1, ICT 2010-1, ICT 2010-10, ICT 2010-11, ICT 2010-12, ICT 2010-17, ICT 2010-19, ICT 2010-24, ICT 2010-9, ICT 2012-10, ICT 2012-13, ICT 2012-157, ICT 2012-37, ICT 2012-38, ICT 2012-47, ICT 2012-58, ICT 2012-59, ICT 2012-61, ICT 2012-78, ICT 2012-85, ICT 2012-97, ICT 2012-98, INGRC 2775, Morang -2, Mustang Local, NGRC 2765, NGRC 2775, NGRC 2785, Unnati (6), NGRC 2791, Preeti (3), S R 0 8, S R O 98, SR 06, SRO 15
8 and 9	Highly susceptible	2019	
		2020	ICT 2001-13, ICT 2002—11, ICT 2004-44, ICT 2012-15, ICT 2012-62, ICT 2012-81, ICT 2012-86, NGRC 2783

Table 3: Data for disease scoring and area under disease curve value for rapeseed genotypes against alternaria blight disease at ORP, Nawalpur, Sarlahi

SN	Genotypes	2019					2020				
		DS 1	DS 2	DS 3	DS 4	AUDPC	DS 1	DS 2	DS 3	DS 4	AUDPC
1	ICT 2006-3	2	3	5	6	933	1	2	3	6	661
2	ICT 2001-25	2	3	5	6	933	1	2	4	7	778
3	ICT 2002-4	2	3	5	7	972	2	2	4	7	817
4	ICT 2002-10	3	5	6	7	1244	1	2	3	5	622
5	ICT 2004-44	3	5	6	7	1244	2	2	5	8	933
6	Unnati	1	3	4	7	856	1	2	4	6	739

