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MANAGEMENT OF POTATO LATE BLIGHT THROUGH HOST PLANT RESISTANCE AND FUNGICIDE USE IN SOUTH OMO ZONE, SNNPR, ETHIOPIA

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Abstract

The study was carried out in April 2015 at South Ari district, Senmamer kebele of South Omo Zone Southern Nation Nationality People Regional State to test and demonstrate the effects of integrating host resistance and fungicide application for management of potato late blight disease. In this experiment one relatively late blight resistance improved Irish potato variety (Belete) was collected from Holleta Seed producer Association and susceptible local control potato varieties were used. RCBD with four replications (farmers as replication) were used. A recommended rate of Curzate^{R} R WP fungicide was applied while susceptible local variety developed the first blight symptom. GLM procedures were followed to analyze yield, disease incidence and severity. LSD ($P<0.01$) values were used to separate treatments mean. Total weight of tubers per plot (kg) was show significant difference ($P<0.01$) among treatments. The highest total weight of tubers per plot (kg) was given by treated belete (T_1) (22.625) followed by untreated belete (T_3), untreated local (T_4) and treated local (T_2) (18.525, 11.875and 10.125) respectively (Table 2). Local potato variety also gave the highest unmarketable tubers weight per plot. The result indicated that there were a significant difference ($P<0.01$) and ($P<0.05$) among treatments on late blight incidence and severity respectively. Untreated local variety (T_4) showed highest late blight incidence and severity as compare to treated belete variety (T_1). The experiment result suggested that application Curzate^{R} R WP fungicide twice on variety belete results in significant reduction on late blight progress, with a corresponding increased tubers yield.

Keywords: Host Resistance; Late Blight Incidence; Belete Variety; Curzate^{R} R WP.

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1. Introduction

Potato (*Solanum tuberosum L.*) is the most important crop in developing countries and its production is expanding more rapidly than other crops [1, 2]. It is becoming an important source of rural employment, income and food for ever growing populations. The crop is the fourth major crop of the world next to rice, wheat and maize [3]. Potato was introduced to Ethiopia in the 19th century by a German Botanist Schimper [1, 4]. It is grown by approximately 1 million farmers [5]. The crop is considered as a high-potential food security crop because of its ability to provide a high yields per unit input with a shorter crop cycle (< 120 days) than major cereal crops like maize [6].Ethiopia is among the top potato producers country in Africa, about 70% of its arable land in the high altitude (1500 m.a.s) being suitable for potato production [7, 8]. Even though the country has huge potentials for potato production only smaller portion of the arable land is covered by the crop. The main reason associated to this underutilization of the crop is the narrow genetic base and most of the people use cereals as staple food. In addition to this, lack of high yielding and disease resistant varieties, insect and diseases problems are also the main challenges. Potato late blight caused by *Phytophthora infestans* is the major production constraints in Ethiopia. The disease is a serious production constraint in major potato growing areas of African especially in Kenya and Ethiopia. [9] Reported that the disease causes 100% yield loss on unimproved local cultivar and 67.1% on a susceptible variety. Management of potato crop against this pathogen is important to maximize the yield. The disease occurs throughout the major potato producing areas and it is very challenging to produce potato during the main rainy season without chemical protection measures [10, 11]. Although fungicides have been used to manage late blight, both the efficacy and availability of commonly used fungicide have been threatened [12]. In addition to this resource poor growers could not afford an ever increasing fungicide. Combining host resistance with fungicide application will be an option to manage the disease. Therefore, the aim of the research was to test and demonstrate the effects of integrating host resistance and fungicide application for management of potato late blight disease.

2. Materials and Methods

2.1. Treatments and Experimental Design

The study was carried out in South Ari district; Senmamer kebele South Omo Zone Southern Nation Nationality People Regional State located 10 km away from Jinka town. The area receives mean annual rainfall of 1000 mm during the main rainy seasons. The temperature of the zone varies with maximum and minimum temperatures of 35^{o}C and 15^{o}C.It has a sub-humid, warm to hot climate. The sites are situated at 653432N and 231980E with an altitude of 2100 m.a.s.l.

