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Influence of Host Management on Downy Mildew Control in Onion

Shabeer Ahmad and Hakim Khan
Department of Plant Pathology, NWFP Agricultural University, Peshawar, Pakistan

Abstract: The interactive effect of three different levels of NPK fertilizer, plant population and irrigation was studied on downy mildew severity and yield of onion. The lowest disease severity was recorded in treatment where NPK 120:90:60 kg/ha, coupled with plant population 0.5 million/ha and eight irrigations. In this treatment the yield and bulb size were also the highest. However, number of bulbs was lower than some other treatments indicating the non-significant effect of disease.

Key words: Onion, downy mildew, *Peronospora destructor*, host management, Pakistan.

Introduction

One of the major constraints for successful production of onion crop in North West Frontier Province (NWFP) of Pakistan is the attack of downy mildew caused by *Peronospora destructor*. The attack of disease varied from 40-80 % in Malakand Division of NWFP during 1988 (Mohibullah, 1988). It was 40% higher in Barikot than Khwazakhela circle in the same division during 1989-90 (Defoer, 1991). Higher severities of this disease resulted in substantial loss in yield. Tahir *et al*. (1990) recorded 52.2% less yield in the downy mildew un-protected onion.

Different fungicides are used for the control of downy mildew. However, the high prices of the fungicides, their less availability in market at the appropriate time and the ignorance of the farmers to use them properly have forced the onion growers to adopt the nonchemical methods for disease control. Some host management practices have been proved effective in reducing the downy mildew loss. The effect of low level plant populations on downy mildew control was evident from the studies wherein 44 plants/m^2 showed the lowest attack of the disease (24%) and 12.6% increase in yield than the check (Mohibullah, 1989). Similarly, a plant density of 0.5 million/ ha received 25.6% disease attack and gave 23.6 t/ha yield (Mohibullah, 1991). The influence of variable fertilizer levels was also significant on downy mildew. In using several combinations, NPK level 180: 50 : 180 was the most effective in reducing downy mildew attack (Mohibullah, 1991). In a diagnostic survey of farmer fields in Malakand division a positive correlation between low disease severity and low levels of nitrogenous and phosphatic fertilizers was observed. However, the disease attack increased with elevated number of irrigations at some while not at other places (Ahmad & Karimullah, 1994). This research was initiated to investigate the interactive effects of some of these host management practices on downy mildew and yield of onion.

Materials and Methods

Twenty-seven different treatments of this complex experiment included the interaction with one another of each of the three levels of NPK (90:60:30; 120:90:60 and 150:120:90 kg/ha), plant populations (0.5, 0.75 and 1.0 million plants/ha) and irrigations (6, 7 and 8). Using onion variety, Swat-1, the experiment was laid out at NWFP Agricultural University Research Farm, Peshawar during the years 1997-98 and 1998-99 in a split-plot randomized complete block design with each treatment replicated thrice. After first appearance of downy mildew, data on its severity (1-9 scale) were recorded at an interval of 10 days (Mohibullah, 1991) and converted to Area Under Disease Progress Curve (AUDPC) following Shaner and Finney (1977). Other data on bulb yield, bulb number and bulb size were recorded at the time of harvest of the crop. All data were subjected to analysis of variance and Least Significant Difference (LSD) test to determine the differences among treatments (Steel and Torrie, 1960).

Results

Area under disease progress curve (AUDPC): Significant differences were observed in AUDPC for different treatments during two years (Tables 1 & 2). In each case the lowest AUDPC was recorded in treatment where eight irrigations, NPK 120:90:60 kg/ha and 0.5 million plants/ha were used (T22). However, the highest AUDPC values were recorded in T27 (Tables 1 & 2). Difference between the values of the two treatments was 50-70 %. In these treatments, the NPK and plant population levels were different from one another indicating that both plant density and fertilizer doses played significant role in causing variation in AUDPC. On the other hand mostly the effect of variable number of irrigations was non-significant on AUDPC. Similarly, the interactive effect of irrigation levels and fertilizer doses was non-significant as against the significant effect of fertilizer and plant population on AUDPC. Mohibullah (1991) reported that during the year 1988-89, the lowest disease intensity was recorded in treatment with 30 cm inter and 10 cm intra-row spacing as compared to the highest disease in treatment with 10 cm inter- and 5 cm intra- row spacing. However, during the year 1989-90 treatment with 20 and 10 cm inter and intra-row spacing, respectively had lowest attack of downy mildew. The studies made by Ahmad and Karimullah (1994) showed that increased number of irrigations caused high intensity of downy mildew in onion. The significant effect of high plant density and elevated levels of fertilizers on disease intensity can be explained in terms of conducive environment for disease development being provided by canopy shading effects. On the other hand, the maximum number (eight) of irrigations given to onion fields was not enough than required to enhance the pathogen activity and so its effects on disease was not as significant as in other cases.

