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Research Article

Nitrogen Level and Irrigation Interval on Mitigating *Stemphylium* Blight and Downy Mildew in Onion

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Abstract

Field trial was conducted on horticultural farm of Lamjung Agriculture Campus, Lamjung, Nepal between December-April 2016/17 on onion (*Allium cepa*), following two factorial Randomized Block Design with three replications and fifteen treatments to assess disease severity of *Stemphylium* blight (*Stemphylium vesicarium*) and Downy mildew (*Peronospora destructor*). The onion cultivar Red Creole, widely grown in this locality and susceptible to these diseases was used for trial. The disease intensity for *Stemphylium* leaf blight and Downy mildew was rated on weekly basis. Disease severity of both the disease significantly varied with nitrogen level and irrigation interval during initial and middle growth stage of onion, but in contrary, was found non-significant during later days as the plant approached harvesting stage. Area under Disease Progress Curve (AUDPC) also significantly varied in both treatments for both disease. Yield parameters recorded viz. bulb diameter and bulb yield significantly varied with nitrogen level and irrigation interval. The interaction effect of both the treatment was found non-significant for disease severity, AUDPC level and yield parameters during entire growth stage of onion. The results indicated that 7 days irrigation interval and government recommended dose of nitrogen i.e. 235 kg/ha were significantly better over other level of treatments in reducing *Stemphylium* blight and Downy mildew disease severity and also increasing yield parameters.

Keywords: AUDPC; disease severity; Downy mildew; Onion; *Stemphylium* blight.

Introduction

Onion belongs to class monocotyledon, family Alliaceae and the genus *Allium*. The genus *Allium* includes more than 500 species. Onion is grown as rabi season crop for their green leaves and bulbs. It is an important vegetable crop of Nepal based on per capita consumption, area under cultivation & number of households involved in farming (Budhathoki, 1997). It stands at the third position in production among the vegetable crop in the world after tomato and cabbage (FAO, 1996). Trade and Export Promotion Center (2017) coated that Nepal imported onion worth Rs. 2.44 billion within the first seven months of fiscal year of 2073 from countries including India, China, Thailand and Nicaragua. Likewise, the import in fiscal year 2071/72 was more than 96.3 million kilograms worth more than Rs. 3 billion and is much worse in fiscal year 2072/73 exceeding 120 million kilograms worth Rs. 3.26 billion depicting a heavy deficit of in-country onion production. Onions requires 13- 21^{o}C for vegetative growth and 15.6-25^{o}C for bulb development. It is prone to attack of Viruses,

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phytoplasmas, bacteria and fungi, resulting in a decline in productivity (Schwartz and Mohan, 1995). *Stemphylium vesicarium*, (phylum:Ascomycota; order: pleosporales) is a foliar blight disease of onion. Conidia are the spore produced asexually by various fungi at the tip of a specialized hypha. *S. vesicarium* has muriform septa, pale to olivaceous brown conidia, rounded at the apex, with no pointed ends. The conidia is 20-50 µm x 15-26 µm in size and has up to 6 transverse and several longitudinal septa often constricted at the three major transverse (Miller *et al*. 1978). Non-lineated light yellow to brown water soaked lesions progressing from tip to base appear, turning light brown to tan and then black on sporulation (Simmons, 1969). Appreciable loss in yield of onion was observed in whole of Northern and Eastern India because of *Stemphylium* blight (Gupta *et al*., 1996). 90% loss in onion crop by *Stemphylium* with most damage occurring after rains splashing for more than 24 hours was reported by Miller *et al*. (1978). *Peronospora destructor* Berk. (Class: Oomycota; order: Peronosporales), an obligate biotroph, is the casual organism of Downy mildew of *Allium* species. Its Conidia are pyriform or fusiform measuring 40-72 x 18-20 microns. Fungus fruits over the surface of leaves and seed stems, producing the characteristics violet Downy mildew. Mirakhur *et al*. (1978) reported Downy mildew in onion in Kashmir valley during the 1974-75 and 1975-76 seasons causing 60-70% loss in yield. Likewise, Sugha and Singh (1991) reported 12-75% losses in crop yield depending upon growth stage of plants affected and severity of disease in the Kangra valley of Himachal Pradesh of India during 1988-89. Application of inorganic N fertilizers promotes growth of host plant but increases susceptibility to foliar diseases (Develash and Sugha, 1997; Bains and Jhooty, 1978; Doshi and Thakore, 1995). Abd-Elrazik *et al*. (1988); Ali *et al*., (1984); Bhonde *et al.* (2001) reported increase in disease incidence with high irrigation frequency. Effect of agronomic practices *i.e.* use of different doses of nitrogenous fertilizer and frequency of irrigation have been found effective in management of diseases and insect pest in various crops (Fugro, 2000; Sharma *et al*., 2001; Vijay and Balasubramanian, 2002; Rathore and Chundawat, 2003). Disease severity is the percentage of relevant host tissues or organ covered by symptom or lesion or damaged by the disease. AUDPC is commonly a trapezoidal method of measuring quantitative summary of disease intensity between each pair of adjacent disease rating over time (Madden et al. 2007). Consider the sample time points in a sequence {ti}, where the time interval between two time points may be consistent or may vary, and associated measures of the disease level {yi}. Then AUDPC (Ak) is calculated as:

