Journal of Applied and Natural Science 8 (3): 1302 - 1305 (2016)

JANS

Influence of agronomic practices on severity of late blight of potato (*Phytophthora infestans*)

S. Dey[1*] and A. Chakraborty[2]

[1]Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741252(West Bengal), INDIA
[2]AICRP on Potato, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia-741235 (West Bengal), INDIA
*Corresponding author. E-mail**:** sdey.patho@gmail.com

Received: November 20, 2015; Revised received: March 26, 2016; Accepted: July 21, 2016

Abstract: An experiment was carried out to find out the influence of such agronomic practices on severity of the disease and to seek a proper cultural practice for management late blight of potato (*Phytophthora infestans*). The experimental results showed that the severity of late blight disease could be minimized by reducing the depth of irrigation (*i.e.* ¼ of irrigation channel). It was observed that the disease severity could be minimized by increasing the row-to-row and plant-to-plant spacing (60 × 25 cm). It was also observed that when less than recommended dose of nitrogenous fertilizer (200 Kg N/ha) along with slightly more than recommended dose of phosphorus and potassium fertilizer (200 Kg P_2O_5/ha and 250 Kg K_2O/ha) was applied, severity and spread of the disease was found to be under check. Therefore, for better management of late blight of potato the proper agronomic practices should be integrated with the application of fungicides. This will not only reduce the number of sprays but also reduces the health hazards owing to application of fungicides.

Keywords: Cultural management, Fertilizer dose, Irrigation, Late blight, Severity, Spacing

INTRODUCTION

Potato (*Solanum tuberosum* Linn), belonging to the family *Solanaceae* has established itself as an important non-cereal food crop in India. It is now cultivated in almost all the states under diverse agro-climatic condition except Kerala. It is a staple food in several countries particularly in Europe. Potato is the most popular crop in West Bengal next to cereals. Contribution of potato in agricultural GDP from unit area of cultivable land is about 3.7 times higher than rice and 5.4 times higher than wheat (Anonymous, 2015).

In field condition it has been observed critically that the incidence of several diseases affect the crop almost each and every year. Among them one of the important and devastating fungal disease is late blight. The disease caused by *Phytophthora infestans* (Mont.) de Bary which affects leaves and stems as well as tubers and causes heavy losses. The worldwide losses due to late blight are estimated at €12 billion (Haverkort *et al*., 2009). In India, losses caused by late blight ranges from 5-90% depending upon the climatic conditions with an average of 15% across the country (Collins, 2000). For managing this disease a number of chemicals have been evaluated by different scientists and found to be effective. But it is an established fact that *P. infestans* develops resistance to systemic fungicides. Therefore management of the disease by altering cultural practices may be very effective in future (Miller *et al*., 2006; Perez and Forbes, 2010).

Therefore, the present investigation was carried out to know the influence of different agronomic practices like irrigation, spacing and different fertilizer doses on severity of the disease and the objective of the investigation was to find out the proper spacing, optimum dose of irrigation and fertilizer application which will be able to keep severity of the disease under check so that the less amount of fungicides needed to ultimately control the disease.

MATERIALS AND METHODS

The experiment was conducted at Adisaptagram Block Seed Farm, Mogra, Hooghly, West Bengal, India at 9.75m above sea level during 2010-2011 and 2011-2012 crop season following randomized block design (RBD). The potato variety Kufri Chandramukhi (KCM) was planted during mid of November in both the season. To study the influence of irrigation on severity of late blight four doses of irrigation was applied *viz.* ¼ of irrigation channel (T_1), ½ of irrigation channel (T_2), ¾ of irrigation channel (T_3) and full of irrigation channel (T_4). The height of full irrigation channel was 15cm. At every irrigation dose severity of the disease was recorded at every seven days interval following the scale of Horsfall and Barrett (1945) as used in modified form (0-11) by a number of scientists

ISSN : 0974-9411 (Print), 2231-5209 (Online)

