



ECONOMIC ASSESSMENT OF SOME SEED TREATMENT MATERIALS ON THE MANAGEMENT OF DOWNY MILDEW ON SELECTED PEARL MILLET CULTIVARS IN MAIDUGURI AND GOMBE, NIGERIA

*¹Abraham, P., ²Bdliya, B. S., and ³David, S. H.

¹Department of Horticultural Technology, Federal College of Horticulture, P. M. B. 108, Dadinkowa Gombe State, Nigeria.

²Department of Crop Protection, University of Maiduguri, P. M. B. 1069, Borno State, Nigeria.

³Department of Agricultural Economics, Ahmadu Bello University Zaria, Nigeria.

*Corresponding E-mail: : peterabraham06@yahoo.com

Manuscript received: 22/01/2019

Accepted: 12/03/2019

Published: March 2019

ABSTRACT

A field trial was conducted at Maiduguri and Gombe towns to assess the economic implications of All Star 40DS, Silicon dioxide (SiO₂) and Diatomaceous Earth (DE) on the management of downy mildew (*Sclerosporagraminicola*(Sacc.) Schroet) in selected pearl millet cultivars. Split plot design was used where three cultivars (SOSAT-C88, Ex-Borno and LCIC-7902) were assigned to main plots while four seed treatment materials (SiO₂, DE, SiO₂ + DE, All Star 40DS) and control to sub plots and replicated four times.. The results obtained showed that in Maiduguri, all Star 40DS had the highest net benefit (₦ 114,617.86) and marginal rate of returns (1.20), followed by SiO₂ + DE which gave the net benefit of (N 99, 663.57) and marginal rate of returns (1.00) while the control had the lowest net benefit (₦ 40, 617.86) and marginal rate of returns (0.40). The result of the combined analysis also showed that all the seed treatment applications translated into gain except with the control. There were also gains of ₦ 0.33, ₦ 0.21 and ₦ 0.15 from the application of All Star and SiO₂ + DE respectively and loss of ₦ 0.19 from the control for every ₦ 1.00 naira that was spent. From the present results, SiO₂ + DE treatment can therefore be used as an alternative to manage downy mildew of pearl millet as it is cost-effective, available and ecofriendly.

Keywords: Pearl millet, Downy mildew, Seed treatment, Management, Economic Assessment

INTRODUCTION

Pearl millet is one of the most important staple food for over 400 million people who live in the world's poorest and most food-insecure regions in about 30 countries, particularly in India and Africa (Shukla, *et al.*, 2015; Macauley and Ramadjita, 2015). Downy mildew (*Sclerosporagraminicola* (Sacc.) Schroet) is the most important and wide spread disease of pearl millet in West Africa and India (Rachie and Majmudar, 1980; Gwary *et al.*, 2006, Shukla, *et al.*, 2015), hampering its growth and productivity with continuing potential to cause catastrophic loss (Gerard and Cathryn, 2001). Substantial yield and quality losses of up to 54.6% due to pearl millet downy mildew at 0% seed treatment was reported in a three years study in Sudan savanna of Nigeria (Gwary *et al.*, 2009). Growing disease resistant varieties and hybrids have been reported as the most effective, eco-friendly and economic control of downy mildew (Thakur *et al.*, 2011). However, the introduction and mass cultivation of genetically new pearl millet cultivars have led to the evolution of new pathotypes of *S. graminicola* (Thakur *et al.*, 1999, 2004; Thakur and Rao, 1997). Pathogenic variations in populations of *S. graminicola*, have continually been reported in different major pearl millet growing countries such as India and Nigeria (Thakur *et al.*, 2001; Gwary *et al.*, 2007). The inability to find a millet cultivar that is resistant to all pathotypes of the *S. graminicola* (Gwary *et al.*, 2007) raised some concern about pearl millet production in Nigeria especially in the very dry areas, where it is the only crop that can be successfully grown. Hence, the need to search for other measures that can protect pearl millet against downy mildew.

