@LIMENTECH CIENCIA Y TECNOLOGÍA ALIMENTARIA
ISSN Impreso 1692-7125/ ISSN Electrónico 2711-3035. Volumen 21 No. 2, p. 69 - 84, año 2023
Facultad de Ingenierías y Arquitectura
Universidad de Pamplona

FUNGAL DISEASES IN BLACKBERRY (*Rubus* spp.) IN THE MUNICIPALITIES OF PAMPLONA AND PAMPLONITA, NORTH OF SANTANDER

ENFERMEDADES FÚNGICAS EN MORA (*Rubus* spp.) EN LOS MUNICIPIOS DE PAMPLONA Y PAMPLONITA NORTE DE SANTANDER

Castellanos González Leónides[1], Vera Peña Mariam S.[2,] Calderón Gutiérrez Jefferson A.[3]

*[1]Universidad de Pamplona, Facultad de Ciencias Agrarias, sede Pamplona. - [2] Ingeniero agrónomo independiente. - [3] Ingeniero agrónomo independiente*Correo electrónico: lclcastell@gmail.com, https://orcid.org/0000-0001-9285-4879; m.sofia7@outlook.com, https://orcid.org.0009-0002-0936-7469, Jheferalexcalderon5@hotmail.com https://orcid.org/0009-0002-3514-9836. Tel: 3166993265, Pamplona-Norte de Santander. Colombia*

Recibido: julio 30 de 2023; Aceptado: noviembre 30 de 2023

ABSTRACT

The objective of this research project was to evaluate the incidence and severity of the main fungal diseases affecting commercial varieties of blackberry (*Rubus* spp.) in the municipalities of Pamplona and Pamplonita Norte de Santander. An exploratory research was carried out by selecting 50 farms producing the crop, 26 in Pamplona and 24 in Pamplonita. Within each farm, 10 plants were taken and the incidence and severity of diseases were evaluated following the recommended methodologies in each case. The most important diseases present were anthracnose (*Colletotrichum gloesporoides*), fruit rot (*Botrytis cinerea*), powdery mildew (*Oidium* sp.) and rust (*Gerwasia* sp.). In Pamplona, a higher incidence of stem anthracnose and incidence and severity of powdery mildew on foliage was observed on Castilla blackberry, while the incidence and severity of powdery

mildew was higher for plantations older than 4 years. In Pamplonita, the severity of anthracnose on the foliage of Uva blackberry was lower between 2 and 4 years of age. The incidence of branch anthracnose was higher in Pamplona, while both the incidence and severity of anthracnose and powdery mildew were higher in Pamplonita. Rust was observed only in Pamplona. In blackberry Uva, the incidence of anthracnose on branches was significantly higher in cold weather, while the incidence and severity of anthracnose and powdery mildew on foliage were higher in medium weather.

Key words: blackberry, species, fungi, incidence, severity.

RESUMEN

El presente proyecto de investigación tuvo como objetivo evaluar la incidencia y severidad de las principales enfermedades fungosas foliares que afectan las variedades comerciales de mora (*Rubus* spp.) en los municipios de Pamplona y Pamplonita Norte de Santander. Se realizó una investigación exploratoria seleccionándose 50 fincas productoras del cultivo, 26 en Pamplona y 24 en municipio de Pamplonita. Dentro de cada finca se tomaron 10 plantas evaluándose la incidencia y severidad de las enfermedades siguiendo las metodologías recomendadas en cada caso. Las enfermedades más importantes presentes fueron antracnosis (*Colletotrichum gloedporoides*), pudrición del fruto (*Botritis cinerea*), mildio polvoso (*Oidio* sp.) y roya (*Gerwasia* sp.). En Pamplona se observó mayor incidencia de la antracnosis en tallo y de incidencia y de severidad del mildio polvoso en el follaje en mora Castilla, mientras que la incidencia y severidad del mildio polvoso fue mayor para las plantaciones de más de

@LIMENTECH CIENCIA Y TECNOLOGÍA ALIMENTARIA
ISSN Impreso 1692-7125/ ISSN Electrónico 2711-3035. Volumen 21 No. 2, p. 69 - 85, año 2023
Facultad de Ingenierías y Arquitectura
Universidad de Pamplona

4 años. En Pamplonita la severidad de antracnosis en el follaje en mora Uva fue menor en edades entre 2 y 4 años. La incidencia de antracnosis en ramas fue superior en Pamplona, mientras que tanto la incidencia como la severidad de antracnosis y de mildio polvoso fueron mayores para Pamplonita. La roya se observó solo en Pamplona. En mora Uva la incidencia de antracnosis en ramas fue significativamente superior en clima frio, mientras que la incidencia y severidad en el follaje de la antracnosis y el mildio polvoso fueron mayores en clima medio.

*Autor a quien debe dirigirse la correspondencia
Leónides Castellanos González. E-mail:
lclcastell@gmail.com

Palabras clave: zarzamora, especies, hongos, incidencia, severidad.