Bulb yield, size and number: The two-year data (1997-1999) showed significant differences among different treatments indicating the effects of plant population, fertilizer doses and irrigation regimes on onion yield and its different components. During 1997-98, the highest bulb yield (18 t/ha)and bulb size (5.3 cm) were observed in T22 which were 55.6% and 28.3% higher than their lowest values in other treatments. However, the average number of bulbs was the highest in T21 and T27 (Table 1). Bulb yield (22.3 t/ha) and bulb size (6.1 cm) were also the highest in T22 during 1998-99

Table 1: Effect of interaction of different levels of irrigation, NPK fertilizer and plant population on downy mildew severity and yield in onion during 1997-98.

Treatment	AUDPC	Yield (t/ha)	Bulb size (cm)	Bulb number/ (m^2)
T1. $I_1F_1P_1$	314.0 CDE*	8.5 B	4.2 C-J	16.3 M
T2. $I_1F_1P_2$	314.0 CDE	8.0 B	4.3 B-I	20.7 KL
T3. $I_1F_1P_3$	375.0 BC	10.2 AB	4.5 B-G	24.3 H-K
T4. $I_1F_2P_1$	238.8 FG	11.2 AB	3.8 IJ	26.7 E-J
T5. $I_1F_2P_2$	449.8 A	8.8 B	4.1 E-J	28.3 D-H
T6. $I_1F_2P_3$	449.8 A	9.4 B	4.2 C-J	32.7 BC
T7. $I_1F_3P_1$	238.8 FG	9.7 B	4.5 B-G	18.3 LM
T8. $I_1F_3P_2$	314.0 CDE	10.3 AB	4.6 B-E	23.0 JK
T9. $I_1F_3P_3$	375.0 BC	9.8 AB	4.5 B-F	25.0 G-J
T10. $I_2F_1P_1$	300.0 DEF	5.3 B	3.9 F-J	25.0 G-J
T11. $I_2F_1P_2$	375.0 BC	8.9 B	3.9 F-J	28.0 D-I
T12. $I_2F_1P_3$	449.8 A	12.7 AB	3.9 F-J	23.0 ABC
T13. $I_2F_2P_1$	314.0 CDE	12.0 AB	4.3 B-J	24.0 IJK
T14. $I_2F_2P_2$	375.0 BC	11.3 AB	3.9 HIJ	26.0 E-J
T15. $I_2F_2P_3$	413.8 AB	12.5 AB	3.8 J	31.7 BCD
T16. $I_2F_3P_1$	252.7 EFG	9.5 B	4.2 C-J	27.3 E-I
T17. $I_2F_3P_2$	314.0 CDE	9.6 B	4.4 B-H	30.0 CDE
T18. $I_2F_3P_3$	375.0 BC	9.2 B	4.1 E-J	32.7 BC
T19. $I_3F_1P_1$	314.0 CDE	10.7 AB	4.7 BCD	29.3 C-F
T20. $I_3F_1P_2$	375.0 BC	10.0 AB	4.5 B-E	32.0 BCD
T21. $I_3F_1P_3$	449.8 A	10.3 AB	4.3 B-J	34.7 AB
T22. $I_3F_2P_1$	224.8 G	18.0 A	5.3 A	26.7 E-J
T23. $I_3F_2P_2$	375.0 BC	13.0 AB	4.2 B-J	29.0 C-G
T24. $I_3F_2P_3$	449.8 A	13.5 AB	4.2 B-J	37.0 A
T25. $I_3F_3P_1$	347.3 CD	10.5 AB	4.8 B	25.3 F-J
T26. $I_3F_3P_2$	375.0 BC	13.3 AB	4.7 BCD	29.7 CDE
T27. $I_3F_3P_3$	449.8 A	9.2 B	4.7 BC	34.7 AB
Mean	355.5	10.6	4.3	27.8
LSD value	63.7	8.2	0.6	4.3
CV (%)	10.8	46.9	7.9	9.4

