Field Screening of Garlic Genotypes for Identification of Resistant Sources against Purple Blotch Disease

Abstract

Garlic (*Allium sativum* L.) is one of the oldest cultivated plants in the world and belongs to the family Amaryllidaceae. Purple blotch caused by *Alternaria porri* (Ellis) Ciferri is one such disease which causes a great deal of loss for farmers. The best method to manage purple blotch is to adopt resistant genotypes for cultivation, which is highly necessary in areas with a high incidence. In order to identify resistant sources, 37 genotypes were field screened under artificial epiphytotic conditions at AINRPOG (All India Network Research Project on Onion and Garlic), MARS (Main Agricultural Research Station), Dharwad during *Rabi*, 2019 and 2020. Results from two years showed that no genotype was immune to purple blotch. Among the genotypes tested, five genotypes *viz*., G50, Bhima Purple, DOGR426, DOGR543 and DOGR569 were resistant to infection (1-10%), 17 genotypes moderately resistant to infection (11-20%), while 4 genotypes were moderately susceptible to infection (21-40%). On a scale of 0 to 5, only one genotype (HRG Local) showed susceptible (41-75%) in reaction. Among the remaining genotypes, disease reactions differed between years. The genotypes that are resistant can be utilized by breeders to produce high yielding purple blotch resistant varieties.

Keywords: Purple blotch, artificial screening, Per cent disease Index, disease reaction

Introduction

Garlic (*Allium sativum* L.) is one of the most popular and the oldest cultivated plants in the world belong to the family Amaryllidaceae. Garlic bulb comprises of water (84.09 %), organic matter (13.38 %) and inorganic matter (1.53 %) along with 0.1 per cent volatile oil (Chalson and McFerren, 2007). The bulbs contain a colourless, odourless and water soluble compound called allicin. On crushing or chewing, enzyme allinase present in the raw garlic bulbs breaks down into allin to produce allicin which cannot be observed in cooked garlic. Diallyl disulfide possesses the true garlic odour (Vijaykumar et al. 2022a). Nevertheless, the crop is attacked by many diseases over its lifetime, resulting in low yields, resulting in economic losses. In recent years, purple blotch caused by *Alternaria porri* (Ellis) Ciferri has become one of the most serious diseases affecting garlic (Vijaykumar et al. 2021). This foliar pathogen alters metabolic processes by reducing the photosynthetic activity. It has been reported that foliar infection can reach 90% in susceptible garlic cultivars (Bisht and Agarwal, 1993). The bulb shelf life is reduced as a result of leaf damage and blackening of scales at bulb maturity. The drying of leaves can significantly reduce bulb yield in garlic (25-60%).

A number of states, including Gujarat, Maharashtra, Andhra Pradesh, Haryana, Karnataka, Odisha, and Himachal Pradesh, have reported purple blotch in garlic as an economically important disease (Raju, 1970; Bhangale, and Joi, 1983; Gupta et al. 1986; Sharma, 1986; Mishra et al. 1989 and Sugha and Tyagi, 1994). Initially, purple blotch appears as a multitude of tiny white spots that are irregular or circular in shape. Spots gradually grow larger, become oval-shaped or irregular, and eventually change from white to violet color. Later stages of development show the central portion of the spots changing to purple. This is surrounded by a pale yellow orange to salmon band beyond which is a pale green zone. The dark purple colour is the most distinctive disease symptom. A distinct yellowing usually extends from both ends of the spots, often reaching the tips and bases of the leaves (Aveling, 1998). Host plant resistance is an effective, economical and environmentally safe component of an integrated approach. Therefore, an attempt was made to identify resistant sources to mitigating loss in farmers' field.

Materials and Methods

Totally thirty seven garlic genotypes collected from ICAR-DOGR (Directorate of Onion and Garlic), Rajgurunagar, Pune and ICAR-IARI, New Delhi along with local genotypes (DWG1, HRG Local and Gadag Local) as commercial check were subjected for field screening during *Rabi* 2019 and 2020 against purple blotch at AINRPOG (All India Network Research Project on Onion and Garlic), MARS (Main Agricultural Research Station), Dharwad. All the genotypes were sown in two rows of two meter length with a plant spacing of 30 cm × 10 cm (row to row and plant to plant) in non-replicated augmented design. All the recommended agronomic practices were followed, except disease management practices. Inoculum of *Alternaria porri* (2×10^6 spores/ml) was uniformly sprayed during evening hours at 30 days after sowing to create uniform disease pressure throughout the field. The disease severity was recorded at 90 days after sowing using a scale of 0-5 (Sharma, 1986) by randomly selecting ten plants in each genotype. Per cent disease index was calculated by using formula given by Wheeler (1969). Based on their disease severity, genotypes were categorized into immune (0 %), resistant (1-10 %), moderately resistant (11-20 %), moderately susceptible (21-40 %), susceptible (41-75 %) and highly susceptible (75-100 %).

