PERFORMANCE OF BLIGHT-RESISTANT GRAM SELECTIONS IN WILT NURSERY AND AT SIX LOCATIONS

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The reaction of eight blight-resistant selections of gram to wilt and their yield performance was studied in wilt nursery at Lyallpur from 1963-64 to 1967-68. The yield performance of these selections was also studied at six different locations in blight and wilt affected areas during 1961-62.

The incidence of wilt during years of trial corresponded closely with the rainfall received during the gram season. High incidence of wilt in 1963-64 gram season corresponded with a dry gram season of 2.72 inches rainfall, whereas the lowest incidence of wilt in 1967-68 was associated with a high rainfall amounting to 7.84 inches. As an average of five years, the incidence of wilt on C727 was a little lower than the standard varieties Pb7 and C612, the differences being non-significant.

The average yield of C727 for the six years of the trial at Lyallpur was significantly higher than the average yield of C612 for these years. The average yield of the selections corresponded closely with the rainfall received during the gram growing seasons; high yield being obtained in year of high rainfall.

The average yield of selections C727 and P71 for six locations was significantly higher than the standard variety C612. Some varieties reacted in differential manner at certain localities during 1961-62 gram season. The highly blight-resistant selections gave significantly lower yield in wilt infested localities (Gujranwala, Rakh Uttra and Lyallpur) than the standard variety Pb7, but gave higher or almost similar yield as that of Pb7 in blight affected localities (Rawalpindi, Sargodha and Campbellpur). However, C727 behaved consistently at these six locations.

INTRODUCTION

The development of high yielding varieties of gram resistant to blight or wilt, and to both the diseases is an urgent need of agriculture in West Pakistan. Blight caused by *Ascochyta rabiei* is particularly serious in areas receiving more than six inches rainfall during gram growing season (Sattar, 1933). On the other hand, wilt caused by *Fusarium lateritium* f. *ciceri* (Erwin, 1958) is favoured by dry weather and is generally serious in parts receiving less than 3.5 inches rain during gram growing period. There are areas in West Pakistan where

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these two diseases co-exist (Luthra *et al.*, 1943). Blight is serious in years or months of high rainfall and wilt is serious in years or months of low rainfall.

Since the first report of the sources of resistance to blight (Luthra *et al.*, 1941), a number of blight-resistant varieties of gram have been developed. F8, the first blight-resistant variety released for cultivation in blight affected areas in 1941, proved highly susceptible to wilt and was low yielding (Luthra *et al.*, 1943). As a result of hybridization of F8 with the local gram varieties, C12/34 and C612 were evolved, and were released for general cultivation in blight affected areas in 1947 and 1952 respectively. Recently, a number of high yielding selections which showed moderate to high resistance to blight in the epiphytotics of 1957-58 and 1958-59 gram seasons have been reported (Kausar and Rasheed, 1967). One of these selections, C727, has been approved by the Department of Agriculture to replace C612 for cultivation in blight affected areas. Thus, substantial progress has been made in the development of gram varieties resistant to blight, but varieties of gram highly resistant to wilt are not yet available in West Pakistan.

Because of the importance of wilt and its co-existence with blight in certain gram growing areas in West Pakistan, information on the reaction of blight-resistant selections to wilt and their performance in blight affected and wilt infested areas is highly desirable. The present paper summarises the results of investigations on the reaction of blight-resistant selections reported by Kausar and Rasheed (1967) to wilt and their yield performance in wilt nursery at Lyallpur during 1963-64 to 1967-68 gram seasons. The yield performance of these selections grown at six different localities in blight and wilt affected areas during 1961-62 gram season is also being reported.

MATERIALS AND METHODS

The reaction of blight-resistant selections to wilt and their yield performance reported in this paper were studied in quadruplicated randomised blocks laid out in the wilt nursery, in square 22 of the West Pakistan Agricultural University Estate, Lyallpur during 1963-64 to 1967-68 gram seasons. The selections of gram included in the investigation comprised eight blight-resistant selections reported by Kausar and Rasheed (1967) and two standard varieties of gram, Ph7 and C612. The size of the experimental plot was 66 feet by 7 feet. In each plot, 66 foot long seven rows of the selection or variety were planted one foot apart.

