Pestic. Phytomed. (Belgrade), 38(1), 2023, 23–31
DOI: https://doi.org/10.2298/PIF2301023J

UDC 632.35:632.935:633.825(63)
Original scientific paper

Management of ginger bacterial wilt (*Ralstonia solanacearum*) epidemics by soil solarization and botanical mulching at Tepi, southwestern Ethiopia

Merga Jibat* and Abukiya Getu

Tepi Agricultural Research Centre. P.O.Box 34, Tepi, Ethiopia
**Corresponding author: mergajibat@gmail.com*

Received: 24 November 2022
Accepted: 4 January 2023

SUMMARY

Ginger is one of the most valuable cash crops for farmers in different parts of Ethiopia. Bacterial wilt disease, caused by *Ralstonia solanacearum*, creates major limitation to production of ginger in Ethiopia. Heavy losses due to the disease occur regularly, causing an additional impediment for production in infected areas. Field tests were conducted at Tepi, South-Western Ethiopia, during the 2019 and 2020 main cropping seasons to assess the effects of soil solarization and botanical mulch on epidemics of bacterial wilt of ginger. Four soil solarization periods, lasting two, four, six or eight weeks before planting were integrated with four different botanical mulch treatments after planting: vetivar grass, lemon grass, Chinese chive and *Lantana camara*. Unsolarized and unmulched plots were used as the control for comparison. Treatments were arranged in factorial arrangements with randomized complete block design with three replications. The outcomes indicated that soil solarization integrated with lemon grass mulch treatments significantly reduced bacterial wilt mean incidence by 22.1% up to 42.2%, compared to control plots. These treatments also dramatically reduced AUDPC and disease progress rates. Soil solarization for eight weeks integrated with lemon grass mulch resulted in the lowest (42.2%) final mean disease severity and AUDPC (33.8%) in comparison to the control. Typical results of this study indicated that soil solarization integrated with botanical mulch treatments were effective in slowing dawn the epidemics of bacterial wilt and in recovering ginger production and productivity, and they are consequently recommended for application in the study areas along with other crop management schemes.

Keywords: ginger, bacterial wilt, mulching, soil solarization, plant disease management

INTRODUCTION

Ginger has a significant contributing role to the local economy of Ethiopia. It has an export potential, adds value to economic growth, creates a lot of job opportunity locally, and impacts gender empowerment, accessibility and government priorities regarding small farmers in Ethiopia (Vijayalaxmi & Sreepada, 2012). Bacterial wilt of ginger caused by the soil-borne bacteria *Ralstonia solanacearum* is a problem demanding careful consideration in ginger-growing areas of Ethiopia. This disease regularly occurs late in the rainy period. Diseased plants show inward curling, yellowing and browning of the entire shoot, and near-death signs. The basal portion of the yellow stem (shoot) is water-soaked and easily broken off from the underground rhizome and there is milky bacterial ooze exuding from cut stems or rhizomes (Habetewold et al., 2015, Jibat et al ., 2018).

Bacterial wilt is triggered by *R. solanacearum* and its management is challenging once it has established in the field. Owing to its extensive host range, long persistence in soil, propagation in many ways (planting material, irrigation water, farm implements and vectors), it lives in vegetation as dormant infection and hereditarily assorted strains (Allen et al., 2005). However, knowing these features of the disease, it is quite valuable to examine the conditions that regulate disease development and plan a sound disease management approach.

Soil solarization is a nonchemical technique for monitoring soil-borne pests using high temperatures produced by captivating radiant energy from the sun as a 5% rise in soil temperature reduces bacterial diseases. Soil solarization during the hot seasonal months raises soil temperature to levels that kill many disease-producing organisms (Elmore et.al*.,* 1997) and speeds up the breakdown of organic material in soil and so add the benefit of release of soluble nutrients, such as nitrogen ($N0_3^-$, NH_4^+), calcium (Ca^{++}), magnesium (Mg^{++}), potassium (K^+), and fulvic acid, making them more available to plants (Wilen & Elmore, 2007). Studies done by Stapleton et al. (2008) show that plants often grow faster and produce both higher and better quality yields when grown in solarized soil. When correctly done, the top 15 cm of soil will heat up to as high as 60 °C, depending on conditions on the site. Plastic sheets shelter the soil for 4 to 6 weeks allowing solar radiation to be confined in the soil, heating the top 30 to 45 cm and killing a wide variety of soil-borne pests, such as weeds, pathogens, nematodes and insects (Wilen & Elmore, 2007).