$$A_K = \sum_{i=1}^{N_i-1} \frac{(y_i + y_{i+1})}{2}(t_{i+1} - t_i)$$

Materials and Methods

Field trial was conducted on horticultural farm of Lamjung Agriculture Campus, Lamjung, Nepal(latitude: 28.125896; longitude: 84.416133 and altitude: 630.02m) between December - April 2016/17 on onion following two factorial Randomized Block Design with three replications and fifteen treatments. Different dose of Nitrogen viz.60%, 80%, 100%, 120% and 140% of government recommended dose and irrigation intervals viz. 4 days, 7 days and 10 days were evaluated for their field efficacy against *Stemphylium* leaf blight and Downy mildew of onion. Government recommended dose of NPK is 235:177:77kg/ha respectively (Krishi Diary 2073). Full dose of P and K while 50% of N was supplied during transplanting while remaining N was supplied in equal proportion in 30 and 45 days after transplanting. 1.3 kg well rotten farm yard manure (Krishi Diary 2073) was applied per plot while seedling transplantation. Irrigation was rescheduled when soil moisture exceeded the threshold value of 15% after each rainfall. Irrigation was applied until 15 days before harvesting. Plots were partitioned using a polythene sheet, dug into ground up to 40-45 cm depth, isolating each plot. The onion cultivar Red Creole, widely grown in this locality and susceptible to above mentioned diseases was used for the trial. Nursery bed was prepared in October 2016 on local farmer seed bed while seedling were transplanted in December 2016. The trial was conducted in an area of 11.7×3.6m. The plot size was maintained at 0.9×0.5m holding 30 plants per plot keeping row to row distance as 15 cm and plant to plant distance 10 cm. 12 plants per plot were under observation. *Stemphylium* blight was 1st observed in the field during February 2017 while Downy mildew was observed a month later. Both diseases were rated about 1 week after their first incidence in the field. Bulb diameter and bulb weight were the yield parameters recorded. Bulb diameter refers to the average width at the widest point in the middle portion of mature bulb measured with vernier calliper. Average bulb weight was computed by weighing 12 bulbs together and taking their average. The disease intensity for *Stemphylium* leaf blight and Downy mildew was rated using 0-5 scale (Sharma, 1986). AUDPC was also calculated. The data of rainfall during crop growing period was recorded from the field itself using a rain gauge (Fig. 1). The data were analyzed statistically using computer package program SPSS version 20.0. Mean separation was done using Least Significant Difference (LSD) and Duncan's Multiple Range Test (DMRT) at 5% significance level.(Gomez and Gomez, 1984) The correlation between yield and AUDPC levels was calculated and graphed using MS-Excel.