Besides the natural rainfall at Lyallpur during the years of the experiment (Table 1), the selections and varieties under investigation received one irrigation in January. Observations on the reaction of gram selections and varieties to wilt (as percentage of plants affected) and yield of grain were taken.

TABLE 1.—*Rainfall at Lyallpur during* 1963-64 *to* 1967-68 *gram seasons*

Months	Rainfall in inches during the gram seasons				
	1963-64	1964-65	1965-66	1966-67	1967-68
September ..	0.00	1.22	0.00	2.33	0.55
October ..	0.08	0.00	0.10	0.49	1.28
November ..	0.37	0.00	0.42	0.00	0.17
December ..	0.45	0.00	0.00	3.10	3.10
January ..	1.19	0.25	0.00	0.00	0.51
February ..	0.10	0.20	1.00	0.24	1.33
March ..	0.01	0.33	0.22	3.32	0.85
April ..	0.52	1.67	0.96	0.73	0.10
Total ..	2.72	3.67	2.70	10.21	7.89

TABLE 2.—*Rainfall at different gram growing localities of the experiment during* 1961-62

Months	Rainfall in inches at the localities					
	Campbellpur	Mianwali	Rawalpindi	Gujranwala	Lyallpur	Sargodha
September, 1961 ..	2.86	0.93	9.66	2.97	1.55	1.08
October, 1961 ..	0.34	0.30	1.55	0.22	0.15	0.00
November, 1961 ..	1.00	0.08	1.53	0.41	0.07	0.12
December, 1961 ..	0.12	0.00	0.41	0.99	0.11	0.00
January, 1962 ..	0.50	0.06	0.75	0.76	0.58	0.00
February, 1962 ..	0.42	0.20	2.24	0.95	0.79	0.97
March, 1962 ..	1.64	0.59	3.37	—*	1.22	1.20
April, 1962 ..	0.50	0.10	1.21	0.21	0.19	0.04
Total (September to April)	7.36	2.26	20.72	6.51	4.66	3.41
Total (October to April)	4.50	1.33	11.06	3.64	3.11	2.33

*Information not available.

The yield data were subjected to the analysis of variance for the interpretation of results. Percentage of wilt incidence were transformed for the analysis of variance (Bliss, 1937).

The blight-resistant selections alongwith the two standard varieties were also grown at Agricultural Farms, Campbellpur, Rawalpindi, Sargodha, Gujranwala, Rakh Uttra and in wilt nursery at Lyallpur during 1961-62 gram season in quadruplicated randomised blocks. The size of the experimental plot, the number and length of rows and the distance between them was the same as at Lyallpur in the wilt nursery mentioned above. The yield of grain obtained at these stations and at Lyallpur were analysed for the interpretation of results on the performance of these selections at different localities. The rainfall received at these localities during 1961-62 gram season is given in Table 2.

Campbellpur, Rawalpindi and Sargodha represented localities affected by blight, whereas Rakh Uttra, Gujranwala and Lyallpur represented wilt infested areas where blight and wilt co-exist.

EXPERIMENTAL RESULTS

(i) Reaction to Wilt

The incidence of wilt on selections and varieties of gram at Lyallpur during 1963-64 to 1967-68 gram seasons is summarised in Table 3. Taking the average of the five years of the trial, C727 followed by Pb7 and C612 had the lowest incidence of wilt, whereas 5/1A followed by CS1WF had the highest wilt. The incidence of wilt on C727 was a little lower than on Pb7 and C612. However, the difference in the incidence of wilt on them were non-significant. Selections *CS16B, CS16A, CS1WF and 5/1A which have shown high resistance* to blight (Kausar and Rasheed, 1963) were generally more susceptible to wilt than C727, which is moderately resistant to blight. The moderately blight-resistant selections P78 and P71 and the highly blight-resistant selection CS19 were intermediate in this respect. Selection 5/1A had significantly higher wilt than other selections, whereas CS1WF had significantly higher incidence of wilt than other selections except CS19. However, the difference in the incidence of wilt on selection other than 5/1A and CS1WF was non-significant.

