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Development of an Integrated Disease Management Model for Control of Onion Downy Mildew

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Abstract: An integrated disease management model (IDMM) was developed, from the findings of two year research, which included the testing of NPK fertilizer 120:90:60 kg ha^{-1}, plant population 0.5 million plants ha^{-1}, 8 irrigations/season, fungicide Ridomil @ 250 g 100 L^{-1} plus Antracol/Dithane M-45 @ 200/300 g 100 L^{-1} and herbicide Ronstar @ 5 ml L^{-1}. This model was verified against Farmers' Own Practices (FOPs) for control of downy mildew of onions. The IDMM reduced the Area Under Disease Progress Curve (AUDPC) and increased substantially bulb size (cm) and bulb yield (t ha^{-1}) by 3.7-4.1 and 20.3-28.2%, respectively. The multi location testing of IDMM proved its superiority over FOPs in minimizing the disease attack and improving the crop yield.

Key words: Integrated disease, management model, downy mildew, onion

Introduction

Onion is an important bulb vegetable crop of Pakistan. It was grown on an area of 85.5 thousands ha during 1998-99 in Pakistan. In the Northwest Frontier Province (NWFP) of Pakistan, the area and production of this crop were 8.1 thousands ha^{-1} and 120.5 thousands tones, respectively (Anonymous, 1999). Several constraints affect onion yield adversely in this province, which include the use of low quality seed, imbalanced fertilizers, uneven irrigations and above all, attack of various insect-pests and diseases.

In the NWPF, onion is attacked by several serious diseases, such as downy mildew (*Peronospora destructor*), purple blotch (*Alternaria porri*), grey mold (*Botrytis* sp.) and pink rot (*Fusarium* sp.). Among these, downy mildew is the most destructive disease, which reduced bulb yield upto 52-60% (Tahir *et al*., 1990; Brien, 1992). Several chemical, cultural and biological methods are used to control this disease.

Among the fungicides that controlled the downy mildew were: metalaxyl and cyomaxanil (Palti, 1989), Ridomil MZ-71 WP and Sandofan M (Mohibullah, 1991) and Antracol-70 WP followed by Ridomil MZ-72 WP (Tahir *et al*., 1990). These fungicides increased yield by 8-52% over control. Teviotdale *et al*. (1980) cited that Ridomil controlled the disease on bulb as well as seed crop. Similarly, Boyadzhiev *et al*. (1983) noted that Ridomil was very effective in reducing downy mildew infection in onions. Smith *et al*. (1986) quoted that Mancozeb @ 1.07 kg ha^{-1} and chlorothalonil @ 3.54 kg ha^{-1} completely controlled this disease. Ahmad and Khan (2000) reported the highest reduction (71.9%) in AUDPC by the application of Dithane M-45 plus Ridomil. The fungicide combination gave the highest bulb yield (21.9 t ha^{-1}), bulb number (41.3) and bulb size (5.9 cm).

Some host management practices have proved effective in reducing the downy mildew loss. The effect of low level plant populations on downy mildew control was evident from the disease (24%) and 12.6% increase in yield than the check (Mohibullah, 1989). Similarly, a plant density of 0.5 million ha^{-1} received 25.6% disease attack and gave 23.6 t ha^{-1} 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 farmers 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 and Karimullah, 1994). Ahmad and Khan (2001) concluded the highest AUDPC value was recorded in treatments where fertilizer level and population density were maximum. The lowest AUDPC was recorded in the treatment where, 8 irrigations, 120:90:60 kg ha^{-1} NPK and 0.5 million plants ha^{-1} were used. This treatment produced the highest (22.3 t ha^{-1}) bulb yield and bulb size (6.1 cm).

The main objectives of this research was to develop an Integrated Disease Management Model (IDMM) and test it against Farmers' Own Practices (FOPs) at multi location for control of onion downy mildew.