Mulching the plant beds with green botanical leaves/organic wastes is crucial to avoid soil splashing and erosion of soil due to heavy rain which decreases bacterial disease feasts. It also complements organic matter to the soil, checks weed emergence and preserves moisture during the latter part of the cropping period. It can recover soil structure by cumulative availability of nitrogen and other essential nutrients for growing healthy plants, as well as controlling a range of diseases. Typically, soil solarization and mulching leave no chemical residues and thus provide a simple method, suitable to reduce the inoculum of the bacterial wilt-causing pathogen in the soil. Therefore, the aim of this study was to reduce ginger bacterial wilt epidemic development and enhance ginger rhizome yield through soil solarization and botanical mulching of the soil.

MATERIALS AND METHODS

Experimental site

The trial was undertaken at Tepi Agricultural Research Centre (TARC), Ethiopia during the 2019 and 2020 main cropping seasons. TARC is located in Yeki district, Southern Nations Nationalities and Peoples' Regional State, which is 600 km south-west of the capital, Addis Ababa. It is situated between 35°08' longitude and 7°08' latitude and at an altitude of 1200 m.a.s.l. The average lowest and highest temperatures are 15 and 30 °C, respectively. It obtains an average annual rainfall of 1630 mm (Guji et al., 2019).

Experimental materials and treatments

Soil solarization for 2, 4, 6 and 8 weeks before ginger planting was evaluated in relation to bacterial wilt either alone or in integration with botanical mulch consisting of vetiver grass, lemon grass, Chinese chive and *Lantana camara* at 10 tons/ha. Soil solarization over different time periods before planting and mulch treatment after planting with different botanicals were applied as cultural management practices to reduce pathogen inocula and prevent disease epidemics.

The plot to be solarized was systematically cultivated and smoothed so as to prevent ripping of the sheet. Later, all plots were watered and covered with transparent polyethylene sheets of 1.5 cm thickness for 2, 4, 6 and 8 weeks under high and direct solar radiation, and an unsolarized plot was used as the control (Stapleton et al., 2008). All free ends were buried and then the soil around them compressed so as to prevent leakage of heated air or moisture from solarized plots. The first mulching was done at the time of planting with green leaves of vetiver grass, lemon grass, Chines chive and *Lantana camara* at 10 tons/ha, and the unmulched plot was used as the control. The experiment depended on repetitive epidemics of bacterial wilt since the site is a hot spot area of disease with a former history.

Experimental design and trial management

A total of 17 treatments including controls were laid out in a randomized complete block design in a factorial arrangement with three replications. Planting was done on a total plot size of 4 m^2 (2 m width and 2 m length) with six rows of ginger and four harvestable central rows. A recommended spacing of 0.15 m between plants and 0.3 m between rows were used. Spacing between plots and blocks were 0.5 and 1 m, respectively. Total area allocated for the experiment was 44.5 m × 8 m (356 m^2). The four central rows were considered for data collections. All other cultural practices for growing ginger under field conditions were applied uniformly following recommended practices.