Chart 1. Disease scoring scale (0-5 grade) for purple blotch of garlic (Sharma, 1986)

Disease score	Per cent leaf area infected	Disease reaction
0	No disease symptoms	Immune
1	A few spots towards tip covering 10 per cent leaf area	Resistant
2	Several dark purplish brown patches covering 11 to 20 per cent leaf area	Moderately resistant
3	Several patches with pale outer zone covering 21 to 40 per cent leaf area	Moderately susceptible
4	Yellow streaks covering 41 to 75 per cent leaf area	Susceptible
5	Complete drying of the leaves or breaking of leaves from centre	Highly susceptible

Results and Discussion

Totally 37 garlic genotypes were screened during *Rabi* 2019 and 2020 against purple blotch under artificial epiphytotic condition in the field to identify the resistant sources as described in "Material and methods" and data are presented in Table 1.

During *Rabi* 2019, none of the genotypes showed immune or highly susceptible reaction to purple blotch. Among 37 genotypes, seven genotypes (G50, Bhima Purple, DOGR81W, DOGR389, DOGR426, DOGR543 and DOGR569) showed resistant reaction, whereas, 23 genotypes (G282, GG2, GG4, Bhima Omkar, Godavari, Phule Baswant, DWG1, DOGR51, DOGR102, DOGR113, DOGR119, DOGR150, DOGR181, DOGR185, DOGR325, DOGR329, DOGR353, DOGR440, DOGR517, DOGR534, DOGR548, DOGR604 and DOGR744) showed moderately resistant reaction and six genotypes (G41, Gadag Local, DOGR75, DOGR228, DOGR409 and DOGR756) showed moderately susceptible reaction while remaining one genotype (HRG Local) was found susceptible to purple blotch of garlic.

During *Rabi* 2020, none of the genotypes showed immune or highly susceptible reaction purple blotch. Among 37 genotypes, eight genotypes (G50, Bhima Purple, DOGR119, DOGR150, DOGR329, DOGR426, DOGR543 and DOGR569) showed resistant reaction whereas, 21 genotypes (G41, G282, GG2, Bhima Omkar, Phule Baswant, DWG1, DOGR51, DOGR75, DOGR81W, DOGR102, DOGR113, DOGR181, DOGR325, DOGR353, DOGR389, DOGR440, DOGR517, DOGR534, DOGR548, DOGR604 and DOGR744) showed moderately resistant reaction and seven genotypes (GG4, Godavari, Gadag Local, DOGR185, DOGR228, DOGR409 and DOGR756) showed moderately susceptible reaction while, remaining one genotype (HRG Local) was found susceptible in reaction.

Thirty seven genotypes grouped into different reaction types based on the results obtained from two years. It was found that none of the genotypes were immune to purple blotch (Table 2). Five genotypes *viz.*, G50, Bhima Purple, DOGR426, DOGR543 and DOGR569 showed resistant reaction over the seasons whereas, seventeen genotypes *viz.*, G282, GG2, Bhima Omkar, Phule Baswant, DWG1, DOGR51, DOGR75, DOGR81W, DOGR102, DOGR113, DOGR181, DOGR325, DOGR353, DOGR389, DOGR440, DOGR517, DOGR534, DOGR548, DOGR604 and DOGR744 showed moderately resistant in reaction and four genotypes (Gadag Local, DOGR228, DOGR409 and DOGR756) showed moderately susceptible reaction while, only one genotype (HRG Local) showed susceptible reaction to purple blotch of garlic. However, no genotype was found to be highly susceptible to purple blotch.

Host plant resistance is one of the key strategies for reducing disease losses. Farmers can easily use this method of management, and it is relatively affordable and environmentally friendly. Moreover, resistant cultivars conserve natural resources and are more cost-effective, time-saving, and energy-efficient than other methods of disease control (Roopadevi and Patil, 2017).