Irrigations, I_1 = 6, I_2 = 7 and I_3 = 8
NPK (kg/ha) , F_1 = 90:60:30, F_2 = 120:90:60 and F_3 = 50:120:90
P_1 = 0.5, P_2 = 0.75 and P_3 = 1.0 (million plants/ha)
*Figures followed by different letter(s) in the same column are significantly different from one another at 5% level of significance.

Table 2: Effect of interaction of different levels of irrigation, NPK fertilizer and plant population on downy mildew severity and yield in onion during 1998-99.

Treatment	AUDPC	Yield (t/ha)	Bulb size (cm)	Bulb number/ (m^2)
T1. $I_1F_1P_1$	386.1 F*	7.0 E	4.6 DE	36.3 FGHIJ
T2. $I_1F_1P_2$	425.1 E	9.0 CDE	4.5 DEF	43.3 FGHIJ
T3. $I_1F_1P_3$	508.6 D	10.0 BCDE	4.54 DEF	55.0 DEF
T4. $I_1F_2P_1$	427.7 E	10.7 BCDE	3.9 IJK	33.7 GHIJ
T5. $I_1F_2P_2$	508.6 D	9.0 CDE	4.3 DEFG	46.3 FGHIJ
T6. $I_1F_2P_3$	583.3 BC	10.0 BCDE	3.9 IJK	70.7 BCD
T7. $I_1F_3P_1$	427.7 E	6.5 E	4.6 CD	29.7 IJ
T8. $I_1F_3P_2$	508.6 D	6.7 E	4.54 DEF	33.7 GHIJ
T9. $I_1F_3P_3$	583.3 BC	11.3 BCDE	3.9 HIJ	69.3 CDE
T10. $I_2F_1P_1$	427.7 E	7.7 DE	4.9 BC	35.7 FGHIJ
T11. $I_2F_1P_2$	508.6 D	9.0 CDE	4.0 GHIJ	47.0 FGHIJ
T12. $I_2F_1P_3$	583.3 BC	13.7 BC	3.5 MN	88.7 ABC
T13. $I_2F_2P_1$	427.7 E	10.5 BCDE	4.6 CD	32.0 HIJ
T14. $I_2F_2P_2$	508.6 D	11.0 BCDE	4.3 EFG	52.0 DEFGH
T15. $I_2F_2P_3$	600.0 B	13.7 BC	3.8 IJKL	94.3 A
T16. $I_2F_3P_1$	427.7 E	8.7 CDE	5.1 B	28.7 J
T17. $I_2F_3P_2$	508.6 D	9.0 CDE	4.3 EFGH	49.7 EFGHI
T18. $I_2F_3P_3$	588.9 BC	11.7 BCDE	3.7 JKLM	90.3 AB
T19. $I_3F_1P_1$	427.7 E	7.9 DE	5.1 B	30.0 IJ
T20. $I_3F_1P_2$	508.6 D	11.3 BCDE	4.2 FGH	53.7 DEFG
T21. $I_3F_1P_3$	600.0 B	10.3 BCDE	3.5 LMN	76.7 ABC
T22. $I_3F_2P_1$	222.2 G	22.3 A	6.1 A	34.0 GHIJ
T23. $I_3F_2P_2$	508.6 D	11.7 BCDE	4.3 EFGH	52.3 DEFGH
T24. $I_3F_2P_3$	600.0 B	10.3 BCDE	3.4 N	92.7 A
T25. $I_3F_3P_1$	508.6 D	11.0 BCD	5.1 B	30.3 IJ
T26. $I_3F_3P_2$	552.9 C	12.7 BCD	4.1 GHI	55.7 DEF
T27. $I_3F_3P_3$	652.7 A	14.9 D	3.6 KLMN	83.0 ABC
Mean	500.8	10.7	4.3	53.5
LSD value	37.7	5.3	0.3	20.8
CV (%)	4.5	30.3	4.4	23.4