Disease assessment

Ginger bacterial wilt incidence (number of plants wilted) was visually evaluated at 15-days interval starting from 60 days after planting (DAP). Plants that displayed either whole or partial wilting were all deliberately wilted and staked to avoid double counting in succeeding assessments. Wilt incidence for each treatment was then considered as a percentage in the total number of plants grown. Disease progress was plotted by considering the disease incidence against time. The area under disease progress curve (AUDPC) based on disease incidence was calculated using the formula recommended by Campbell and Madden (1990):

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

where n is the total number of assessments, t_i is time of the i^{th} assessment in days from the first assessment date, x_i is the percentage of disease incidence at i^{th} assessment. AUDPC was expressed in %-days since incidence (x) was expressed as percentage and time (t) in days (Campbell & Madden, 1990). AUDPC values were standardized by dividing the values by the epidemic periods (Campbell & Madden, 1990).

Data analysis

Data on bacterial wilt incidence was scrutinized. Analysis of variance (ANOVA) was done for disease incidence and rAUDPC to see the outcome of treatments and their interactions. A logistic ln (Y/1-Y), (Van der Plank, 1963) model was used for estimation of disease progression parameters from each treatment. The converted disease incidence data were regressed over time (DAP) to decide the rate. The fitness of the models was established based on degrees of the coefficient of determination (R^2) and residuals (SE) reached using the model (Campbell & Madden, 1990). The slope of the regression line predicted the disease progress rate.

Regression was considered using Minitab (Release 15.0 for windows®, 2007). The least significant difference (LSD) was used for mean separation at 5% level of significance. ANOVA was executed using the General Linear Model (GLM) of SAS procedure version 9.3 (SAS, 2014). The association of final disease incidence and rAUDPC with yield and yield constituents was examined using correlation analysis. The two years were considered as the same because of the homogeneity of variances confirmed using Bartlett's test (Gomez & Gomez, 1984) and the F-test was nonsignificant for most of the parameters calculated in each year. Thus, data were pooled for analysis.

RESULTS AND DISCUSSION

Disease incidence

Pooled analysis of bacterial wilt incidence data revealed non-significant ($P>0.05$) variation between the 2019 and 2020 main cropping seasons. Therefore, data for both years were pooled and analyzed. Interaction effects of soil solarization with botanical mulch on disease incidence showed highly significant ($P<0.001$) difference at the last date of assessment. Standardized AUDPC values similarly showed significant difference and revealed likely patterns in wilt incidence for both soil solarization and botanical mulch.

The maximum (50.02%) disease incidence was documented from the unsolarized and unmulched control plot, followed by plots solarized for six weeks and mulched with *Lantana camara*, which scored 40.14% at the final date of assessment (120 DAP). The lowest (29.0%) level of disease incidence was obtained in plots with soil solarized for eight weeks, and mulched with lemon grass, at the final assessment 120 DAP. An analogous trend was observed for the rAUDPC (Table 1). This might be attributed to soil solarization as it increases the tilth and nutrient status of soil. It had been previously shown that micro-organisms beneficial to plant growth were either stimulated (*Rhizobium* spp. and *Trichoderma* spp.) or less affected (*Bacillus* spp. and Actinomycetes) by soil solarization than pathogenic organisms (Stapleton & Devay, 1982).

Lower wilt incidence and rAUDPC values found in plots treated with soil solarization for eight weeks and mulched with lemon grass might be credited with the accessibility of nutrients, release of essential oils and boosted population of beneficial soil microorganisms. Available nutrients may increase crop potency and essential oils may incorporate lethal chemicals that could consequently reduce wilt epidemics. In line with this result, a study conducted by Guji et al. (2019) reported that an addition of potassium fertilizer (100 kg ha^{-1}) in combination with soil solarization and lemon grass abridged bacterial wilt incidence by 42.5% over the control. Another earlier study integrated biofumigation with *Brassica* spp., palmarosa and lemon grass with mulching, which released volatiles of essential oils into pathogen-infected fields and reduced bacterial wilt incidence (Arthy et al., 2005). Such plants have high glucosinolates and upon mulching they hydrolyse to antimicrobial isothiocyanates, nitriles or thiocyanates, thereby reducing *R. solanacearum* populations in the soil and wilt incidence in crops (Blok et al., 2000).