In general, the incidence of wilt was the highest in 1963-64 gram season with an average incidence of 18.9 per cent, followed by 1964-65, 1965-66, 1967-68 and 1966-67 gram seasons, with an average incidence of 7.7, 5.8, 5.2 and 4.7 per cent respectively. This more or less corresponded with the rainfall received during the gram season in the years of trial. High incidence of wilt in 1963-64

TABLE 3.—*Incidence of wilt on selections and varieties of gram at Lyallpur during 1963-64 to 1967-68*

Selection or Variety	Incidence of wilt (per acre) during years					Average
	1963-64	1964-65	1965-66	1966-67[1]	1967-68[2]	
C727	10.89	6.40	1.59	3.79	4.64	5.46
Pb7	7.81	7.64	0.58	6.54	4.82	5.48
C612	17.61	7.45	1.01	1.89	4.81	6.55
P78	25.61	8.86	0.42	2.43	5.65	8.59
P71	28.51	9.55	1.59	1.46	4.65	9.15
CS19	18.08	8.93	5.33	3.21	4.54	9.22**
CS16B	16.97	4.62	6.55	4.96	6.60	9.38**
CS16A	20.27	7.17	7.13	3.37	5.85	10.10*
CS1WF	18.67	6.53	13.79	10.80	4.68	10.92*
5/1A	24.70	9.49	20.44	8.24	6.07	13.79

*Average of 4 years (1963-64, 1964-65, 1965-66, and 1967-68).
**Average of 3 years (1963-64, 1964-65, and 1965-66).
1. During 1966-67, CS19, CS16B, and CS16A and CS1WF were replaced by F8, CS30, C727/2 and F10 respectively.
2. During 1967-68, CS30 was used instead of CS16B.

TABLE 4.—*Blight-resistant gram selections in wilt nursery at Lyallpur for six years*

Selection or Variety	Yield of grain (maunds per acre) during years						Average
	1961-62	1963-64	1964-65	1965-66	1966-67	1967-68	
C727	8.89	2.46	3.60	1.65	1.51	7.50	4.27
Pb7	9.10	0.57	3.53	2.65	1.58	6.11	3.92
P71	4.68	0.48	2.94	0.29	2.50	6.09	2.83
P78	4.12	1.30	2.76	0.36	1.67	4.36	2.43
CS1WF	2.66	0.57	0.77	0.00	0.11*	5.69	2.42
CS19	2.34	0.09	1.04	0.51	1.29*	7.44	2.28
C612	3.60	0.99	2.72	0.37	0.81	3.90	2.06
CS16A	3.56	0.13	0.97	0.15	1.82*	4.44	1.85
5/1A	2.27	0.40	1.91	0.52	1.43	4.51	1.84
CS16B	2.49	0.13	1.88	0.29	0.24*	4.82**	1.20
Least significant difference at							
5 per cent level	2.83	1.12	2.27	0.70	0.50	3.74	0.91
1 per cent level	3.82	1.51	3.07	0.95	0.67	5.06	1.19

*During 1966-67, F10, C727/2, CS30 and F8 were sown in place of CS1WF, CS16A, CS16B, and CS19.
**During 1967-68, CS30 was sown in place of CS16B.

gram season corresponded with a dry gram season of 2.72 inches rain during September to April, whereas, low incidence of 5.2 and 4.7 per cent during 1967-68 and 1966-67 were in gram seasons of relatively high rainfall amounting to 7.84 and 7.11 inches respectively.

(ii) Yield of Grain

The yield of grain of eight blight-resistant selections for the six years of the trial summarised in Table 4 classifies them in three categories with respect to the yield of standard varieties C612. The average yield of C727 for the six years was significantly higher than the average yield of C612 for these years. The average yield of selections P71, P78, CS1WF and CS19 was higher than that of C612, but was not significantly higher statistically. The average yield of selections CS16A, 5/1A and CS16B were lower than that of C612, but non-significantly so statistically.