Synthetic fungicides have been reported to be effective downy mildew cereals (Aliyuet *et al.*, 2011). Although silicon (Si), which is the second most abundant element on the earth is not listed among the essential elements; it is known to be absorbed into plants to confer plant resistance to both abiotic and biotic stresses (Epstein, 1994; Belanger *et al.*, 1995; Ma *et al.*, 2001; Brecht *et al.*, 2003; Liang *et al.*, 2005). There is a cumulative body of evidence linking the presence of Si with resistance of plants against fungal pathogens such as *Podosphaeraxanthii* (syn. *Sphaerothecafuliginea*) (Menzies *et al.*, 1992) and *Pythium* spp. (Cherif *et al.*, 1994) in cucumber; *Pyriculariagrisea* in rice (Datnoff *et al.*, 1997); and powdery mildews in barley (Carver *et al.*, 1987) and wheat (Belanger *et al.*, 2003). DE has also been reported to have anti-fungal and insecticidal properties on sugarcane and grape crops (Parr and Kerr, 2007; Matichenkov and Calvert, 2002). This study was

conducted to assess the economic implications of All Star 40DS, Silicon dioxide (SiO₂) and Diatomaceous Earth (DE) on the management of downy mildew (*Sclerosporagraminicola*) in pearl millet production.

MATERIALS AND METHODS

Multi-location field trials were conducted during the 2012 cropping season at the research farm of the University of Maiduguri (14°N, 3°E) and Gombe (10°N, 11°S), Nigeria. Three pearl millet cultivars (SOSAT-C88, Ex-Borno and LCIC-7902) obtained from Lake Chad Research Institute, Maiduguri and five seed treatment materials (SiO₂ (SiO₂ 60%WP, BDH Chemicals Ltd Poole England Inc.), DE (SiO₂ 50.37%WP, Bularafa Yobe State.), SiO₂ + DE, All Star 40DS (20% metalaxyl and 20% Imidacloprid, Jiangsu Kesheng Group Co., Ltd. Nigeria) and Control (seeds treated with water)) were used in the study. SOSAT-C88 is a resistant variety to downy mildew while Ex-Borno and LCIC-7902 were susceptible to the disease. The field trials were laid out in a split plot design replicated four times. The three millet cultivars were randomly assigned to the main-plots which measure 27.5 x 3.5m (96.25m²) each separated by 1m alley while the five seed treatment materials were assigned randomly to the sub-plots which measure 4.5 x 3.5m (15.75m²) each separated by 0.5m alley.

The seeds of each cultivar were primed in SiO₂⁻² (20mM/litter) aqueous solution (sufficient to submerge the seeds) in a 25cm³ plastic container, covered with a lid and then placed on a mechanical shaker for 6 hours as described by Johnson *et al.*, (2005) and Deepak *et al.*, (2008). The DE was supplied in a form of crude soft chalky rock. The rock was weighed using a Salter balance and then milled into a fine powder with the aid of pestle and mortar in the laboratory. DE was used as seed dressing at rate of 50g/3kg seeds. In the case of SiO₂+DE treatment, the seeds were primed in SiO₂ solution (20mM/liter) and then dressed with DE (50g/3kg seeds) before sowing. All Star 40DS was applied as seed dressing chemical at rate of 10g a.i/3kg seeds according to methods described by Smiley *et al.* (2002). In case of the control no seed treatment material was applied to the seeds but they were primed in water before sowing.

The sites were harrowed and leveled before marking out the field layout. The seeds were manually sown when the rains stabilized at the rate of approximately 10 seeds per hole at inter row and intra row spacing of 70cm and 50cm, respectively. There were a total of 4 rows per plot giving a plant population of 40 stands per plot. At three weeks after sowing, during the first weeding plants were thinned

to two plants per stand. Fertilizer was applied at the recommended rates of 60kg N/ha, 30kg P₂O₅/ha and 30kg K₂O/ha (Onwueme and Sinha, 1991). Basal dose of NPK (15:15:15) at the rate of 30kg N/ha, 30kg P₂O₅/ha and 30kg K₂O/ha were applied at sowing. The remaining dose of 30kg N/ha was applied six weeks after sowing by side placement. Weeds were controlled manually using hoe at 3 and 6 weeks after sowing. Harvest was done manually at maturity using cutlass and placed in their respective plots for further drying after which the panicles were cut and threshed.