Disease progress rate

The disease development rates and parameter estimates of bacterial wilt displayed variations regarding soil solarization periods and mulch types. Disease progress rates in the vetivar grass mulched plots ranged from 0.024 to 0.028 units/day (Table 2), whereas the rates in the lemon grass mulch treatment ranged between 0.011 and 0.025 units/day. In Chinese chive mulched plots, the rates were in between 0.012 and 0.025 units/day, and 0.015 to 0.027 unit/day in *Lantana camara* mulch treatment. It was also obvious that the disease progressed at relatively quicker rates on unsolarized and unmulched plots (0.032 units/day) than on solarized and mulched plots over the years. The results showed that the rate at which bacterial wilt progressed was slower when soil solarization for four weeks was applied along with the lemon grass mulch. This technique could help to explore the synergetic ability of each treatment to obstruct wilt epidemic development. Previous studies had also shown that combinations of soil solarization with other cultural practices decreased disease progress rates by strengthening the resistance of plants to the pathogen. In a study, for instance, soil solarization combined with potassium fertilizer and lemon grass increased plant resistance and decreased disease progress rate (Guji et al., 2019).

Table 1. Interaction effects of soil solarization and botanical mulch on bacterial wilt (*R. solanacearum*) final disease incidence (%) and standardized area under disease progress curve (%-days) at Tepi, Ethiopia, during 2019/2020 main cropping seasons

Treatment combination[1]	Disease incidence (%) and rAUDPC (%-days)				Disease incidence (%) and rAUDPC (%-days)			
	Week 2		Week 4		Week 6		Week 8	
	PDI_f[2]	rAUDPC[3]	PDI_f[2]	rAUDPC[3]	PDI_f[2]	rAUDPC[3]	PDI_f[2]	rAUDPC[3]
VG	34.68^{defg}	23.05^{fgh}	38.26^{bcd}	25.46^{cde}	39.41^{bc}	24.08^{efg}	33.76^{efgh}	24.7^{6def}
LG	39.1^{bc}	24.17^{efg}	33.27^{fghi}	22.54^{gh}	30.33^{hi}	21.63hi	29.0^{i}	20.3^{i}
Ch	37.57^{bcde}	25.18^{cde}	36.06^{cdef}	28.95^{b}	31.56g^{hi}	24.38^{ef}	29.53^{i}	22.10^{h}
LC	39.85^{bc}	26.42^{cd}	39.08^{bc}	26.63^{c}	40.14^{b}	25.6^{cde}	38.13^{bcd}	24.86^{cde}
Control	50.2^{a}	33.43^{a}	50.2^{a}	33.43^{a}	50.2^{a}	33.43^{a}	50.2^{a}	33.43^{a}
LSD (0.05)	3.87	1.8						
CV (%)	6.37	4.34						

[1] VG = vetivar grass; LG = lemon grass; Ch = Chinese chive; LC = *Lantana camara*. [2] Percent disease incidence 120 days after planting (DAP). [3] rAUDPC = standardized area under disease progress curve of ginger bacterial wilt. Means followed by the same letter(s) within a column are not significantly different at 5% level of significance.

Table 2. Effects of soil solarization and botanical mulch on disease progress rate (r) and parameter estimates of bacterial wilt (*R. solanacearum*) on ginger at Tepi, Ethiopia, during 2019/2020 main cropping seasons

Botanical mulch	Soil solarization period [1]	Disease progress rate (r) at Tepi			
		Disease progress rate (unit day^{-1}) [2]	SE of rate [3]	SE of intercept [4]	R^2 (%) [5]
	Control	0.032	0.278	0.278	90.7
Vetivar grass	W2	0.025	0.138	0.138	96.2
	W4	0.028	0.078	0.078	98.7
	W6	0.024	0.124	0.124	96.0
	W8	0.024	0.140	0.140	94.6
	Control	0.032	0.278	0.278	90.7
Lemon grass	W2	0.025	0.063	0.063	98.9
	W4	0.020	0.107	0.107	95.5
	W6	0.018	0.118	0.118	93.4
	W8	0.011	0.073	0.073	93.8
	Control	0.032	0.278	0.278	90.7
Chinese chive	W2	0.012	0.066	0.066	95.4
	W4	0.022	0.057	0.057	98.9
	W6	0.025	0.042	0.042	99.5
	W8	0.022	0.202	0.202	89.5
	Control	0.032	0.278	0.278	90.7
Lantana camara	W2	0.015	0.155	0.155	88.0
	W4	0.027	0.134	0.134	96.6
	W6	0.026	0.125	0.125	97.0
	W8	0.024	0.117	0.117	96.8

