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FINAL REPORT

THE ROLE OF SEEDLING DISEASES IN POOR ESTABLISHMENT OF SUNFLOWER IN SOUTH AFRICA

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EXECUTIVE SUMMARY

Poor establishment has been identified as one of the important constraints in sunflower production in South Africa. Although the contribution of other factors such as seedling vigour, seedbed preparation and soil temperature to poor establishment have been investigated, there is no information on the role of seedling diseases as a production constraint in sunflower production in South Africa. The main aim of this study was to determine the incidence of seedling diseases of sunflower and the major causal organisms associated with these diseases, as well as the efficacy of the standard seed treatment to control the most important pathogens. The first phase of the project involved surveys and sampling of diseased sunflower seedlings and morphological and preliminary molecular characterization of fungi associated with diseased tissues. The second phase included the final molecular characterization of the potential pathogens and the evaluation of their pathogenicity and virulence and the effect of the standard seed treatment on survival, growth, root, hypocotyl and cotyledon rot severity under glasshouse conditions. Since it was found that the standard seed treatment is not effective against many of the virulent pathogens identified in this study, the third phase of the project evaluated other seed treatments against these pathogens. Species or anastomosis groups of *Alternaria*, *Bipolaris*, *Curvularia*, *Epicoccum/Phoma*, *Diaporthe*, *Fusarium*, *Macrophomina*, *Nothophoma*, *Pythium*, *Rhizoctonia* and *Setosphaeria* were included in the seed treatment trials. Four chemical products and three biological products were included in the study. This study showed that the chemical products were the most effective and that there are chemical products that performed as well and in certain instances better than the standard seed treatment (ST5). Also important is that these compounds were not phytotoxic to the seedlings. Since it is known that soilborne pathgens are often part of a complex that cause disease, the fourth phase of the research evaluated the effect of the chemical seed treatments and treatments with saprophytic fungi against different complexes of the most virulent soilborne pathogens identified in this study viz. *Fusarium solani* species complex, *P. irregulare*, *P. ultimum* and the anastomosis groups (AGs) AG 2-2LP, AG 4HGI, AG 4HGIII and SB3 within *Rhizoctonia solani*. Seven combinations/mixes of the different pathogens were included as follows: Control (no pathogen), mix 1 [*Fusarium solani* species complex (FSSC)], mix 2 (both *Pythium* spp.), mix 3 (all four *R. solani* AGs), mix

4 (FSSC and both *Pythium* spp.), mix 5 (FSSC and all four *R. solani* AGs), mix 6 (both *Pythium* spp. and all four *R. solani* AGs) and mix 7 (FSSC, both *Pythium* spp. and all four *R. solani* AGs). The total inoculum concentration for each mix was 0.5% mass inoculum/mass planting medium. Four chemical products [ST2 = Experimental Code BYF14182 from Bayer Crop Science with a.i. not disclosed + Cruiser® 600 FS from Syngenta with a.i thiamethoxam (insecticide) ; ST3 = Experimental Code BYF14182 from Bayer Crop Science with a.i. not disclosed + Cruiser® 600 FS from Syngenta with a.i thiamethoxam (higher dosage than ST2); ST4 = Cruiser® 600 FS from Syngenta with a.i thiamethoxam (insecticide); ST5 = Celest® XL from Syngenta with a.i. fludioxonil and mefenoxam + Cruiser® 600 FS from Syngenta with a.i thiamethoxam (insecticide) (standard registered seed treatment for sunflower); ST6 = Maxim Quattro® from Syngenta with a.i. thiabendazole, azoxystrobin, fludioxonil and mefenoxam + Cruiser® 600 FS from Syngenta with a.i thiamethoxam (insecticide)] and three saprophytic or non-pathogeniv fungi viz. *F. incarnatum-equiseti* species complex, *P. acanthicum* and *Rhizoctonia* AG-A that were frequently isolated from sunflower seedlings during the surveys conducted in 2014/15 and 2015/16 were tested for their effect on survival, growth and root and hypocotyl rot on sunflower seedlings under glasshouse conditions. Seed treatment ST1 was untreated seed. Results showed that survival of seedlings in soil inoculated with pathogen mixes 3, 4, 5, 6 and 7 were significantly reduced when planted to untreated seed (ST1). In soil inoculated with these mixes, seed treatment ST6 significantly improved survival and the highest survival rates were recorded in these soils for seed treatment ST6. Other seed treatments that also significantly improved survival in soil inoculated with these pathogen mixes were ST2, ST3 and ST5 with ST2 and ST3 performing better than ST5 in soil inoculated with pathogen mixes 3, 5, 6 and 7 and performing the same as ST5 in soil inoculated with pathogen mix 4. All the pathogen mixes except mix 6 significantly reduced the growth of seedlings with the greatest reductions caused by mixes 1, 4, 5 and 7. None of the seed treatments significantly improved growth in soil inoculated with mixes 1 and 7, and all seed treatments improved growth in soil inoculated with mix 3. Only seed treatment ST6 significantly improved growth in soil inoculated with mixes 2, 4 and 5. All the pathogen mixes caused significant root rot, with the highest being reported for pathogen mixes 1, 4, 5 and 7. Seed treatment ST6 was the most effective treatment to reduce root