The economic assessment was based on the grain yield obtained. Partial budgets involving the analysis of variable input costs and benefits were drawn for all the treatments. Items considered were the gross benefit (₦/ha) calculated as yield of pearl millet (kg/ha) multiplied by market price (₦/ha), total cost (₦/ha) of all inputs and labour used, and the net benefit (₦/ha) calculated as gross benefit less total cost. The marginal rate of return (MRR) was the net benefit divided by total cost. All data collected were subjected to analysis of variance (ANOVA) and differences between means were tested with Duncan Multiple Range Test (DMRT) at 5% level of significance

RESULTS AND DISCUSSION

In Maiduguri, the results of the economic assessment of seed treatment on the control of downy mildew of pearl millet showed that there was a net benefit and positive marginal returns derived from each treatment applications at Maiduguri. However, All

Star had the highest net benefit (₦ 114,617.86) and marginal rate of returns (1.20), followed by SiO₂ + DE which gave the net benefit of (₦ 99, 663.57) and marginal rate of returns (1.00) while the control had the lowest net benefit (₦ 40, 617.86) and marginal rate of returns(0.40) (Table 1). This implies that for every naira spent, a net profit of 120% and 100% were obtained from crops treated with All Star and SiO₂ + DE respectively. The result of the combine analysis also showed that all the seed treatment applications translated into gain except the control. There were gains of ₦0.33, ₦0.21 and ₦0.15 from the application of All Star and SiO₂ + DE respectively and loss of ₦ 0.19 from the control for every ₦ 1.00 naira spent (Table 1). The efficacy of Star plus, SiO₂ and DE in increasing crop yield due to their ability to suppress fungal diseases in cereal crops and hence increased net profit have been reported (Datnoff *et al.*, 2001; Deepak *et al.*, 2008; Aliyuet al., 2011; Abraham and Bdiya, 2015). In Gombe however, application of any of the treatments resulted in a loss. The general low grain yield recorded from all the treated crops at this location and selling of the grains at the period when price was low are possible reasons for the incurred loss.

In conclusion, the results of this study showed that application of All Star gave the highest net benefit and marginal rate of returns followed by SiO₂ + DE. SiO₂ + DE can therefore be used as an alternative to manage downy mildew of pearl millet as it is cost-effective, available and ecofriendly.

Table 1: Economic assessment of All Star 40DS, SiO₂ and DE on the management of downy mildew in pearl millet production.

Treatment	Maiduguri					Gombe					Combined				
	Grain Yield (Kg/ha)	Total Cost (₦1/ha)	Gross Benefit (₦1/ha)	Net Benefit (₦1/ha)	MRR2	Grain Yield (Kg/ha)	Total Cost (₦1/ha)	Gross Benefit (₦1/ha)	Net Benefit (₦1/ha)	MRR2	Grain Yield (Kg/ha)	Total Cost (₦1/ha)	Gross Benefit (₦1/ha)	Net Benefit (₦1/ha)	MRR2
SiO ₂	1761.10	98340.74	188678.57	90337.83	0.90	338.61	97540.74	36379.64	-61161.10	-0.63	1049.90	9794.74	112489.29	14548.55	0.15
DE	1533.30	96100.00	164282.14	66182.14	0.70	255.56	95300.00	27381.43	-67918.57	-0.71	894.40	95700.00	95828.57	128.57	0.00
SiO ₂ +DE	1866.70	100340.00	200003.57	99663.57	1.00	397.78	99460.00	42619.29	-57020.71	0.60	1132.20	99990.00	121307.14	21317.14	0.21
All Star	1966.70	96100.00	210717.86	114617.86	1.20	413.33	95300.00	44285.32	-51014.64	0.54	1190.00	95700.00	127500.00	31800.00	0.33
Control	1266.70	95100.00	135717.86	40617.86	0.40	157.22	94300.00	16845.00	-77455.00	-0.82	711.90	94700.00	76275.00	-18425.00	-0.19