7	ICT 2010-11	1	3	3	5	700	1	2	4	6	739
8	ICT 2001-2	1	1	3	5	544	1	2	3	6	661
9	ICT 2001-13	2	2	5	6	856	2	2	5	8	933
10	ICT 2002—11	1	3	3	5	700	2	2	5	8	933
11	ICT 2002-16	1	2	3	5	622	1	2	3	5	622
12	Morang -2	1	3	5	6	894	1	2	4	6	739
13	ICT 2002-24	2	4	5	6	1011	1	2	4	6	739
14	ACC # 5738	1	3	3	5	700	2	2	2	5	583
15	ICT 2001-35	1	3	5	7	933	0	2	2	4	467
16	ICT 2001-34	2	4	5	6	1011	1	2	3	5	622
17	ICT 2001-41	1	2	3	5	622	2	2	3	6	700
18	Preeti	1	3	4	5	778	1	2	4	7	778
19	Uttara	1	3	4	6	817	0	1	3	5	506
20	ICT 2010-6	2	4	4	6	933	0	2	2	4	467
21	ICT 2025-1	1	2	2	4	506	2	2	2	5	583
22	NGRC 2798	1	2	2	4	506	0	1	2	3	350
23	S R O 98	2	3	3	4	700	2	2	5	7	894
24	Bikash	1	3	4	4	739	1	2	4	7	778
25	ICT 2010-7	1	2	3	3	544	0	1	2	3	350
26	S R O 7	1	3	3	5	700	0	1	3	5	506
27	ICT 2001-4	1	3	3	5	700	1	2	3	6	661
28	ICT 2006-4	2	3	3	5	739	1	2	3	5	622
29	ICT 2001-7	0	1	2	3	350	0	1	3	5	506
30	Unnati	1	3	3	4	661	1	2	4	6	739
31	ICT 2006-1	1	3	5	6	894	0	2	2	4	467
32	ICT 2009-3	1	3	4	5	778	1	2	4	5	700
33	ICT 2006-3	0	2	3	4	544	2	2	4	7	817
34	ICT 2003-24	0	2	3	5	583	2	2	2	5	583
35	ICT 2010-9	0	1	2	3	350	1	2	4	6	739
36	Morang-2	1	3	5	5	856	2	2	2	5	583
37	ICT 2002-10	1	3	4	4	739	2	2	2	5	583
38	ICT 2010-3	1	2	3	4	583	1	2	3	5	622
39	ICT 2004-52	1	2	2	4	506	2	2	2	5	583
40	ICT 2006-4	1	3	3	3	622	1	2	4	6	739
41	ICT 2001-44	1	2	3	3	544	0	1	3	5	506
42	Preeti	1	3	3	5	700	2	2	2	5	583
43	NGRC 2753	1	3	4	4	739	2	2	2	5	583
44	ICT 2001-11	0	1	3	3	428	0	2	2	4	467
45	ICT 2003-5	1	3	4	5	778	0	2	2	4	467
46	NGRC 2295	0	1	3	4	467	2	2	2	4	544
47	ICT 2001-20	3	5	6	7	1244	2	2	2	5	583
48	Bikash	0	2	4	4	622	0	2	2	4	467
49	ICT 2003-9	2	4	5	6	1011	1	2	4	6	739
50	ICT 2010-19	0	3	4	4	700	1	2	4	7	778
51	ICT 2001-6	0	1	1	3	272	1	2	5	7	856
52	ICT 2001-44	0	1	3	3	428	1	2	5	7	856
53	NGRC 2765	3	5	5	6	1128	1	2	4	6	739
54	Unnati	2	3	5	5	894	0	2	4	7	739
55	ICT 2009-2	0	1	3	3	428	0	2	2	4	467
56	ICT 2010-4	0	1	4	4	544	0	2	2	4	467
57	ICT 2010-10	0	1	4	4	544	1	2	4	6	739
58	Doti Local	3	3	3	4	739	1	2	4	6	739
59	ICT 2003-10	1	3	3	4	661	0	2	2	3	428
60	Morang-2	0	1	3	3	428	1	2	4	5	700
61	ICT 2002-9	0	1	3	3	428	1	2	4	6	739
62	SR 06	0	1	3	5	506	2	2	3	6	700
63	ICT 2003-12	0	1	3	5	506	2	2	2	5	583
64	ICT 2010-2	3	5	6	6	1206	0	2	2	4	467
65	ICT 2004-1	3	5	7	7	1322	1	1	1	3	311
66	Preeti	2	4	6	7	1128	0	2	2	4	467
67	ICT 2006-2	1	3	5	5	856	2	2	2	4	544
68	ICT 2006-3	3	5	6	6	1206	1	1	2	3	389
69	S R O 2	3	5	6	6	1206	1	1	1	3	311
70	NGRC 2766	3	5	5	5	1089	2	2	2	4	544
71	ICT 2004-42	2	3	5	6	933	1	1	2	3	389