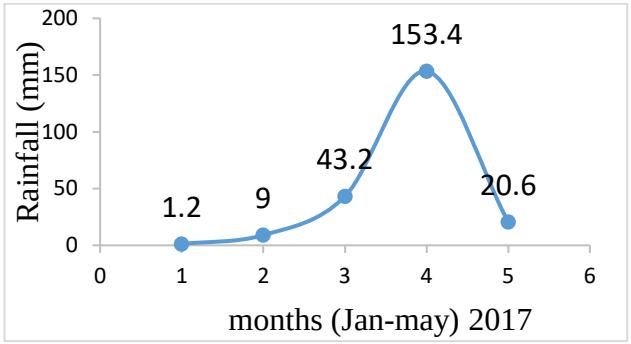

Fig. 1: Rainfall pattern at Lamjung Agriculture Campus, Lamjung, Nepal during Jan-May2017

Result and Discussion

Stemphylium Blight

AUDPC significantly varied in both the treatments & was found to be lowest in recommended nitrogen dose followed by 120% of recommended dose (Table 1). 120%, 140% & 80% of recommended dose were statistically similar. 60% of recommended dose recorded highest AUDPC but was statistically similar with 80% & 140%. Similar results have been found by, Sandhu, et al. (1964) in purple blotch of onion where disease incidence was high with nitrogen level below recommended dose. Also, lowest Disease severity and AUDPC was observed in 7 days irrigation interval while highest was for 10 days interval. Findings of Mishra & Gupta (2009) is in cognizance with this result. *Stemphylium* proliferates more in wet condition provided by 4 days irrigation interval (Maude, 1990). The interaction effect of nitrogen level and irrigation interval was found non-significant for AUDPC and disease severity during entire growth stage of onion. However AUDPC was highest in interaction of 60%of recommended dose and 10 days irrigation interval and lowest in interaction of recommended nitrogen and 7 days irrigation interval.

Downy Mildew

Downy mildew also showed somewhat similar result as that of *Stemphylium* blight. Here too, both the treatments showed significant difference for AUDPC (Table 2). Lowest AUDPC was recorded for recommended nitrogen dose but was statistically similar with 120% of recommended dose. 60% of nitrogen recommended dose recorded highest AUDPC but was statistically similar with 80% & 140%. Van Doom, (1959) reported dense leaf growth resulting from excess nitrogen application increases disease severity of Downy mildew in onion. Similar results were also obtained in the findings Doshi and Thakore, (1995); Develash and Sugha, (1997) in different crops and by Rathore and Chandawat (2003) and Mandal, Saravanan, & Maiti, (2008) in Downy mildew (*Peronospora plantaginis*) severity of Isabgol. Likewise, Disease severity and AUDPC for Downy mildew was lowest for 7 days irrigation interval while 10 day interval recorded highest. Palti, (1989) reported that incidence of Downy mildew increase with increase in irrigation frequency and is more pronounced in seasons when dew is prevalent. The interaction effect of different nitrogen level and irrigation interval was found non-significant for AUDPC and disease severity during entire growth stage of onion. However AUDPC was highest in interaction of 60%of recommended dose and 10 days irrigation interval and lowest in interaction of recommended nitrogen and 7 days irrigation interval.

Table 1: Effect of nitrogen level and irrigation interval on disease severity of *Stemphylium* blight in onion at Lamjung Agriculture Campus, Lamjung, Nepal during Dec 2016-Apr 2017