INTRODUCTION

The genus Rubus, to which the blackberry belongs, also known as blackberry, is undoubtedly one of the most diverse in terms of its morphological and genetic characteristics. Many can be found as wild species, and others that are cultivated, because they are highly appreciated for their edible fruits internationally. The Moorish variety of Castile (Rubus glaucus Bent). is one of the most important commercially cultivated fruits in the world (Calapiña & Chacón, 2020).

In Colombia, the cultivation of blackberries is used for the export and processing of processed food products for national consumption, being a crop that provides production alternatives to small and large producers (Hernández et al., 2018).

According to the Ministry of Agriculture of Colombia reports that between 2015 and 2020 the area planted in blackberry crops increased by 4%, reaching for the last year the 15,800 hectares cultivated. On the other hand, the harvested areas registered an overall increase of 9.3%, and production an increase of 28%, which allows inferring an overall increase in the productivity of this activity in the country during the last five years (Ministry of Agriculture and Rural Development - MADR, 2021).

The Departmental Strategic Plan for Science, Technology and Innovation of Norte de Santander 2014-2024 identified fruit and vegetables as a priority production chain where the cultivation of blackberries is located (Norte de Santander Governorate, 2014).

In the municipalities of Pamplona and Pamplonita there is a set of local populations, wild, cultivated and some introductions of various species of Rubus sp. , recognising six different taxa: R. glaucus (Moor of Castile with thorns and without thorns), R. alpinus, R. rosifolius, R. bogotensis, R. floribundus and R. adenotrichos (Cancino et al., 2011). R. glaucus Benth, is the species that is currently commercially cultivated in Colombia and South America. However, according to González et al. (2019) blackberry producers in the municipality of Pamplona use the cultivar Castilla by 45%, Castilla y Mora Uva by 30% and blackberry Uva by 10%. According to the criteria of the botanists of the University of Pamplona the mulberry Uva corresponds to the species R. floribundus (Cancino et al., 2011).

In the municipalities of Pamplona and Pamplonita there is a set of local populations, wild, cultivated and some introductions of various species of Rubus sp. , recognising six different taxa: R. glaucus (Moor of Castile with thorns and without thorns), R. alpinus, R. rosifolius, R. bogotensis, R. floribundus and R. adenotrichos (Cancino et al., 2011). R. glaucus Benth, is the species that is currently commercially cultivated in Colombia and South America. However, according to González et al. (2019) blackberry producers in the municipality of Pamplona use the cultivar Castilla by 45%, Castilla y Mora Uva by 30% and blackberry Uva by 10%. According to the criteria of the botanists of the University of Pamplona the mulberry Uva corresponds to the species R. floribundus (Cancino et al., 2011).

Taking into account the above, the present project aimed to evaluate the incidence and severity of the main foliar fungal diseases affecting commercial varieties of blackberry in the municipalities of Pamplona and Pamplonita, Norte de Santander.

MATERIALS AND METHODS

An exploratory investigation was carried out to know the diseases present and their incidence and severity in the blackberry plantations in the municipalities of Pamplona and Pamplonita in the Northern Department of Santander in the period from July to September 2022.

Observations and measurements were made of the incidence and severity of diseases in commercial varieties of blackberry in the two municipalities, Mora Uva and Mora Castilla with and without thorn. 50 blackberry farms were randomly selected, which constituted the sample, 26 in the municipality of Pamplona 24 in the municipality of Pamplonita, representing 72,46% of the farms in these municipalities according to the information provided by the Association of Mora de Pamplonita ASPAFE and the Association of blackberry producers of Pamplona ASPRI. In the municipality of Pamplona 21 fields corresponded to Mora Uva, two to Mora Castilla with thorn and one to Mora Castilla without thorn, while in Pamplonita all the fields visited had planted the Mora Uva

In each field an observation path was made in double diagonal, sampling exhaustively 10 plants, five in each diagonal. For each disease, a specific sampling was carried out to determine incidence and severity depending on the diseased organ, following the methodology recommended by Saldarriaga et al. (2017) for the main diseases of the arrears in Colombia as set out below:

Fruit rot (Botrytis cinerea)

10 random plants were taken per field of each commercial variety on each farm in the municipalities. The evaluation was carried out by dividing the plant into four quadrants, in which 4 clusters were taken into account that had at least 50 % of the fruits in grade 5 of ripening (Saldarriaga et al., 2017). the incidence was estimated using the formula (Agrios, 2005).

Antracnosis (Colletotrichum spp.)

In each of the selected plants, healthy and diseased main stems or branches were counted. Only incidence was evaluated as the proportion of the number of affected stems per plant on the number of observed stems per plant per 100 % (Agrios, 2005).

The incidence of anthracnose in fruits and leaves was also estimated, proceeding in a similar way to that proposed for rot by Botrytis, the same formula of Agrios was used (2005).

The severity of the disease was estimated in the foliage of the 10 plants of the field, for which the four quadrants of each plant were sampled and a scale of 6 degrees was applied (Agrios, 2005). If the foliage of the selected branch of the quadrant was healthy, it was assigned grade 0 and if it had more than 75% of foliage with symptoms of the disease, it was assigned grade 5. To estimate the severity of each field, the formula of Towsend and Heuberger was used (Agrios, 2005).