72	Bikash	1	3	5	5	856	1	1	2	4	428
73	ICT 2010-11	2	3	5	7	972	1	1	2	4	428
74	ICT 2001-25	1	2	5	6	817	0	1	3	5	506
75	ICT 2002-5	1	3	5	5	856	0	1	3	5	506
76	ICT 2009-1	1	2	4	5	700	0	1	4	6	622
77	ICT 2004-1	1	3	5	5	856	0	1	3	5	506
78	Unnati	1	3	4	5	778	1	2	4	6	739
79	Bal tori	1	3	4	5	778	0	1	4	6	622
80	ICT 2003-3	1	3	5	6	894	1	2	4	6	739
81	ICT 2010-1	1	3	4	4	739	1	2	5	7	856
82	ICT 2001-36	1	3	4	4	739	2	2	2	5	583
83	ICT 2010-12	1	3	5	5	856	1	2	4	6	739
84	Morang-2	1	3	4	4	739	0	2	2	3	428
85	ICT 2001-40	1	1	3	3	467	2	2	2	5	583
86	NGRC 2777	1	3	3	4	661	0	1	3	5	506
87	ICT 2001-20	1	3	4	5	778	0	2	2	4	467
88	ICT 2001-23	1	3	3	4	661	2	2	2	5	583
89	Chitwan local	3	5	5	6	1128	1	2	3	6	661
90	Preeti	3	3	5	5	933	0	1	3	5	506
91	ICT 2015-2	3	3	5	5	933	1	2	3	5	622
92	ICT 2001-19	3	3	5	5	933	2	2	4	7	817
93	ICT 2002-8	3	4	5	5	1011	1	2	4	7	778
94	NGRC 2749	1	3	5	5	856	1	2	4	5	700
95	NGRC 2752	3	3	3	3	700	1	2	3	4	583
96	Bikash	3	4	5	7	1089	1	2	4	7	778
97	Gopi Tori	3	4	5	5	1011	1	2	4	6	739
98	ICT 2010-17	3	4	5	5	1011	1	2	4	6	739
99	Goldee Tori	1	3	4	5	778	1	2	4	6	739
100	ICT 2010-24	1	3	3	5	700	1	2	4	6	739
101	ICT 2012-1	3	5	6	7	1244	1	2	3	5	622
102	Unnati	1	3	4	5	778	1	2	4	6	739
103	ICT 2012-13	1	3	4	5	778	1	2	4	7	778
104	ICT 2010-14	1	3	4	5	778	1	2	3	5	622
105	ICT 2012-38	1	3	5	5	856	0	2	2	5	506
106	ICT 2012-41	3	4	5	6	1050	1	2	3	5	622
107	ICT 2012-47	3	4	6	6	1128	1	2	4	6	739
108	Preeti	3	5	6	6	1206	0	1	4	6	622
109	ICT 2012-60	3	5	6	6	1206	0	2	2	4	467
110	ICT 2012-67	1	3	4	5	778	2	2	2	5	583
111	ICT 2012-74	1	3	4	5	778	2	2	2	5	583
112	ICT 2012-35	1	3	4	5	778	1	2	3	5	622
113	ICT 2012.101	1	3	5	5	856	1	2	3	5	622
114	Morang-2	1	2	3	4	583	1	2	3	5	622
115	ICT 2012-120	1	4	5	5	933	2	2	2	5	583
116	SRO 15	2	3	4	5	817	2	2	5	7	894
117	ICT 2012-90	1	3	4	5	778	2	2	2	5	583
118	ICT 2012-85	1	3	5	6	894	1	2	4	6	739
119	ICT 2012-37	1	3	5	6	894	1	2	4	7	778
120	Bikash	1	3	5	5	856	1	2	5	8	894
121	NGRC 2759	1	3	5	5	856	1	2	3	5	622
122	ICT 2012-22	1	3	5	5	856	1	2	3	5	622
123	ICT 2012-94	1	2	3	4	583	0	2	2	4	467
124	ICT 2012-36	1	3	4	4	739	1	2	3	5	622
125	ICT 2012-97	1	3	3	4	661	1	2	5	7	856
126	Unnati	1	3	4	4	739	0	1	4	6	622
127	ICT 2012-15	1	3	5	5	856	1	2	5	8	894
128	ICT 2012-81	1	3	4	4	739	2	2	5	8	933
129	ICT 2012-86	2	3	5	5	894	1	2	5	8	894
130	ICT 2012-62	1	3	3	4	661	1	2	5	8	894
131	ICT 2012-27	1	2	3	3	544	1	2	4	5	700
132	Preeti	1	3	3	5	700	1	2	3	4	583
133	ICT 2012-82	1	3	3	3	622	1	2	4	5	700
134	ICT 2012-110	1	3	4	5	778	0	2	2	4	467
135	ICT 2012-6	1	2	2	3	467	1	2	3	5	622
136	ICT 2012-16	1	3	4	4	739	2	2	2	5	583