[1] W2 = soil solarization for two weeks; W4 = soil solarization for four weeks; W6 = soil solarization for six weeks; W8 = soil solarization for eight weeks; [2] Disease progress rate obtained from regression line of disease incidence with time of assessment (days). [3] Standard error of rate. [4] Standard error of parameter estimates. [5] Coefficient of determination of the Logistic model.

Disease progress curve

The disease development curves of bacterial wilt (incidence versus DAP) were drawn separately for each mulch type with different weeks of soil solarization before planting (Figure 1). Each curve for soil solarization period and mulch type revealed that disease severity developed increasingly starting from the onset to the final severity examination during the study periods. The four disease progress curves for each solarization period also indicated that disease progress was not analogous for each mulch type used. Disease severity in control plots followed relatively high progressive curves and exhibited the peak levels of bacterial wilt severity. Soil solarization for two weeks alone and in combination with *Lantana camara* treatment showed similar curves as control plots. However, disease progress curves for plots treated with soil solarization for eight weeks and mulching with lemon grass rose gradually and displayed the lowest bacterial wilt severity at different days after planting. Consistently, a previous study showed that, during solarisation of soil, positive changes occur in the structure of soil, in solubility of mineral substances available to plants and microbial growth, and in populations of soil-borne microorganisms (Katan et al., 1980). These fluctuations affect the inoculum concentration of plant pathogens, as well as their aggressiveness and survival. Changes in the populations of other soil-borne microorganisms that occur during and after soil solarization may influence disease suppression in soil and enhance plant growth.