Abbreviations: 1- Nigerian currency (Naira); 2- Marginal Rate of Returns

REFERENCES

- Abraham, P. and Bdliya, B.S. (2015). Efficacy of Cultivar, Silicon Dioxide and Diatomaceous Earth on the management of Downy Mildew of Pearl Millet in Maiduguri and Gombe, Nigeria. Abstract of papers presented at the 40th annual conference of the NSPP, held at the Auditorium, Raw Materials Research and Development Council, Maitama, Abuja., 17th- 20th March, 2015. p. 53
- Aliyu, B., Hati, S.S., Dimari, G.A. and Donli, P.O. (2011). Comparative assessment of metalaxyl enhanced protection of pearl millet varieties in the control of downy mildew. *J. Cereals and Oilseeds*, 2(2):26-31.
- Aliyu, B., Hati, S.S., Donli, P.O. and Anaso, A.B. (2008). Effect of metalaxyl and neem seed oil on the incidence of downy mildew of pearl millet. *Cont. J. Agron.* 2:1-7.
- Analyse-it. (2007). *General and clinical laboratory analyses software version 2.10*. Analyse-it software Ltd. P.O. Box 77, Leeds, LS12 5XA, England.
- Belanger, R. B., Bowen P. A, Ehret, D. L. and Menzies, J.G. (1995). Soluble silicon: its role in crop and disease management of greenhouse crops. *Plant Disease*, 79: 329-336.
- Belanger, R. B., Bowen, P. A, Ehret, D. L. and Menzies, J.G. (2003). Cytological evidence of an active role of silicon in wheat resistance to powdery mildew. *Phytopathology*, 93: 402-412.
- Brecht, M., Datnoff, L., Nagata, R. and Kucharek, T. (2003). The role of silicon in suppressing tray leaf spot development in St. Augustine grass. Publication in University of Florida, 1-4, Gainesville.
- Carver, T.L.W., Zeyen, R.J. and Ahlstrand, G.G. (1987). The relationship between insoluble silicon and success or failure of attempted primary penetration by powdery mildew (*Erysiphegraminis*) germlings on barley. *Physiol. Mol. Plant Pathol.*, 31: 133-48.
- Cherif, M, Asselin, A. and Belanger R. R. 1994. Defense responses induced by soluble silicon in cucumber roots infected by *Pythium* sp. *Phytopathology*, 84:326-242.
- Datnoff, L.E. and Snyder, G.H. (2001). Effect of calcium silicate on blast and brown spot intensities and yields of rice. *Plant disease*, 75(7): 729-732.
- Datnoff, L.E., Daren, C.W. and Snyder, G.H. (1997). Silicon fertilization for disease management in rice in Florida. *Crop Protection*, 16:525-35.
- Deepak, S., Manjunath, G., Manjula, S., Niranjana-Raj, S., Geetha, N.P. and Shetty H.S. (2008). Involvement of silicon in pearl millet resistance to downy mildew disease and its interplay with cell wall proline/hydroxyproline-rich glycoprotein. *Australasian Plant Pathology*, 37, 498-504.
- Epstien, E. (1994). The anomaly of silicon in plant biology. *Proc. Natl. Acad. Sci. USA.*, 91:11-17.
- Gerard, J.G., and Carthryn, T. (2001). Pearl millet in Developing countries. *Intl. Sorghum and millet newsletter*, 42: 1-7.
- Gwary, D. M., Saleh, B.S. and Gwary S. D. (2006). Evaluation of new pearl millet lines to Maiduguri pathotypes of *Sclerosporagraminicola*. *Intl. J. Agric. Biol.*, 8: 597-601.
- Gwary, D. M., Bdliya, B.S. and Bdliya, J.A. (2009). Appraisal of yield loss in pearl millet due to downy mildew pathogen in Nigerian Sudan Savanna. *Archive of Phytopathology and Plant Protection*, 42 (11):1010-19.
- Gwary, D.M., Garba, I. and Gwary S.D. (2007). Evidence of pathogenic variation in *Sclerosporagraminicola* populations of pearl millet regions of Nigeria. *Intl. J. Agric. Biol.*, 9(1): 94-7.
- Johnson, S.E., Lauren, J.G., Welch, R.M. and Duxbuy, J.M. (2005). A comparison of the effects of micronutrient seed priming and soil fertilization on the mineral nutrition of chickpea (*Cicerarietinum*), lentil (*Lensculinaris*), rice (*Oryzasativa*) and wheat (*Triticumeastivum*) in Nepal. *Expl. Agric.* 44: 427-48.
- Liang, Y. C., Sun, W. C., Si, J. and Romheld, V. (2005). Effects of foliar- and root-applied silicon on the enhancement of induced resistance to powdery mildew in *Cucumissativus*. *Plant Pathol.*, 54: 678-685.
- Ma, J.F., Goto, S., Tami, S. and Ichii, M. (2001). Role of root hairs and lateral roots in silicon uptake by rice. *Plant Physiol.*, 127:1773-1780.
- Macauley, H. and Ramadjita, T. (2015). Cereal Crops: Rice, Maize, Millet, Sorghum, Wheat. Feeding Africa: An action plan for agricultural transformation organized by United Nations Economic Commission for Africa held on 21-23rd October, 2015 at AbdouDiouf International Conference Center Dakar, Senegal, Pp. 36.
- Matichenkov, V.V. and Calvert, D. V. (2002). Silicon as a beneficial element for sugarcane. *J. of American Society of Sugarcane Technol.*, 22: 200-207.
- Menzies, J.G., Bowen, P., Ehret, P. and Glass A.D.M. (1992). Foliar application of potassium silicate reduces severity of powdery mildew on cucumber, muskmelon and zucchini squash. *J. Am. Soc. Hortic. Sci.* 177: 902-905.
- Onwueme, I. C. and Sinha, T. D. (1991). *Field Crop Production in Tropical Africa*. CTA, Wageningen, Neitherlands, pp.480.