With respect to the standard variety Pb7, except C727 the average yield of other selections for the six years was significantly lower than that of Pb7. The average yield of C727 for six years was higher than that of Pb7, but the increase was non-significant. C727 outyielded Pb7 in three out of six years; but the increase in yield was significant during one year only. It may be added, that the average yield of Pb7 for the six years was significantly higher than that of the standard variety C612. Pb7 outyielded C612 during five out of the six years of the trial and significantly so during three years.

The yield of C727 was consistently higher than that of C612 during six years of the trial and significantly so during three years. However, the behaviour of CS19 and CS1WF was inconsistent. These selections gave higher yield than C612 particularly during 1967-68, a year of high rainfall. Similarly, selections C16A, 5/1A and CS30 outyielded C612 particularly during 1967-68, a year of high rainfall. The behaviour of P71 and P78 was more or less intermediate. These selections gave higher or about the same yield as that of C612 during the six years of the trial.

The average yield of the selections and varieties under trial varied considerably during the years of the trial. Taking average of all the selections and varieties, significantly higher yield was obtained in 1967-68 (5.48 maunds per acre) than in 1961-62 (4.37 maunds per acre), which was also significantly higher than the average yield in 1964-65 (2.21 maunds per acre). The average yield in years 1963-64 (0.71 maunds per acre) and 1965-66 (0.75 maunds per acre) were significantly lower than yield in the other three years. The average yield of these selections and varieties corresponded closely with the rainfall received during the gram growing seasons.

Low yields during 1963-64 and 1965-66 were associated with low rainfall amounting to 2.72 and 2.70 inches respectively. High yields of 1967-68 and 1961-62 followed high rainfall of 7.89 and 4.66 inches respectively. The average yield of these selections and varieties during 1966-67 with 7.11 inches rainfall was significantly lower than that in 1967-68 with a rainfall of 7.89. This is due to the fact that rains in 1967-68 were well distributed during the gram growing season, whereas rains were not so distributed in 1966-67. In 1966-67 gram season, 2.33 inches rain was received in September, 1966 and 3.33 in March, 1967, so that only 0.73 inches rain was received during October, November, January and February.

There was a differential behaviour of gram selections to different gram seasons. The gram selections highly resistant to blight tended to do better than C612 during years of high rainfall than during years of low rainfall. However, the behaviour of C727 was more or less consistent.

(iii) Yield Performance of Selections at Different Localities

The yield of grain of eight blight-resistant selections and two standard varieties grown at six locations in blight and wilt affected areas is given in Table 5. Taking the average yield of grain at six locations, C727 and P71 gave significantly higher yield than the standard variety C612. Pb7, P78 and CS16A gave higher yield than C612, but the increase in yield was non-significant. Likewise, CS1WF, CS19 and CS16B gave lower yield than C612, but the difference in yield was non-significant. However, 5/1A gave significantly lower yield than both the standard varieties Pb7 and C612. The average yield of C727 and P71 as average of six stations was higher than Pb7, but the increase was non-significant. P78, CS16A and C612 gave lower yield than Pb7, but the difference in yield was non-significant. However, CS1WF, CS19, CS16B and 5/1A gave significantly lower yield than Pb7.

Some varieties apparently reacted in a differential manner at certain localities. Generally, P78, CS16A, CS1WF, CS19 and CS16B gave significantly lower yield than Pb7 in wilt infested localities at Gujranwala, Rakh Uttra and Lyallpur. However, in blight affected areas at Rawalpindi, Sargodha and Campbellpur these varieties gave higher or almost similar yield as Pb7. As a matter of fact, P78, C727 and P71 gave significantly higher yield than Pb7 at Campbellpur However, the behaviour of C727 was more or less consistent.