rot caused by mixes 1, 4 and 7 while treatments ST3, ST4, ST5 and ST6 significantly reduced root rot of seedlings in soil with mix 5. Seed treatment ST2, ST3, ST4, ST5 and ST6 significantly reduced root rot severity caused by mix 6. There were no difference in root rot severity of seedlings from seed treated with any of the seed treatments and planted in soil with mixtures 2 and 3. The highest hypocotyl rot severities were recorded for seedlings planted in soil inoculated with mixes 1, 4, 5, 6 and 7. None of the seed treatments caused any reduction in hypocotyl rot severity of seedlings in soil inoculated with mix 1, but all the seed treatments significantly reduced hypocotyl rot severity caused by mixes 4 and 6 and seed treatments ST3 and ST6 significantly reduced hypocotyl rot caused by mix 5. Seed treatment ST6 significantly reduced hypocotyl rot caused by mix 7. In the trial to compare the effect of saprophytic fungi and seed treatment ST6 on survival, growth and root and hypocotyl rot severity of seedlings planted in soil inoculated with the different pathogen mixes, pathogen mixes 3, 5, 6 and 7 caused significant reductions in survival of sunflower seedlings. There was no (pathogen mixes 3 and 7) or very little (0.8%) survival for the treatments with the saprophytic fungi whereas survival rates of 59.2, 58.3, 50.8 and 50.8% were recorded for these mixes, respectively for treatment ST6. Application of saprophytic *Fusarium*, *Rhizoctonia* and ST6 treatments in soil not inoculated with pathogens caused a significant reduction in growth. Compared to the controls inoculated with the pathogen mixes only ST6 significantly improved growth in pathogen mix 1, saprophytic *Fusarium* and ST6 in pathogen mix 2 and saprophytic *Rhizoctonia* and ST6 for pathogen mix 4. None of the saprophytic fungi significantly reduced root rot severity whereas ST6 significantly reduced root rot severity in pathogen mixes 1 and 2. Hypocotyl rot severity was highest in pathogen mix 1 and all the saprophytic fungi and ST6 significantly reduced hypocotyl rot severity in this pathogen mix. The saprophytic fungi were not able to improve survival or reduce root rot which are the two most important parameters measured in this study and it seems that they are not able to compete with the most virulent fungi included in this study. Proper establishment of seedlings is very important to improve yield and an essential component of sustainable production. Our results showed that seed treatment ST6 is the most effective treatment to significantly improve establishment of sunflower seedlings. Other treatments that were also effective were treatments ST2 and ST3 and these treatments were often more effective than the

standard seed treatment ST5. The ability of seed treatments ST2, ST3 and ST6 to protect seedlings against a complex of the most important pathogens affecting sunflower seedlings is very significant. Many of the pathogens affecting sunflower seedlings have a broad host range and cannot be controlled with crop rotation. Since crop rotation is such an important part of conservation agriculture, crops such as maize, sunflower and soybean that are susceptible to some of the same pathogens, are often rotated in the same field. In order to protect seedlings against these pathogens with a broad host range, effective seed treatment can play a significant role and should be included in an integrated management strategy against soilborne diseases of sunflower. The current study demonstrated the ability of seed treatments which included combinations of active ingredients to effectively target a complex of pathogens associated with sunflower seedlings to significantly improve survival, growth and reduce root and hypocotyl rot severity. The results obtained under glasshouse conditions showed that it would be worthwhile to evaluate these treatments under field conditions in different production areas with different disease complexes and climatic conditions in order to confirm the positive results obtained in the glasshouse study, and also to motivate for registration of products that effectively controlled the most virulent pathogens of sunflower seedlings.