Materials and Methods

The Integrated Disease Management Model (IDMM) comprised of fungicides Ridomil plus Dithane M-45 @ 300 + 200 g 100 L^{-1}, plant population @ 0.5 million plants ha^{-1} (CV. "Swat-1"), NPK fertilizer @ 120:90:60 kg ha^{-1}, eight irrigations/season and herbicides Ronstar @ 5 ml L^{-1} for verification against Farmers' Own Practices (FOPs). FOPs included the use of onion variety "Swat-1", plant density @ 0.9 million plants ha^{-1}, NPK fertilizer @ 100:0:0 kg ha^{-1}, biweekly irrigations, hand weeding and one spray of fungicides Dithane M-45 @ 300g 100 L^{-1}. The experiment was laid out at each of the four locations in the NWFP with four replications in RCB design. Data on onion downy mildew severity (1-9) scale was recorded before the start of first spray and after each spray of fungicide at an interval of 10 days (Mohibullah, 1991) and was converted to Area Under Disease Progress Curve (AUDPC) following Shaner and Finney (1977).

$$AUDPC = \sum_{n=1}^{1}\{(X_i + X_{i-1})2\}\{t_i - t_{i-1}\}$$

where as X_i = Present disease severity; X_{i-1} = Previous disease severity and t_i-t_{i-1} = Time difference between two consecutive disease severities.

Data on size, number and weight of bulbs were recorded at the time of harvest of the crop. All the data were subjected to Analysis of Variance (ANOVA) and Least Significant Difference (LSD) test.

Results and Discussion

Area under disease progress curve (AUDPC): Significant differences ($P < 0.05$) occurred in AUDPC calculated for IDMM and FOPs of different locations (Table 1). In both cases, the lowest value was recorded at Zoor Mandi and the highest at Zakhi Qabristan and Miana. Difference between the highest and the lowest value was 66.5% for IDMM and 102.5% for FOPs. Again the lowest value of IDMM and FOPs was lower than across locations mean by 39.4 and 51.9%, respectively. All this indicated that IDMM caused more reduction than FOPs in disease severity at the test locations.

Bulb size: Variation occurred in values of bulb size at different locations. In both the treatments, the greatest bulb size was recorded at Zoor Mandi, which was higher by 16.9 and 23.8% than their respective lowest values. Treatmentwise, bulb size in IDMM was greater by 95.2-115.6%.

Table 1: Effect of multi location testing of IDMM vs. FOPs on downy mildew severity (AUDPC), bulb size, bulb number and bulb yield in onion

	AUDPC		Bulb size (cm)		Bulb number		Bulb yield (t ha^{-1})	
Locations	IDMM	FOPs	IDMM	FOPs	IDMM	FOPs	IDMM	FOPs
Miana	177.0a	496.5a	6.9b	3.2b	49.6	85.7	47.6b	27.3b
Zarif Shah	116.0b	256.8b	8.2a	4.2a	49.9	86.3	60.2a	32.0a
Zakhi Qabristan	188.2a	291.2a	7.0b	3.3b	49.7	85.3	48.9b	27.9b
Zoor Mandi	113.0b	245.2b	8.3a	4.2a	49.5	86.4	60.3a	33.1a
Mean	148.5	372.4	7.9	3.7	49.7	85.9	54.2	30.1
LSD (0.05)	42.1	99.0	0.2	0.2	NS	NS	2.2	1.4
CV (%)	14.2	13.3	1.2	4.7	1.4	3.3	1.9	3.5

AUDPC = Area under disease progress curve IDMM = Integrated disease management model. FOPs = Farmers' own practices
Values followed by different letters are significantly different ($P<0.05$) from one another

Bulb number: Non-significant differences ($P>0.05$) were noticed in bulb number recorded at different locations. However, the two treatments at the same location showed variation that ranged from 71.6-74.5% with the highest difference at Zoor Mandi (74.5%). By using high plant population in FOPs treatment, farmers get more number of bulbs per unit area. However, due to non availability of sufficient space and the resultant competition, bulb size decreased affecting the yield adversely. On the other hand, in the IDMM, inspite of lower number of bulbs, the size and yield were more than FOPs which showed its superiority over the latter. In this treatment, the maintenance of above optimum level of plant population is uneconomical because it requires more seed, space, fertilizer and water and provides more conducive environment for downy mildew development (Table 1).

Bulb yield: Significant differences ($P<0.05$) in yield were observed between the treatments (Table 1). In both the treatments, the highest yield was recorded at Zoor Mandi. However, it was higher by 82.2% in IDMM than in FOPs indicating best treatment effect. Location effect was evident from increase in yield recorded at Zoor Mandi, which was more than some other locations by 18.9-21.1% in IDMM and 15.7-17.5% in FOPs.

The IDM Model showed superiority over the FOPs at several locations. Its use caused decrease in disease severity and increase in size, number and yield of bulbs. Through this research, more emphasis has been put on the nonchemical or low chemical methods of downy mildew control because, farmers are gerenrally ignorant of such cultural controls. Through the use of balanced fertilizers, optimum level of plant density, proper irrigation regimes and weed control, good health of plants and protection of the environment can be maintained.

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