The average yield of selections and varieties was the highest (14.42 maunds per acre) at Sargodha, followed by Gujranwala (9.62 maunds per acre), Rakh Uttra (7.52 maunds per acre), Campbellpur (5.89 maunds per acre), Rawalpindi (5.14 maunds per acre), and Lyallpur (4.37 maunds per acre). The

TABLE 5.—*Yield of Gram Selections at Six Different Locations In West Pakistan*

Variety	Yield of the selections in maunds per acre at						Average
	Rawalpindi	Sargodha	Gujranwala	Rakh Uttra	Campbellpur	Lyallpur	
C727	6.23	16.54	12.54	6.26	7.77	8.89	9.87
P71	6.53	18.39	10.87	11.04	7.60	4.68	9.85
Pb7	2.15	12.89	12.63	12.37	5.20	9.10	9.06
P78	6.01	13.32	8.98	6.01	8.15	4.12	7.77
CS16A	3.44	16.84	8.50	7.43	6.07	3.56	7.64
C612	6.01	10.09	10.35	7.13	6.70	3.60	7.31
CS1WF	5.54	17.66	5.96	4.25	4.47	2.66	6.76
CS19	5.15	15.29	8.94	2.23	5.27	2.34	6.54
CS16B	3.48	8.81	8.50	9.92	5.00	2.49	6.37
5/1A	6.87	—	—	—	2.72	2.27	3.95
Least significant difference at							
5 per cent level	5.52	8.79	2.39	2.35	1.64	2.83	1.87
1 per cent level	7.42	11.95	3.25	3.19	2.19	3.82	2.46

average yield of the selections and varieties was significantly higher at Sargodha than at Gujranwala, which was significantly higher than at Rakh Uttra. The average yield at Rakh Uttra was significantly higher than at Campbellpur, which was significantly higher than at Lyallpur. However, the differences between average yields at Campbellpur, Ralawpindi and Lyallpur were non-significant.

DISCUSSION

The reaction of blight-resistant gram selections to wilt and their yield performance in wilt nursery at Lyallpur and six locations in blight affected and wilt infested areas has brought out significant differences in their reaction to wilt and their relative suitability for cultivation in different gram growing areas. The wilt nursery at Lyallpur provided conditions favourable for wilt complex as it occurs in nature due to the organisms associated with wilt and physiological wilt as a result of drought. The five years of the trial provided varied weather conditions differing in environment favouring wilt in different degrees.

The six localities in the gram growing areas represented three stations in blight affected and three stations in wilt infested areas.

The average incidence of wilt on the highly blight-resistant selections CS1WF and 5/1A was significantly higher than the moderately blight-resistant selections C727, P78, and P71. The selection C727 proved to be almost as resistant to wilt as the standard varieties Pb7 and C612 used in the experiment. In respect of yield performance in the wilt nursery, the blight-resistant selections classified themselves into three categories. C727 gave significantly higher average yield for the six years of the trial than the standard variety C612. The highly blight-resistant selections CS16A, CS16B and 5/1A gave lower yield than C612, but the differences were non-significant statistically. The moderately blight-resistant selections P71 and P78, and highly blight-resistant selections CS1WF and CS19 gave higher yield than the standard variety C612, which was not higher significantly. Except C727, the average yield of other selections was lower than the standard variety Pb7.

The yield performance of C727 in wilt nursery during different years of the trial representing different intensities of wilt was more or less consistent. However, the highly blight-resistant selections gave better yield during years of high rainfall or under conditions less favourable for the development of wilt and more favourable for the development of blight. Similarly, C727 behaved more or less consistently in its yield performance at different locations representing blight affected and wilt infested areas. However, the highly blight-resistant selections CS1WF, CS16A, CS16B, CS19 and 5/1A gave significantly lower yield in wilt infested localities, but did well in blight affected localities.

Thus, it is apparent that selection C727 combines moderate resistance to blight, moderate resistance to wilt, and high yield. It has shown adaptability for cultivation in blight affected and blight infested areas during years of high intensities of wilt and blight. However, the highly blight-resistant selections CS1WF, CS16A, CS16B, CS19 and 5/1A have shown their suitability for cultivation in blight affected areas only. The behaviour of the moderately blight-resistant selections P71 and P78 appears to be more or less intermediate in this respect.

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