(Shields *et al.*, 1984; Tek, *et al.*, 2004; Bock *et al.*, 2009). For observing influence of spacing on disease development, field experiment was set by taking six spacing (row-to-row × plant-to-plant) *viz.* 50 × 15 cm (T_1), 50 × 20 cm (T_2), 50 × 25 cm (T_3), 60 × 15 cm (T_4), 60 × 20 cm (T_5) and 60 × 25 cm (T_6). The disease build up was recorded at every seven days interval. To observe the influence of fertilizer dose on disease development the field experiment was set by applying the following fertilizer doses in soil at the time of land preparation. These were as follows:

$T_1 = N_{200}P_{150}K_{150}$

$T_2 = N_{225}P_{150}K_{150}$

$T_3 = N_{250}P_{150}K_{150}$

$T_4 = N_{200}P_{200}K_{200}$

$T_5 = N_{200}P_{150}K_{200}$

$T_6 = N_{200}P_{200}K_{150}$

$T_7 = N_{150}P_{150}K_{150}$

$T_8 = N_{200}P_{200}K_{250}$

Finally, per cent disease intensity (PDI) values were calculated by using the formula developed by McKinney (1923).

RESULTS AND DISCUSSION

The results of the experiment are presented in Tables 1 -3. From the results presented in Table 1 it is evident that late blight disease was increased with increasing irrigation dose and at the time of final observation PDI value of late blight reached maximum (73.09%) in the plots applied with full recommended dose of irrigation (*i.e.* T_4). This may be due to the microclimate of plant such as canopy temperature, soil temperature, soil moisture, canopy wetness etc. which influence the development of potato late blight. Higher depth of irrigation also may favour the spread of the disease into healthy plants. More late blight as well as tuber blight of potato was also observed with excess irrigation water (Rotem and Palti, 1969; Johnson *et al.*, 2003).

From the results presented in Table 2 it is evident that the severity of the disease decreased with increase in spacing *i.e.* in spacing 50 × 15 cm the severity of the disease was 92.06%. But in case of spacing 60 × 25 cm

Table 1. Effect of irrigation dose on severity of late blight of potato.

Treatments	Irrigation	PDI[1] of late blight (%)			
		7 DAI[2]	14 DAI	21 DAI	28 DAI
T_1	¼ of irrigation channel	12.50* [d] (20.70)**	20.78[d] (27.12)	27.62[d] (31.70)	36.01[d] (36.88)
T_2	½ of irrigation channel	20.75[c] (27.10)	29.35[c] (32.80)	38.61[c] (38.41)	45.41[c] (42.37)
T_3	¾ of irrigation channel	30.15[b] (33.30)	39.52[b] (38.95)	48.36[b] (44.06)	55.32[b] (48.05)
T_4	Full of irrigation channel (upto 15 cm height)	39.63[a] (39.01)	49.67[a] (44.81)	63.18[a] (52.64)	73.09[a] (58.76)
CD (5%)		0.53	0.94	0.83	0.74
SEm (±)		0.17	0.30	0.27	0.24

[1]PDI- Per cent Disease Intensity; [2]DAI- Days After Initiation; * Values are mean of four replications; ** Values in parentheses are arcsine-transformed values;In a column, means followed by a common letter are not significantly different at the 5 % level by DMRT.

Table 2. Effect on spacing on severity of late blight of potato.

Treatments	Spacing (row × plant) (cm × cm)	PDI[1] of late blight (%)			
		7 DAI[2]	14 DAI	21 DAI	28 DAI
T_1	50 × 15	37.06* [a] (37.50)**	72.48[a] (58.37)	86.12[a] (68.14)	92.06[a] (73.67)
T_2	50 × 20	27.45[b] (31.59)	61.28[b] (51.52)	80.40[b] (63.73)	88.25[b] (69.98)
T_3	50 × 25	21.33[c] (27.50)	52.64[d] (46.51)	73.02[d] (58.71)	83.80[c] (66.29)
T_4	60 × 15	20.91[c] (27.21)	56.42[c] (48.69)	80.18[b] (63.59)	87.52[b] (69.32)
T_5	60 × 20	19.57[cd] (26.24)	50.25[e] (45.14)	75.63[c] (60.42)	80.30[d] (63.65)
T_6	60 × 25	18.87[d] (25.74)	42.33[f] (40.59)	67.51[e] (55.25)	71.82[e] (57.94)
CD (5%)		1.34	0.97	1.50	1.75
SEm (±)		0.44	0.32	0.50	0.58

[1]PDI- Per cent Disease Intensity; [2]DAI- Days After Initiation; * Values are mean of four replications; ** Values in parentheses are arcsine-transformed values; In a column, means followed by a common letter are not significantly different at the 5 % level by DMRT.