Treatments	Disease severity index					
	1	**2**	**3**	**4**	**5**	**AUDPC**
A) Nitrogen level						
60% of NR	0.7^{a}	3.14^{a}	4.27^{a}	4.86^{a}	5.00	105.98^{a}
80% of NR	0.43^{b}	2.88^{ab}	4.14^{a}	4.6^{a}	5.00	100.43^{ab}
NR	0.12^{c}	1.83^{c}	2.79^{b}	3.8^{b}	4.96	77.09^{c}
120% of NR	0.42^{b}	2.47^{b}	3.7^{a}	4.44^{a}	5.00	93.29^{b}
140% of NR	0.87^{a}	2.59^{ab}	3.94^{a}	4.58^{a}	5.00	98.33^{ab}
F-test	**	**	**	**	NS	**
B) Irrigation level						
4 days	0.53^{b}	2.45^{b}	3.76^{b}	4.48^{ab}	5.00	94.13^{b}
7 days	0.37^{c}	2.08^{b}	3.36^{b}	4.2^{b}	4.98	86.21^{c}
10 days	0.65^{a}	3.21^{a}	4.19^{a}	4.72^{a}	5.00	104.73^{a}
F-test	**	**	**	*	NS	**
Interaction(A*B)	NS	NS	NS	NS	NS	NS
SE_m	0.08	0.35	0.32	0.27	0.03	5.98
LSD	0.24	1.02	0.93	0.78	0.01	17.31
CV%	27.3	23.7	14.8	10.4	1.2	10.9

[Note: NR represent nitrogen recommended for onion by government, SEM, LSD and CV denote Standard error of mean, Least Significant Difference and Coefficient of Variation respectively; * and ** denotes significant and highly significant level respectively]

Table 2: Effect of nitrogen level and irrigation interval on disease severity of Downy mildew in onion at Lamjung Agriculture Campus, Lamjung, Nepal during Dec 2016-Apr 2017.

Treatments	Disease severity index					
	1	2	3	4	5	AUDPC
A) Nitrogen level						
60% of NR	0.79^{ab}	3.61^{a}	4.37^{a}	4.73^{a}	5.00	109.3^{a}
80% of NR	0.82^{ab}	3.56^{a}	4.01^{a}	4.65^{ab}	5.00	105.8^{a}
NR	0.52^{c}	2.06^{b}	2.93^{b}	3.87^{c}	4.98	81.32^{b}
120% of NR	0.76^{b}	2.20^{b}	3.27^{b}	4.22^{bc}	5.00	87.93^{b}
140% of NR	0.89^{a}	3.17^{a}	4.12^{a}	4.6^{ab}	5.00	103.8^{a}
F-test	**	**	**	**	NS	**
B) Irrigation level						
4 days	0.75^{b}	2.84^{b}	3.66^{b}	4.43^{ab}	5.00	96.6^{b}
7 days	0.62^{c}	2.45^{b}	3.37^{b}	4.15^{b}	4.9	89.5^{c}
10 days	0.90^{a}	3.46^{a}	4.19^{a}	4.67^{a}	5.00	106.9^{a}
F-test	**	**	**	**	NS	**
Interaction(A*B)	NS	NS	NS	NS	NS	NS
SE_m	0.07	0.38	0.27	0.27	0.017	5.23
LSD	0.21	1.10	0.80	0.78	0.04	15.16
CV%	16.8	22.6	12.8	10.6	0.6	9.3

Disease severity of *Stemphylium* blight and Downy mildew significantly varied with nitrogen level and irrigation interval during initial and middle growth stage while it was found non-significant during later days as the plant approached harvesting stage. (Table 1 and 2). Prolonged leaf wetness resulting from persistent rain above 153mm during the later stage of plant (Fig. 1) might have become critical in mass outbreak of disease thus producing a non-significant difference in treatments. Downy mildew of mustard (*P. parasitca*) also showed higher disease severity at 14 ^{0}C and 152mm rainfall than at 17 ^{0}C and 51mm rainfall (Bains and Jhooty, 1976). Similar case was reported by Suheri, (2000) in *Stemphylium* blight of onion resulting in increased infection with increased leaf wetness duration of 24 hours at all temperature. Mehta et al., (1996) found a positive correlation between prolonged leaf wetness and increased infection frequency.