- Parr, J. and Kerr, G. (2007). Diatomaceous Earth Plant Silica Project: Technical Report. Southern Cross University, On behalf of Australian Diatomaceous Earth Pty Ltd.
- Rachie, K. O. and Majmudar, J. V. (1980). *Pearl millet*, Pennsylvania State University Press, Pennsylvania, pp.307.
- Shukla, A., Lalit, A., Sharma, V., Vats, S and Alam, A. (2015). Pearl and finger millets: the hope of food security. *Applied Research Journal*. 1 (2): 259-66.
- Smiley, R., Crook, R. J. and Paulitz, T. (2002). *Seed treatments for small grain cereals*, Agricultural Research Center, Oregon State University EM, 8797:1-5.
- Thakur, R. P., Rai, K.N., Rao, V. P. and Rao, A. S. (2001). Genetic resistance of pearl millet male sterile line to diverse Indian pathotypes of *Sclerosporagraminicola*. *Plant Dis.*, 85:621-626.
- Thakur, R.P and Rao, V.P. (1997). Variation in virulence and aggressiveness among pathotypes of *Sclerosporagraminicola* on pearl millet , In: Dahlber , J.A. and C.T. Harsh (eds.), ISMN No. 39, *Indian Phytopathol.*, 50:41-47.
- Thakur, R.P., Sharma, R. and Rao, V.P. (2011). Screening Techniques for Pearl Millet Diseases. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. *Information Bulletin*, 89:pp. 56.
- Thakur, R.P., Rao, V.P., Sastry, J.G., Sivaramakrishnan, S., Amrutesh, K.N. and Barbind, L.D. (1999). Evidence of a new virulent pathotype of *Sclerosporagraminicola* on pearl millet. *J. Mycol. Pl. Pathol.*, 29:61-69.