Table 3. Effect on fertilizer dose on severity of late blight of potato.

Treatments	Fertilizer dose (Kg ha^{-1})	PDI[1] of late blight (%) 7 DAI[2]	14 DAI
T_1	$N_{200}P_{150}K_{150}$	26.54* [a] (31.01)**	37.43[b] (37.72)
T_2	$N_{225}P_{150}K_{150}$	27.28[a] (31.48)	40.18[a] (39.33)
T_3	$N_{250}P_{150}K_{150}$	27.96[a] (31.91)	41.87[a] (40.32)
T_4	$N_{200}P_{200}K_{200}$	17.99[c] (25.08)	29.73[c] (33.04)
T_5	$N_{200}P_{150}K_{200}$	18.52[c] (25.47)	30.72[c] (33.66)
T_6	$N_{200}P_{200}K_{150}$	24.07[b] (29.38)	31.36[c] (34.05)
T_7	$N_{150}P_{150}K_{150}$	25.78[ab] (30.51)	36.11[b] (36.93)
T_8	$N_{200}P_{200}K_{250}$	17.78[c] (24.93)	26.52[d] (30.99)
CD (5%)		1.31	1.20
SEm (±)		0.45	0.41

[1]PDI- Per cent Disease Intensity; [2]DAI- Days After Initiation; * Values are mean of four replications; ** Values in parentheses are arcsine-transformed values.; In a column, means followed by a common letter are not significantly different at the 5 % level by DMRT.

the severity of the disease was only 71.82% and in case of spacing ranged from 15 × 20 cm to 60 × 20 cm the severity of the disease reduced gradually *i.e.* 88.25%, 83.80%, 87.52% and 80.30% respectively. Here also the microclimate inside the crop canopy had a marked effect on severity of the disease. The dense population also may favour the spread of the disease.

From the results presented in Table 3 it is evident that phosphorus (P) and potassium (K) had a marked effect on severity of potato late blight *i.e.* in fertilizer dose $N_{200}P_{200}K_{250}$ (T_8) only 26.52% of blight severity was observed 14 days after first appearance of the disease. This was followed by the fertilizer dose $N_{200}P_{200}K_{200}$ (T_4), $N_{200}P_{150}K_{200}$ (T_5) and $N_{200}P_{200}K_{150}$ (T_6) where 29.73%, 30.72% and 31.36% of late blight was observed respectively. But in case of fertilizer dose with higher proportion of nitrogen (N) the severity of late blight increased to a great extent *i.e.* in fertilizer dose $N_{250}P_{150}K_{150}$ (T_3) it was 41.87% and this was followed by$N_{225}P_{150}K_{150}$ (T_2), $N_{200}P_{150}K_{150}$ (T_1) and $N_{150}P_{150}K_{150}$ (T_7) where 40.18%, 37.43% and 36.11% of late blight was observed respectively. These findings are in line with Awan and Struchtemeyer (1957) who observed that increased P and K concentrations tend to lower late blight. Similarly, Rotem and Sari (1983), Carnegie and Colhoun (1983) and Phukan (1993) also observed the same findings that increased nitrogen level had the favourable influence on severity of late blight of potato. Reichbuch *et al.* (1977) and Sawicka (1993) also found higher infection with increased nitrogen fertilization.

There are a number of direct and indirect effects of nitrogenous fertilization on the disease development. The direct effect results in susceptibility at the plant tissue level. Indirect effects of increased fertilization on late blight cause changing in canopy size. It may affect microclimate and which ultimately affect late blight, because, *Phytophthora infestans* is highly sensitive to temperature and humidity, especially humidity (Sharma, 2000; Basu and Maiti, 2007).

Conclusion

From the above study it may be concluded that higher depth of irrigation and dense plant population should be avoided to manage late blight of potato by cultural means. On the other hand application of higher doses of phosphorus and potassium fertilizer also lower the disease rate whereas higher dose of nitrogenous fertilize promote the disease.