Irrigations, I_1 = 6, I_2 = 7 and I_3 = 8
NPK (kg/ha), F_1 = 90:60:30, F_2 = 20:90:60 and F_3 =150:120:90
P_1 = 0.5, P_2 = 0.75 and P_3 = 1.0 (million plants/ha)
*Figures followed by different letter(s) in the same column are significantly different from one another at 5% level of significance.

(Table 2). In contrast to this, the highest number of bulbs was recorded in T15. (Table 2). Pandey *et al*. (1982) obtained maximum seed yield from 20 cm spacing within row. Ali *et al*. (1998) recorded highest seed yield per plant for plants spaced at 30 cm. At low plant population, the chances of disease spread were low and such plants had sufficient space to develop large-sized bulbs. Similarly, with optimum levels of fertilizers and irrigation water, the small number of less diseased plants made efficient use of food material and water that resulted into high yield onion crop.

Discussion

One of the main objectives of using host management tactics for downy mildew control was to provide conducive environment for the successful production of onion crop. These practices are in common use of onion growers from a very long time and need no extra labour, expenses or know-how. Besides this, these may prove to be helpful in minimizing the environmental hazards caused by unscrupulous use of different fungicides. In this study the most significant interactive effect of different host management practices was in treatment where eight irrigations, NPK 120:90:60 kg/ha and 0.5 million plants/ha were used. In this treatment, the disease attack was the lowest and the bulb yield was the highest. Probably these management practices helped in maintaining good health of the plants, allowed less attack of disease and ultimately increased onion yield. The effectiveness of some management practices in reducing downy mildew attack and increasing onion yield is evident from studies wherein optimum levels of plant populations and fertility levels caused the lowest attack of disease and increased yield (Mohibullah, 1989; Mohibullah, 1991). Similarly, Ali *et al*. (1998) observed that spacing plants 30 cm apart minimized the downy mildew infection to 16.11% as compared to disease intensity of 81.11%, when the plants were spaced 10 cm apart. Develash and Sugha (1997) reported that closely spaced and densely planted onion crops developed more disease compared with widely spaced crops. Although the number of bulbs/m^2 was the lowest in best treatment (T22), yet the yield was the highest in this case. This was due to optimum level of plant population with exceptionally large sized bulbs, indicating that it is more advisable to keep the plant population at certain low level. High density crop may become more labour intensive, yield low quality bulbs and provide conductive environment for disease development due to plant canopy shading effects. Mohibullah (1989) recorded the lowest attack of downy mildew and 12.6% increase in onion yield, when the plant population of the crop was kept lower than the check treatment.

The effect of different fertility levels, plant populations and irrigation regimes, when used in combination with one another, was different on downy mildew. The greatest reduction in AUDPC was recorded in treatment (T22) where the highest, second highest and the lowest level of irrigations, NPK fertilizer and plant population were combined, respectively. However, the AUDPC was the highest in some other treatments, where these combinations were different from that of T22. The studies made by Ahmad and Karimullah (1994) showed that downy mildew attack increased with high number of irrigations at some places in Malakand division.

Similarly, Mohibullah (1991) reported that with plant density of 0.5 million plants/ha, the disease attack was low (25.6%) and that the most effective NPK level (180:50:180 kg/ha) reduced downy mildew attack in onion. Develash and Sugha (1997) observed that an increase in level of nitrogen fertilizer increased the disease severity. Phosphorus behaved similar to nitrogen though the increase in disease was lower than that under nitrogen fertilization. In contrast to this an increase in the level of potassium decreased downy mildew severity.

The findings of this research showed the significant role of host management practices particularly in a combination of NPK @ 120:90:60 kg/ha, plant density of 0.5 million/ha and eight irrigations/season by reducing downy mildew attack and increasing onion yield.

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