One relatively late blight resistance improved Irish potato variety was collected from Holleta Seed producer Association (Belete). A susceptible local control potato variety was purchased from the local farmer and planted in April 2015. Large plot size with randomized complete block design with four replications (Farmers as replication) was set up. Each plot consists of six rows (5m x 5m dimensions) with spacing of 75 cm by 30 cm between rows and within plants respectively. A total of 16 (4x4) experimental plots were established. All management practices

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were done per crop requirement. Recommended rate (2.5kg/ha) of fungicide, Curzate^{R} R WP three times was applied every seven days interval after onset of the disease.

By doing this Four treatments sets were created (Belete variety treated (T1) and untreated plot (T2) with chemical and Local variety treated (T3) and untreated plot (T4)). At physiological maturity stage 16 potato plants per plot were randomly selected from the middle four rows and yield data was taken.

Figure 1: Demonstration of the output to the stakeholders

2.2. Disease Assessment

Disease incidence and severity; the experiment site is known by frequency late blight outbreak as a result natural inoculation was considered as a source. Each plant within the plots was carefully visually inspected per week for late blight incidence and severity.
The percent of disease incidence was calculated as;

$$\text{Disease Incidence} = \frac{\text{Number of diseased plants} \times 100}{\text{Total number of plants assessed}}$$

Disease severity was assessed based on interval scales (0-5). Where 0= no infection, 5= complete infection of the plant leaf.

2.3. Data Analysis

Data on yield and disease parameters such as incidence and severity were analyzed following GLM procedures using Statistical Analysis of System (SAS) version 9.0software. Duncan Least Significant Difference (LSD) values were used to separate differences among treatments means ($P<0.01$). Both yield and late blight incidence and severity data were analyzed following GLM procedures.

3. Result and Discussion

3.1. Yield and Yield Components

Results of analysis of variance of the yield four treatments were presented in (Table 1). Total weight of tubers per plot (kg) was show significant difference ($P<0.01$) among treatments. The

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highest total weight of tubers per plot (kg) was given by treated belete (T_1) (22.625) followed by untreated belete (T_3), untreated local (T_4) and treated local (T_2) (18.525, 11.875and 10.125) respectively (Table 2).

3.2. Late Blight Incidence

Late blight disease was noticed in the cropping season while the experiment was conducted. Susceptible local variety developed the first late blight symptom. A recommended rate (2.5 kg/ha) of CurzateR R WP fungicide was applied during this time. Analysis of disease incidence indicated that there were significant differences ($P<0.001$) among treatments (table 1).
The maximum late blight incidence was recorded on the untreated local variety (T_4) followed by treated local variety (T_2) (table 2). Treated belete variety (T_1) and untreated belete (T_3) scored the least late blight disease incidence (Table 2).

3.3. Late Blight Severity

The disease reached its peak level 58 days post planting (about 3 weeks after first symptom appearance).Treatments show a significant difference ($P<0.05$) to late blight severity (Table 1). The maximum late blight severity was recorded on untreated local variety (T_4) and followed by treated local variety (T_2). Local variety developed a complete leaf infection and correspondingly decreased total weight of tubers per plot (kg) (table 2).The remaining two treatments such as treated belete variety(T_1) and untreated belete variety (T_3) scored the lowest late blight severity (Table 2). The disease severity score ranges from 1.25 to 3.50 for treated belete variety (T_1) and untreated local variety (T_4) respectively (Table 2).

3.4. Correlation of Each Parameter to the Treatments and Each Other

The correlation analysis indicated that; disease incidence had positive and significant correlation with disease severity and treatments; whereas it had negative and non-significant correlation with yield as indicated in (Tbale3).In general total tuber weight/plot had negative and significant correlation both to disease severity and incidence (Tbale3).Whereas treatments had positive and significant correlation with disease incidence and severity and negative and non-significant correlation with total tuber weight/plot(Tbale3).