REFERENCES

Anonymous (2015). Vision 2050. Central Potato Research Institute, Shimla. pp. 2.

Awan, A.B. and Struchtemeyer, R.A. (1957). The effect of fertilization on the susceptibility of potatoes to late blight. *Am. Potato J.* 34: 315–319.

Basu, A. and Maiti, M.K. (2007). Epidemiological study on late blight disease of potato caused by Phytophthora infestans in West Bengal. J. Mycopathol. Res. 45(1): 90-93.

Bock, C.H., Gottwald, T.R., Parker, P.E., Cook, A.Z., Ferrandino, F., Parnell, S. and van den Bosch, F. (2009). The Horsfall-Barratt scale and severity estimates of citrus canker. *Eur. J. Plant Pathol.* 125: 23–38.

Carnegie, S.F. and Colhoun, J. (1983). Effects of plant nutrition on susceptibility of potato leaves to *Phytophthora infestans*. *Phytopathologische Zeitschrift.* 108: 242–250.

Collins, W.W. (2000). The global initiative on late blight-alliance for the future. Potato Global Research and Development Vol I. Indian Potato Association, CPRI, Shimla, India, pp. 513-524.

Haverkort, A.J., Struik, P.C., Visser, R.G.F. and Jacobsen, E. (2009). Applied biotechnology to combat late blight in potato caused by *Phytophthora infestans. Potato Res.* 52: 249-264.

Horsfall, J.G. and Barratt, R.W. (1945). An improved grading system for measuring plant diseases. *Phytopathol.* 35: 655.

Johnson, D.A., Martin, M. and Cummings, T.F. (2003). Effect of chemical defoliation, irrigation water, distance from the pivot on late blight tuber rot in center-pivot irrigated potatoes in the Columbia basin. *Plant Dis.* 87: 977-982.

McKinney, H.H. (1923). Influence of soil temperature and moisture on infection of wheat seedling by *Helminthosporium sativum*. *J. Agric. Res.* 26: 195–217.

Miller, J., Nolte, P., Olsen, N., Miller, T., Bohl, B. and Thornton, M. (2006). Late blight management action plan for potatoes. University of Idaho Extension, Idaho Agricultural Experiment Station, pp. 1-11.

Perez, W. and Forbes, G. (2010). Technical Manual: Potato late blight. International Potato Center (CIP), pp. 1-36.

Phukan, S.N. (1993). Effect of plant nutrition on the incidence of late blight disease of potato in relation to plant

age and leaf position. *Indian J. Mycol. and Pathol.* 23 (3): 287–290.

Reichbuch, L., Ignatescu, I. and Iacob, Gh. (1977). Aspecte noi privind sistemul de fertilizare si reactia cartofului la *Phytophthora infestans* (Mont.) de Bary (Mana) si *Alternaria* sp. (Patarea bruna a frunzelor). *Lucrari Stiintifice*. 8: 115–130.

Rotem, J. and Palti, J. (1969). Irrigation and plant diseases. Annu. Rev. Phytopathol. 8: 267-288.

Rotem, J. and Sari, A. (1983). Fertilization and age-conditioned predisposition of potatoes to sporulation of and infection by *Phytophthora infestans*. *J. Plant Dis. Prot.* 90(1): 83–88.

Sawicka, B. (1993). Zmiennosc pojawu i szerzenia sie zarazy ziemniaka (*Phytophthora infestans* (Mont.) de Bary) w warunkach ochrony plantacji i nawozenia azotem. *Biuletyn Instytut Ziemniaka*. 42: 113–122.

Sharma, K.K. (2000). Influence of meteorological factors on potato late blight development in North-western plains of India. J. Indian Potato Assoc. 27(1/2): 1-3.

Shields, E.J., Hygnstrom, J.R., Curwen, D., Stevenson, W.R., Wyman, J.A. and Binning, L.K. (1984). Pest management for potatoes in Wisconsin – a pilot program. *Am. Potato J.* 61(8): 508–515.

Tek, A.L., Stevenson, W.R., Helgeson, J.P. and Jiang, J. (2004). Transfer of tuber soft rot and early blight resistances from *Solanum brevidens* into cultivated potato. *Theo. Appl. Genet*. 109: 249–254.