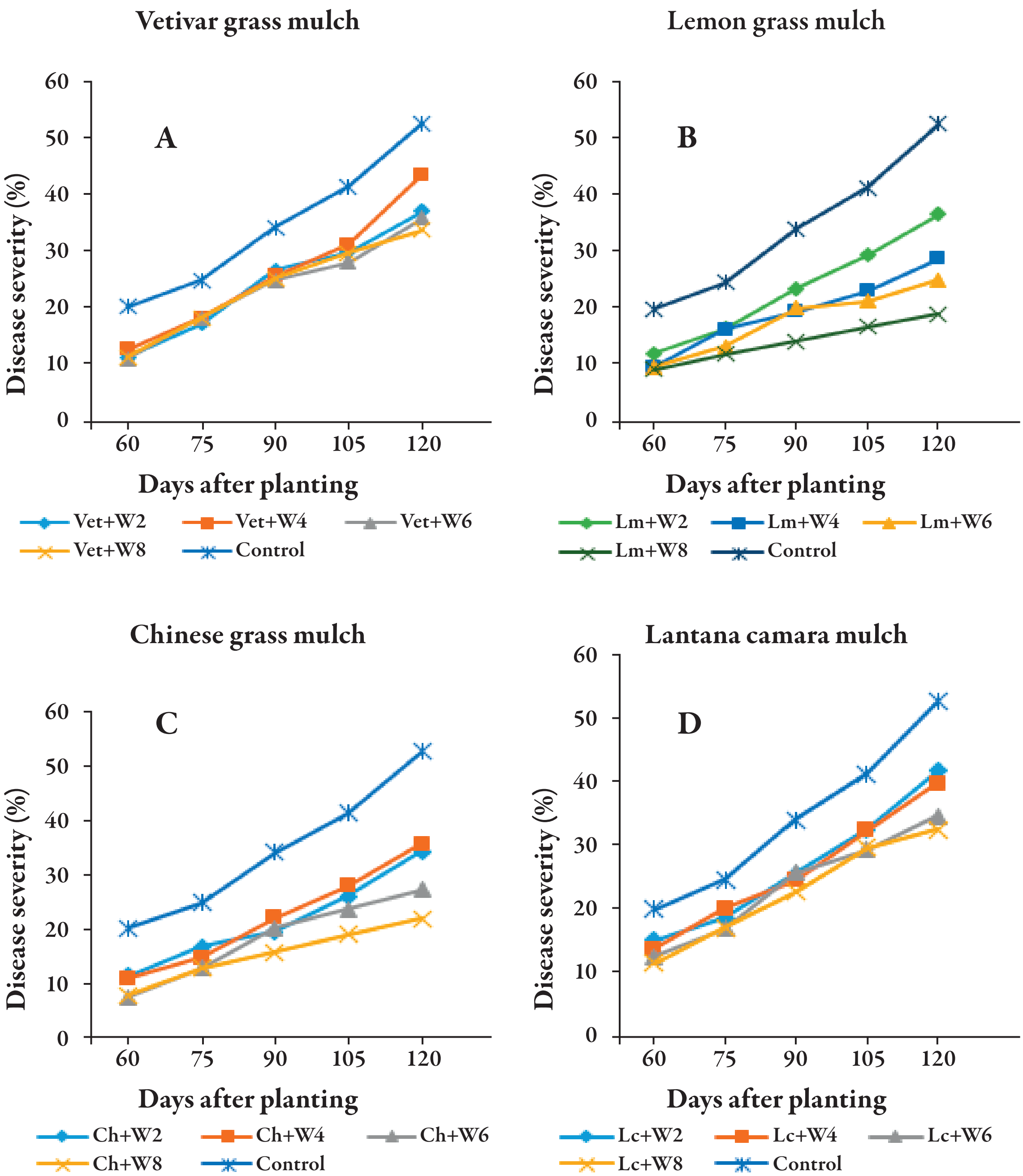

Figure 1. Ginger bacterial wilt (*Ralstonia solanacearum*) disease progress curves as affected by soil solarization for two weeks (W2), four weeks (W4), six weeks (W6) and eight weeks (W8), and botanical mulch with Vet (vetivar grass), Lm (lemon grass), Ch (Chinese chive), and Lc (*Lantana camara*) at Tepi in 2019 and 2020 main cropping seasons.

Table 3. Coefficients of correlation (r) between ginger yield and disease parameters at Tepi, Ethiopia, during 2019 and 2020 main cropping seasons

Parameter	RL (cm)[1]	NFPR[1]	Yield (t ha^{-1})	PSI f (%)[1]	rAUDPC[1]	Dpr (units day^{-1})
RL (cm)	1					
NFPR	0.069^{ns}	1				
Yield (t ha^{-1})	0.423^{**}	0.334^{**}	1			
PSI f (%)	-0.366^{**}	-0.538^{**}	-0.522^{**}	1		
rAUDPC[1]	-0.549^{**}	-0.516^{**}	-0.663^{**}	0.792	1	
Dpr (units day^{-1})	0.026^{ns}	-0.065^{ns}	0.184^{ns}	-0.078^{ns}	-0.081^{ns}	1

[1] RL= rhizome length, NFPR= no. of fingers per rhizome, PSI f= final disease severity index, rAUDPC = standardized area under disease progress curve of bacterial wilt incidence of ginger. ** Level of statistical significance at $P \leq 0.01$. ^{ns} non-significant at $P > 0.05$.

Association of yield and disease parameters

Calculating the relationships between and among the final disease incidence, rAUDPC, disease progress rate, yield and yield-related components was vital since modification of each parameter influenced the reaction of another during the trial. For studying the relationship between disease and yield parameters, a simple correlation analysis was used. Diverse levels of association were observed among disease incidence, rAUDPC, disease progress rate and yield and yield-related components and the data are offered in Table 3.