Yield Parameters

Yield parameters recorded viz. bulb diameter and bulb yield significantly varied with various nitrogen level and irrigation interval. (Table 3) Patel, P. B. & J. J. Patel (2012) found similar result in bulb yield of garlic. Bulb weight and bulb diameter of 140% of nitrogen recommended dose was recorded to be highest followed by 120% and nitrogen recommended dose but were found to be statistically similar. Pandey et al. (1992) also figured out same results in his research. 60% of nitrogen recommended recorded lowest bulb yield and diameter. Halder et al. (1998) pointed that nitrogen enables greater uptake of nutrient elements from soil and also improves dry matter production. Likewise, bulb yield and diameter for 7 days irrigation was highest while that of 10 days was lowest. Net photosynthetic accumulation of plant is hampered with irrigation interval above 7 days accompanied with high temperature and evapotranspiration, hence less dry matter gets into the bulb, resulting in reduced diameter of bulbs (Brown, 1984). Likewise, Greany (1984), reported that solutes concentration in bulbs increases with increase in soil moisture that compensates for high evapotranspiration in high temperature regions, thereby increasing bulb weight. The interaction effect here too was non-significant. However higher bulb diameter and bulb weight was obtained in the nitrogen doses above government recommended with 7 days irrigation interval.

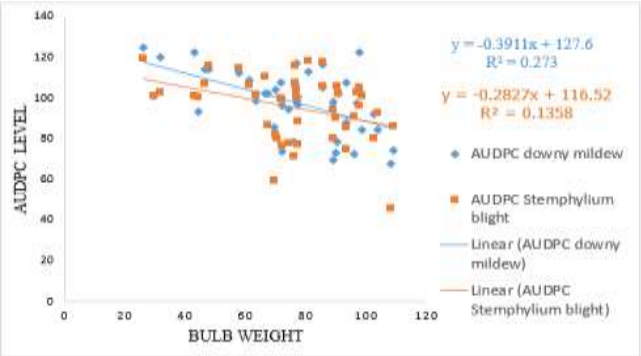

Fig. 2: Relationship between bulb weight and AUDPC for Stemphylium blight and Downy mildew in different nitrogen level and irrigation interval of onion at Lamjung Agriculture Campus, Lamjung, Nepal during Dec 2016-Apr 2017

A linear negative correlation was observed between bulb weight and AUDPC for both the disease with low coefficient of determination (Fig. 2). Equation y =-0.2827x+116.52 and R^2=0.1358 gave the best fit for *Stemphylium* blight and y=-0.3911+127.6 and R^2=0.273 gave the best fit for Downy mildew. (Fig. 2). Decrease in disease severity caused simultaneous increase in bulb weight. Gaunt (1995) explains reduction in yield because of low radiation interceptions and radiation use efficiency caused by foliar diseases.

Table 3: Effect of nitrogen level and irrigation interval on yield parameters of onion at Lamjung Agriculture Campus, Lamjung, Nepal during Dec 2016-Apr 2017

Treatments	Yield Parameters	
	Bulb diameter(cm)	**Bulb weight(g)**
A) Nitrogen level		
60% of NR	3.37[c]	52.95[c]
80% of NR	4.63[b]	70.14[b]
NR	5.44[a]	85.42[a]
120% of NR	5.48[a]	85.52[a]
140% of NR	5.53[a]	86.06[a]
F-test	**	**
B) Irrigation level		
4 days	4.91[b]	75.65[b]
7 days	5.46[a]	84.9[a]
10 days	4.3[c]	67.51[c]
F-test	**	**
Interaction(A*B)	NS	NS
SE_m	0.27	4.71
LSD	0.79	13.64
CV%	9.6	10.7

Conclusion

Seven days irrigation interval and government recommended dose of nitrogen i.e. 235 kg/ha were significantly better over other level of treatments in reducing *Stemphylium* blight and Downy mildew disease severity and also increasing yield parameters. Likewise, a linear negative correlation was observed between bulb weight and AUDPC for both the disease with low coefficient of determination. It indicated 27.3 % of bulb weight being influenced by Downy mildew while 13.58% of bulb weight being influenced by *Stemphylium* blight. Agronomic practices of plant disease management via controlling applied nitrogen dose and irrigation interval, incidence of disease can be significantly reduced. Chemical pesticides despite being swift in disease management have brought irrevocable damage to the human and environment. Thus, Farmers can manage disease in plants economically by focusing on the agronomic practices which they follow in their field day to day. This research recommends onion growers in managing *Stemphylium* blight and Downy mildew in the same regard.

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