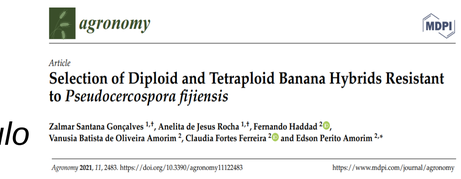
Selection of diploid and tetraploid banana hybrids resistant to *Pseudocercospora fijiensis*



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Introduction, context and objectives

Bananas and plantains are cultivated in tropical and subtropical regions of more than **150 countries**, on approximately 11 million hectares. **Black Sigatoka** can lead to **100% production loss** in the absence of chemical control, which can increase the production cost by 30%, impact health and contaminate the environment. Developing **cultivars resistant** to black Sigatoka is the focus of many banana genetic **breeding programs** in the world and is an alternative to using fungicides. Thus, the **objective** of this work was to **evaluate 23 diploid** and **eight tetraploid** banana hybrids in the **presence** of ***Pseudocercospora fijiensis***.

Mat & Methods

The **experiment** was conducted in the experimental area of **Embrapa** in **Brazil.** The experimental design was **completely randomized**, with 10 replicates per genotype. **Four selection strategies for genotypes resistant** to black Sigatoka were evaluated: (**1**) evaluation of symptoms of the disease during the entire period of the experiment; (**2**) evaluation of symptoms during the summer months; (**3**) evaluation of symptoms during the winter months; and (**4**) classical evaluation of symptoms at the emission and harvest of bunches. The **genotypes** were **evaluated** for their behavior in the presence of black Sigatoka using a **scale of scores of symptoms** of the disease in the leaves, which was proposed by **Stover** (1972) and modified by **Gauhl** (1989). The **evaluations** started in the **sixth month after planting** when symptoms of black Sigatoka on **leaf number 3** were observed until senescence. The **scale of scores** was applied at **intervals of 15 days** for the nº 3 leaves selected. The **scores** were recorded at intervals of 15 days and transformed into a **disease severity index** (DI, %) based on the formula described by **Mckinney** (1923). The area under the disease progress curve (**AUDPC**) was estimated with the formula proposed by **Madden** et al., (2007). **Evaluations** to **select the hybrids** in the **summer** (December to March) and **winter** (June to September) and estimates of the DI and AUDPC for these intervals (seasons of the year), were based on evaluations of the symptoms at 15-day intervals and the number of replicates per genotype. Based on the **averages** of the **four DI** and **four AIDPC**, four **dendrograms** were made using the average **Euclidean distance** and the Kmeans method to group the genotypes. **Using** the same **DIs and AUDPCs**, a **heat map analysis** was conducted that produced a graphic interpretation where data referring to each genotype are represented by colors; shades in the scale of green are associated with levels of genetic resistance and those in the scale of red indicate levels of susceptibility.

Results

Different groups formed depending on the evaluation strategy of the symptoms of black Sigatoka for both the number of genotypes and individuals in each cluster (Figure 1). From the dendrograms, it can be inferred that the **most efficient way** of **differentiating the genotypes** in the **resistant**, moderately resistant and **susceptible** classes is to **evaluate black Sigatoka symptoms** in the leaves during the **winter**. **Higher** mean **values** were observed in the **DI** and **AUDPC** for the evaluations made in the **winter**, **reinforcing** that this is the **best period** to **select genotypes resistant** to the disease, since there were better environmental conditions for the development of the epidemic in the field. With the goal of corroborating the cluster results described above, a **heat map** analysis was conducted based on the **four strategies** used to select the genotypes resistant to black Sigatoka (Figure 2). There was noticeable distinction among the selection periods based on the intensity of the colors in the figures where shades in the **green scale** are associated with levels of genetic **resistance** and those in the **red** scale indicate levels of **susceptibility**. For the set of improved diploids, the DI varied from 0.00 to 48.81 and the AUDPC varied from 0.00 to 2439.51. **Three** improved **diploids** were **completely resistant to black Sigatoka**: CNPMF0519, CNPMF 0557 and CNPMF0612. Another **nine** exhibited **quantitative resistance** to the pathogen, notably CNPMF0811 and CNPMF0993 that had the lowest DI and AUDPC among the genotypes. These five **genotypes** have potential for **use in crosses** with susceptible cultivars with the goal of **developing commercial cultivars resistant** to black Sigatoka. For the tetraploid hybrids evaluated for resistance to black Sigatoka, the DI varied from 15.06 and 63.52 and the AUDPC varied from 1000.21 to 3717.71. The genotype CNPMF0906 (Prata type) and the cultivar BRS Princesa (Silk type) **exhibited moderate resistance** to the pathogen.