The results are consistent with previous reports showing that, although a few lines seem immune to purple blotch, the majority are resistant under natural infestation in open fields (Pathak et al. 1986). A study conducted by Sugha *et al*. (1992) evaluated 94 onion genotypes under natural conditions and found that only two varieties, IC39178 and IC49371, were resistant to purple blotch. Furthermore, Behera *et al*. (2013) observed VG-18 to be a resistant cultivar and another 12 lines to be moderately resistant to purple blotch. It is consistent with the findings of Agarwal and Tiwari (2013), Nandini *et al*. (2018), Kowser *et al*. (2019) and Vijaykumar et al. (2022) who evaluated different garlic genotypes for purple blotch and found that the per cent disease index was negatively correlated with bulb yields and storage quality. Although field screening showed variable responses to purple blotch, it is necessary to evaluate their efficiency as pre-breeding lines by evaluating them in multiple hotspot areas for purple blotch.

Table 1: The response of garlic genotypes to purple blotch caused by *Alternaria porri* during *Rabi*, 2019 and 2020

		2019		2020				2019		2020	
Sl. No.	**Genotypes**	**Per cent disease index**	**Disease grade**	**Per cent disease index**	**Disease grade**	**Sl. No.**	**Genotypes**	**Per cent disease index**	**Disease grade**	**Per cent disease index**	**Disease grade**
1	G41	23.14	3	15.33	2	20	DOGR181	13.74	2	17.32	2
2	G50	9.65	1	8.43	1	21	DOGR185	18.97	2	26.56	3
3	G282	12.33	2	13.87	2	22	DOGR228	32.63	3	29.97	3
4	GG2	13.54	2	14.21	2	23	DOGR325	16.74	2	18.72	2
5	GG4	14.21	2	25.52	3	24	DOGR329	16.78	2	9.87	1
6	Bhima Omkar	16.38	2	15.96	2	25	DOGR353	14.23	2	15.39	2
7	Bhima Purple	8.65	1	8.23	1	26	DOGR389	9.54	1	15.59	2
8	Godavari	16.25	2	22.46	3	27	DOGR409	38.65	3	35.43	3
9	Phule Baswant	13.92	2	14.21	2	28	DOGR426	8.92	1	7.71	1
10	Gadag Local	26.53	3	31.22	3	29	DOGR440	18.28	2	19.92	2

11	HRG Local	45.23	4	46.76	4	30	DOGR517	12.21	2	13.36	2
12	DWG1	19.54	2	18.79	2	31	DOGR534	15.37	2	14.71	2
13	DOGR51	16.43	2	15.32	2	32	DOGR543	6.77	1	7.61	1
14	DOGR75	32.21	3	35.68	2	33	DOGR548	13.22	2	15.46	2
15	DOGR81W	8.97	1	15.33	2	34	DOGR569	9.34	1	8.65	1
16	DOGR102	16.47	2	15.55	2	35	DOGR604	14.68	2	15.78	2
17	DOGR113	13.23	2	14.90	2	36	DOGR744	15.44	2	16.70	2
18	DOGR119	12.23	2	9.87	1	37	DOGR756	32.11	3	34.36	3
19	DOGR150	15.38	2	9.54	1						

Table 2: Grouping of garlic genotypes based on reaction to purple blotch caused by *Alternaria porri*

Disease grade	Per cent leaf infection	Genotypes	Disease reaction	No. of Genotypes
0	0	-	Immune	0
1	1-10	G50, Bhima Purple, DOGR426, DOGR543 and DOGR569	Resistant	5
2	10-20	G282, GG2, Bhima Omkar, Phule Baswant, DWG1, DOGR51, DOGR102, DOGR113, DOGR181, DOGR325, DOGR353, DOGR440, DOGR517, DOGR534, DOGR548, DOGR604 and DOGR744	Moderately Resistant	17
3	21-40	Gadag Local, DOGR228,	Moderately	4

		DOGR409 and DOGR756	susceptible	
4	40-75	HRG Local	Susceptible	1
5	More than 75	-	Highly susceptible	Nil

Conclusion

A total of 37 garlic genotypes were screened against purple blotch under artificial epiphytic conditions and the results revealed that five genotypes showed resistant while seventeen genotypes showed moderately resistant in reaction. In contrast, four of the genotypes showed moderately susceptible reaction and one genotype showed susceptible reaction while none of the genotypes showed highly susceptible reaction to purple blotch. Farmers can cultivate these resistant or moderately resistant genotypes instead of local cultivars to get higher bulb yields when combating purple blotch disease.

Conference disclaimer:

Some part of this manuscript was previously presented in the conference: 3rd International Conference IAAHAS-2023 "Innovative Approaches in Agriculture, Horticulture & Allied Sciences" on March 29-31, 2023 in SGT University , Gurugram, India. Web Link of the proceeding: https://wikifarmer.com/event/iaahas-2023-innovative-approaches-in-agriculture-horticulture-allied-sciences/

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