Table 1: Significances of Mean Square Values for Disease Incidence, Yield and Disease Severity

Source	DF	Disease Incidence (%)	Disease Severity (1-5 scale)	Yield(Total weight of tubers/ plot) (Kg)
Rep	3	28.06^{ns}	0.56250^{ns}	61.298*
Trt	3	1304.86**	4.22917*	135.489**
Error	9	47.50	0.45139	11.720
CV		34.96	30.71	21.68

ns, not significant at $P< 0.05$, * significant at $P<0.05$, ** significant at $P<0.00$

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Table 2: Mean Value of Disease Incidence, Yield and Disease Severity of Four Treatments

Treatments	Disease Incidence (%)	Disease Severity (1-5 scale)	Yield(Total weight of tubers/ plot) (Kg)
Treated Belete(T_1)	5.833c	1.2500c	22.625a
Treated Local(T_2)	19.588b	2.5000ab	10.125b
Untreated Belete(T_3)	8.200c	1.5000bc	18.525a
Untreated Local(T_4)	45.275a	3.5000a	11.875b
CV (%)	34.96	30.71	21.68
LSD	11.024	1.0747	5.476

Note: Means with the same letters are not significantly different

Table 3: Correlation of Five Attributes Each Other

Pearson Correlation Coefficients, N = 16 Prob > |r| under H0: Rho=0					
	Di	**DS**	**Yld**	**Rep**	**Trt**
Di	1.00000	0.86585 <.0001	-0.53149 0.0341	0.11706 0.6659	0.71885 0.0017
DS	0.86585 <.0001	1.00000	-0.49407 0.0517	0.23434 0.3823	0.59887 0.0142
Yld	-0.53149 0.0341	-0.49407 0.0517	1.00000	-0.14750 0.5857	-0.40434 0.1203
Rep	0.11706 0.6659	0.23434 0.3823	-0.14750 0.5857	1.00000	0.00000 1.0000
Trt	0.71885 0.0017	0.59887 0.0142	-0.40434 0.1203	0.00000 1.0000	1.00000

4. Discussion

Occurrence of late blight in sub-sharan Africa has been closely related to the introduction of susceptible varieties. In Ethiopia, potato late blight has been a serious problem since the introduction of the crop. Between 1987 and 2006, more than18 potato varieties were released in Ethiopia [14]. All these cultivars came from potato germplasm introduced by the CIP as resistance varieties to *P. infestans*. Resistance to late blight in these cultivars has been overcome and significant yield losses experienced [14]. In this experiment significant variations were observed among susceptible local and resistance potato varieties in terms of total weight of tubers per plot (Table 2).

According to [15, 16] potato yield loss attributed primarily to late blight is dependent on variety susceptibility or tolerance/ resistance and disease management practices. In our experimental trial the total weight of tubers per plot was gain when resistance host (belete variety) combined with CurzateR R WP fungicide application (Table 2). The present study result was in line with [17], which suggested that integration of host resistance and fungicide application reduced the late blight severity by more than 50 % and results in yield gains of more than 30%. The local control potato variety is highly susceptible to late blight and early infection which results in reduced total yield (Table 2). Report indicated that complete suppression of yield in susceptible variety is possible if the disease occurs early in the season. [18, 19]

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5. Conclusion

The present study suggested that integration of resistance host (belete potato variety) with CurzateR R WP fungicide results in reduced late blight disease progress, with a correspondingly increased total tubers weight. Integrated effects of host resistance and reduced fungicide application were not only gave higher yield and reduced disease progress on potato but also lower cost of production for resources poor farmers and environment pollution risk. In addition to this significantly reduced the possibility of development of chemical resistance pathogen strain. Many report indicated that frequent applications of fungicides results in the development of a new virulent strains of the pathogen.

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