137	NGRC 2763	1	3	4	4	739	1	2	3	5	622
138	Morang-2	1	2	4	4	661	2	2	2	5	583
139	NGRC 2790	1	2	3	4	583	2	2	2	5	583
140	ICT 2012-38	1	3	4	5	778	1	2	4	6	739
141	ICT 2012-98	0	1	3	3	428	1	2	4	6	739
142	ICT 2012-58	0	1	3	3	428	1	2	4	6	739
143	ICT 2012-61	0	1	3	3	428	1	2	4	6	739
144	Bikash	0	1	3	3	428	1	2	4	6	739
145	ICT 2012-59	0	1	3	3	428	1	2	4	6	739
146	ICT 2012-96	1	3	3	4	661	1	2	4	5	700
147	ICT 2012-76	1	2	4	5	700	1	2	4	5	700
148	NGRC 2791	0	1	3	4	467	1	2	4	6	739
149	ICT 2012-78	1	3	5	5	856	1	2	4	6	739
150	Unnati	1	3	4	4	739	0	1	3	5	506
151	ICT 2012-87	1	3	4	5	778	2	2	2	5	583
152	ICT 2012-92	1	3	4	5	778	1	2	3	5	622
153	ICT 2012-103	1	3	4	5	778	1	2	3	5	622
154	ICT 2012-7	1	3	4	4	739	1	2	3	5	622
155	BC 08-7	1	3	4	4	739	0	1	4	6	622
156	Preeti	1	3	4	4	739	1	2	4	7	778
157	ICT 2012-10	1	3	5	5	856	1	2	4	6	739
158	ACC# 9109	1	3	4	4	739	0	2	2	5	506
159	ACC#9118	2	3	4	5	817	0	1	4	6	622
160	Mustang Local	2	3	3	4	700	1	2	4	6	739
161	NGRC 2783	2	3	4	5	817	1	2	5	8	894
162	Morang-2	2	3	5	6	933	1	2	5	8	894
163	NGRC 2775	2	3	5	5	894	1	2	4	7	778
164	S R 0 8	1	3	3	4	661	1	2	3	6	661
165	INGRC 2775	1	2	3	4	583	1	2	4	7	778
166	NGRC 2756	1	3	5	5	856	1	2	3	4	583
167	NGRC 2785	2	3	4	5	817	2	2	3	6	700
168	Bikash	2	3	5	5	894	2	2	2	5	583
169	S R 0 5	2	3	4	4	778	2	2	2	5	583
170	NGRC 2762	2	4	5	6	1011	2	2	2	5	583
171	NGRC 2776	2	4	5	5	972	2	2	2	5	583
172	NGRC 2800	1	5	6	6	1128	1	2	3	5	622
173	S R 0 3	2	4	6	6	1089	1	2	3	5	622
174	Unnati	1	2	4	5	700	1	2	4	5	700
175	NGRC 2757	1	2	4	5	700	1	2	3	5	622
176	NGRC 2767	1	3	4	4	739	2	2	2	5	583
177	S R 0 4	1	3	5	5	856	1	2	4	5	700
178	NGRC 2761	0	2	3	4	544	1	2	4	5	700
179	NGRC 2750	1	3	4	5	778	1	2	3	5	622
180	NGRC 2793	1	3	5	5	856	2	2	2	5	583
181	NGRC 2797	1	2	3	4	583	2	2	2	5	583
182	NGRC 2760	1	3	4	5	778	2	2	2	5	583
183	Preeti	1	4	5	5	933	0	2	2	4	467
184	ICT 2001-12	1	2	3	4	583	2	2	2	4	544
185	ICT 2012-242	1	3	5	5	856	2	2	2	5	583
186	ICT 2012-26	1	3	4	5	778	2	2	2	4	544
187	ICT 2012-157	3	4	5	6	1050	2	2	3	6	700
188	ICT 2012-202	3	5	5	6	1128	0	2	2	4	467
189	NGRC 2751	3	3	5	5	933	2	2	2	5	583
190	Morang-2	2	3	4	4	778	2	2	2	5	583

Note: DS 1: Disease score at 49 days after sowing; DS 2: Disease score at 56 days after sowing; DS 3: Disease score at 63 days after sowing; DS 4: Disease score at 70 days after sowing; and AUDPC: Area under disease progress curve

Conclusions

The low productivity of rapeseed in Nepal may be due to various biotic as well as abiotic factors and alternaria blight is one of the factors responsible for reducing rapeseed yield. Use of resistance or tolerant variety is ideal and environmental approach in disease

management. The moderately resistant genotypes identified will help pathologist as well as breeder to incorporate them in future crop improvement program towards breeding for alternaria bight tolerant lines in rapeseed.

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Authors' Contributions

S. Subedi and BP Yadav designed this research and revised the article for publication. P. Wagle conducted the trial and recorded data. P. Wagle, S. Rasaily, A. Mishra and A. Chaudhary wrote the final manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

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