Conclusions and perspectives

In the context of global **climate change**, according to probabilistic models associated with an increase in the average temperature, a 50% increase is estimated in areas on the planet cultivated with bananas, especially in subtropical regions, such as southern Brazil, and areas at higher elevations. In this scenario of **higher temperatures**, water will be supplied by irrigation, which will also **increase the severity and incidence of black Sigatoka**, since the fungal spores will be in more favorable conditions for germination (Calberto et al., 2015). Therefore, **cultivars adapted to this new condition** will be in **increasing demand** by farmers, especially those associated with genetic resistance to pests and diseases.

Fig. 1

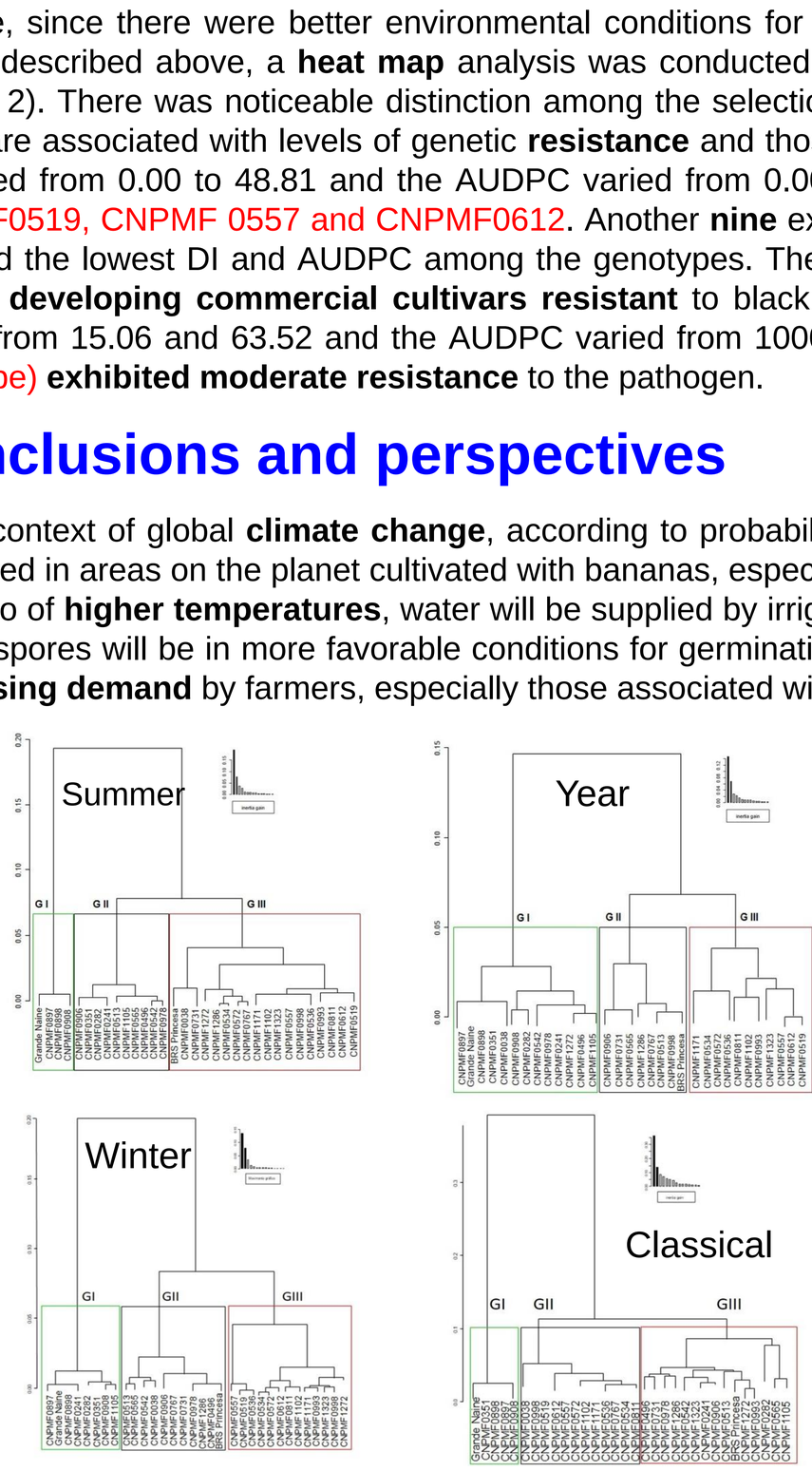
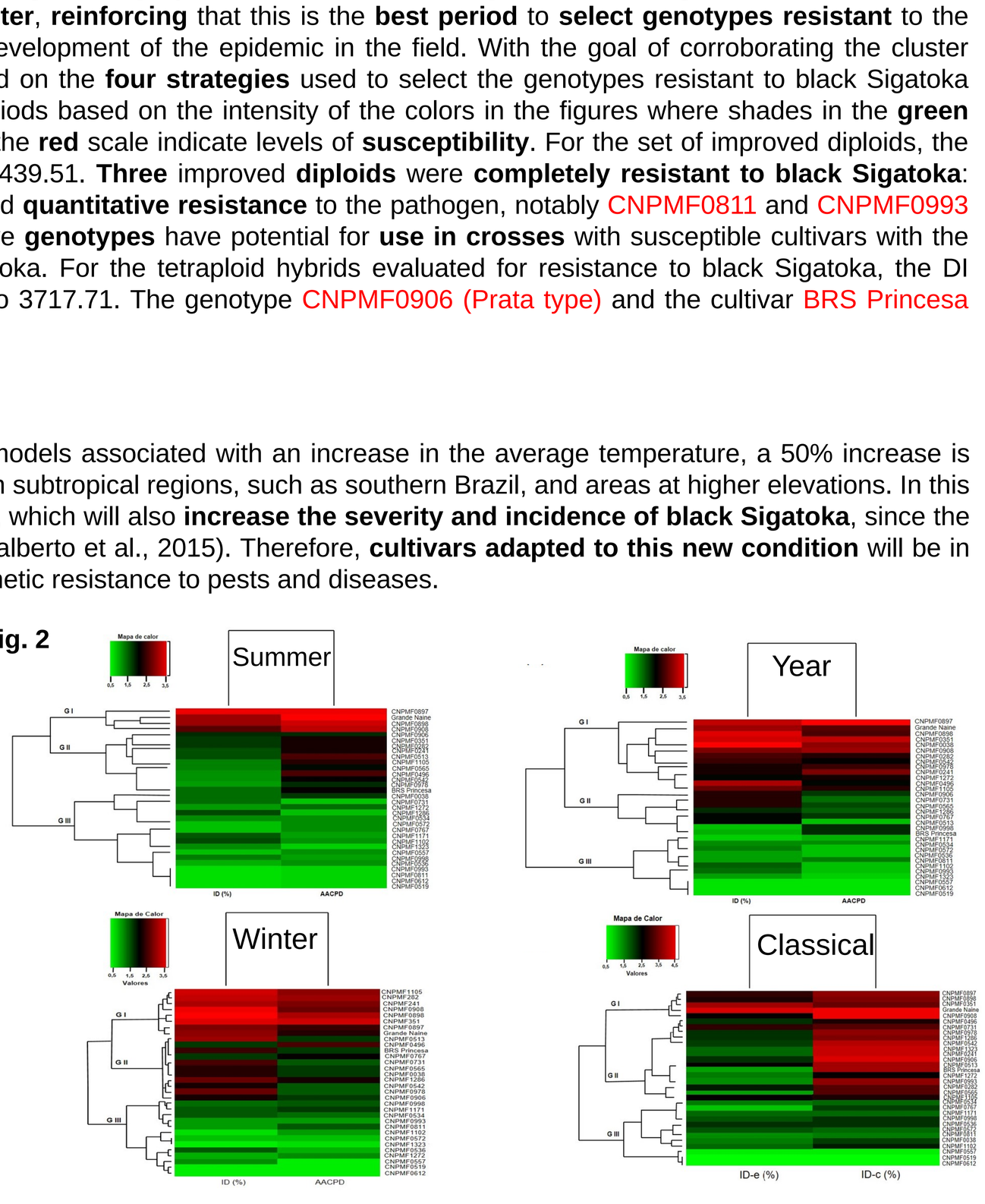


Fig. 2



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