Standardized area under disease progress curve and final disease incidence were absolutely and highly significantly ($P \leq 0.01$) correlated ($r = 0.792^{**}$). This is consistent with Guji et al. (2019), whose study showed an exceptional correlation between the epidemiological parameters PSI and AUDPC. Conversely, negative correlation of rhizome yield with bacterial wilt progress was found to be stronger with rAUDPC than with the final disease incidence. Yield and rAUDPC were seriously and highly significantly ($P \leq 0.01$) correlated ($r = -0.663^{**}$). Such result indicates the presence of strong negative effects of bacterial wilt on rhizome yield of ginger. In addition, similar findings appeared for the correlation between disease parameters and yield-associated components of ginger. This result complies with the findings of Guji et al. (2019), who confirmed that bacterial wilt severity, AUDPC and infection rates were powerfully and negatively associated with ginger rhizome yields.

CONCLUSION

Based on the outcomes found in this study, it can be decided that bacterial wilt incidence, rAUDPC, progress rates and curves were intensely influenced by soil solarization and botanical mulch. Soil solarization for eight weeks before planting and botanical mulch with lemon grass after planting greatly reduced the bacterial wilt of ginger. It is therefore suggested to solarize the soil for several weeks before planting ginger and to apply lemon grass mulch after planting along with other crop management strategies to manage bacterial wilt of ginger in the face of the present and upcoming climate dynamics in southwestern Ethiopia. Additional studies on integrated management of ginger bacterial wilt would continue.

ACKNOWLEDGEMENTS

The study was funded by the Ethiopian Institute of Agricultural Research. We acknowledge all technical and field assistance of the spice section of the Tepi Agriculture Research Center during field preparation, follow-up and data gathering. We are also very appreciative to farmers in the study zones who were directly involved in labor activities.

REFERENCES

Allen, C., Prior, P., & Hayward, A.C. (eds). (2005). *Bacterial wilt disease and the Ralstonia solanacearum species complex*. St. Paul, MN, USA: American Phytopathological Society.

Arthy, J.R., Akiew, E.B., Kirkegaard, J.A., Trevorrow, P.R., Allen, C., Prior, P., & Hayward, A.C. (2005). Using *Brassica* spp. as biofumigants to reduce the population of *Ralstonia solanacearum*. In C. Allen, P. Prior & A. C. Hayward, *Bacterial wilt disease and the Ralstonia solanacearum species complex* (pp 159-165). St. Paul, MN, USA: American Phytopathological Society.

Blok, W.J., Lamers, J.G., Termoshuizen, A.J., & Bollen, G.J. (2000). Control of soilborne plant pathogens by incorporating fresh organic amendments followed by taping. *Phytopathology, 90*, 253-259. doi: 10.1094/PHYTO.2000.90.3.253

Campbell, C.L., & Madden, V.L. (1990). *Introduction to plant disease epidemiology* (p 532). New York, USA: Wiley.

Elmore, C.L., Stapleton, J.J., Bell, C.E., & DeVay, J.E. (1997). *Soil solarization: A non-pesticidal method for controlling diseases, nematodes, and weeds*. Oakland, USA: University of California.

Gomez, K.A., & Gomez, A.A. (1984). *Statistical procedures for agricultural research (2nd ed.)*. New York, US. John Wiley and Sons.

Guji, M.J., Yetayew, H.T., & Kidanu, E.D. (2019). Yield loss of ginger (*Zingiber officinale*) due to bacterial wilt (*Ralstonia solanacearum*) in different wilt management systems in Ethiopia. *Agriculture & Food Security*, *8*(1), 1-11.

Habetewold, K., Bekele, K., Kasahun, S., & Tariku, H. (2015). Prevalence of bacterial wilt of ginger (*Zingiber officinale*) caused by *Ralstonia solansearum* (Smith) in Ethiopia. *International Journal of Research Studies in Agricultural Sciences (IJRSAS*), *1*(6), 14-22.

Jibat, M., Terefe, H., & Derso, E. (2018). Integrated management of bacterial wilt (*Ralstonia solanacearum*) of ginger (*Zingiber officinale*) in Southwestern Ethiopia. *Archives of Phytopathology and Plant Protection, 51*(15-16), 834-851.

Katan, J., Rotem, I., Finkel, Y., & Daniel, J. (1980). Solar heating of the soil for the control of pink root and other soilborne diseases in onions. *Phytoparasitica, 8*(1), 39-50.

SAS Institute (2003). *SAS/STAT user's guide, Version 9.3*. Cary, NC, USA: SAS Institute Inc.

Stapleton, J.J. & DeVay, J.E. (1982). Effect of soil solarization on populations of selected soilborne microorganisms and growth of deciduous fruit tree seedlings. *Phytopathology, 72*(3), 323-326.

Stapleton, J.J., Wilen, C.A., & Molinar, R.H. (2008). *Soil solarization for gardens & landscapes Management* (UC ANR Publication 74145 UC Statewide IPM Program). Davis, CA: University of California.

Van der Plank, J.E. (1963). *Plant diseases: Epidemics and control*. London, UK: Academic Press.

Vijayalaxmi, H., & Sreepada, H. (2014). An economic overview of ginger production in Ethiopia. *International Journal of Science Research, 3*(12), 2051-2054.

Wilen, C.A., & Elmore, C.L. (2007). *Pest notes: Weed management in landscapes (UC ANR 7441)*. Oakland, CA: University of California.

Suzbijanje epidemija bakterijskog uvenuća (*Ralstonia solanacearum*) đumbira primenom solarizacije zemljišta i botaničkog malčiranja u Tepi, jugozapadna Etiopija

REZIME

Đumbir je jedna od najprofitabilnijih kultura za uzgajivače u različitim delovima Etiopije. Bakterijsko uvenuće, koje prouzrokuje *Ralstonia solanacearum*, ograničava proizvodnju đumbira u Etiopiji. Značajni gubici usled ove bolesti javljaju se redovno, stvarajući dodatne prepreke u područjima zaraze. Ogledi su izvedeni u Tepi, jugozapadna Etiopija, tokom proizvodnih sezona 2019. i 2020. kako bi se procenili efekti solarizacije zemljišta i botaničkog malčiranja na epidemiju bakterioznog uvenuća đumbira. Četiri perioda solarizacije u trajanju od dve, četiri, šest i osam nedelja pre sadnje integrisana su sa četiri tretmana malčiranjem nakon sadnje i to biljkama: vetiver, limunova trava, kineski vlašac i lantana (*Lantana camara*). Kontrolne parcele nisu solarizovane, niti malčirane. Tretmani su uređeni faktorijalno u nasumičnom kompletnom blok sistemu sa tri ponavljanja. Rezultati su pokazali da je integrisana primena solarizacije zemljišta i malčiranja limunovom travom značajno smanjila srednje vrednosti za učestalost bakterijskog uvenuća i to od 22.1% do 42.2%, u odnosu na kontrolne parcele. Ovi tretmani su drastično smanjili AUDPC i stopu napredovanja bolesti. Solarizacija u trajanju od osam nedelja integrisana sa malčiranjem limunovom travom dala je najnižu (42.2%) konačnu srednju vrednost stepena oboljevanja, kao i AUDPC (33.8%), u poređenju sa kontrolom. Rezultati istraživanja pokazuju da integrisana primena solarizacije i botaničkog malčiranja efikasno usporava epidemije bakterijskog uvenuća i omogućava oporavak proizvodnje đumbira i njegove produktivnosti, pa se stoga preporučuju za primenu u području istraživanja zajedno sa ostalim metodama zaštite useva.

Ključne reči: đumbir, bakterijsko uvenuće, malčiranje, solarizacija zemljišta, zaštita biljaka od bolesti