Dusty mildew (Oidium sp.). The incidence of the disease was estimated in the branches of each quadrnate. The same formula was used (Agrios, 2005).

The severity of the disease was estimated in the foliage of the 10 plants of the field, for which the four quadrants of each plant were sampled and a scale of 6 degrees was applied (Agrios, 2005). Towsend and Heuberger's formula was also used to estimate the severity of each field (Agrios, 2005).

Roya *Gerwasia* sp. In the same 10 plants selected in the field it was observed whether or not there was presence of rust in the fruits and foliage, being evaluated in the same way explained above. The presence of pustules of this disease was also observed in fruits. For the fruits the same procedure was followed as for Botrytis (Agrios, 2005) and for the foliage the same implemented in anthracnose in the foliage and the dusty mildew, employed the same formula of Towsend and Heuberger referred to above (Agrios, 2005).

Formulas used:

$$\%\ \boldsymbol{Fruit\ incidence\ (SI)} = \frac{\boldsymbol{Number\ of\ stems\ with\ symptoms}}{\boldsymbol{Total\ of\ leaves\ sampled}} * \mathbf{100}$$ (Agrios, 2005).

$$\%\ \boldsymbol{Fruit\ incidence\ (FI)} = \frac{\boldsymbol{Number\ of\ fruits\ with\ symptoms}}{\boldsymbol{Total\ of\ leaves\ sampled}} * \mathbf{100}$$ (Agrios, 2005).

$$\%\ \boldsymbol{leaves\ incidence\ (LI)} = \frac{\boldsymbol{Number\ of\ leaves\ with\ symptoms}}{\boldsymbol{Total\ of\ leaves\ sampled}} * \mathbf{100}$$ (Agrios, 2005).

$$\%\ \mathbf{Severity} = \frac{\sum(\mathbf{aXb})}{\mathbf{KN}} * \mathbf{100}$$ Towsend y Heuberger (Agrios, 2005).

Where: ∑= summation symbol, S= Severty, a = Scale degree, b= Number of leaves with each A degree of the scale, K= Maximum degree of scale = 5, y N= Total number of branches sampled in the 10 plants.

From the results of the previous sampling and the tabulation of the data, the incidence and severity of diseases were determined according to the varieties and ages of the plantations and the altitudinal floors.

The ages were grouped into three ranges of 0-2 years, 2-4 years and more than 4 years corresponding to the stages of establishment, production stage and post-pruning renewal (Infoagro, 2022).

Two height ranges were considered temperate floor between 1,000 and 2,000 m.s.n.m. and cold floor between 2,000 and 3,000 m. s. n. m. (Colombiaverde, 2022).

When the assumption of normality of the data of the incidence and severity variables was not met, comparisons were made using non-parametric methods, Mann Whitney to compare two variables and Kruskal Wallis to compare three variables. The SPSS statistical package for Windows was used with a reliability level of 95%.

RESULTS AND DISCUSION

The main diseases in the three varieties of blackberry were anthracnose, dusty mildew, rust and rot by Botrytis. Anthracnose was present with typical symptoms in foliage, stems, and fruits in all varieties, rust manifested in leaves and fruits. Rot by Botrytis manifested itself mostly in the fruits. The powdery mildew was presented mainly in leaves while the fluffy mildew that has been observed on tours of the fields on other occasions, especially in fruits, was not reported. In this aspect we will have to deepen considering that most of the fields were planted with Grape Berry.

Each disease presented with different characteristics in each variety and municipality. These results coincide with the main diseases reported in other publications for mora Castilla (Huila Governorate; ICA, 2011; Bogotá Chamber of Commerce, 2015; Agrosavia, 2020) with the exception of the hairy mildew as mentioned above.

In Caldas, Quindío and Risaralda, was carried out in 2001, an investigation with the aim of identifying the diseases in Castilla blackberry, and outstanding for their incidence anthracnose and gray mold, after the dusty mildew, and with a lower incidence of rust (Botero et al., 2002).

In the municipality of Pamplona, the disease with the highest incidence was anthracnose in both branches and leaves in the varieties Castilla and mora Uva. We observed 55.71 % of incidence in branches of blackberry with

significant statistical difference in relation to blackberry Castilla and although in blackberry Uva there was an incidence in fruit was 13.23%, it did not differ significantly from the varieties of blackberry Castilla. The rot by Botritys in fruit also presented a tendency to be low in blackberry Castilla and blackberry Uva, with incidences less than 5% and without statistical difference.

The incidence of rust in fruit and leaf, as well as the severity in foliage was relatively very low in all varieties without statistical difference. The powdery mildew in blackberry varieties Castilla reached incidence of 48.15% and severity of 9.63% with statistical difference with blackberry Uva (Table 1).

Table 1. Incidence (%) in fruits, leaves and severity (%) in leaves by varieties

Diseases	Variable	Blackberry Castile	Blackberry Grape
Anthracnose in fruits	Incidence (%)	5,45 NS	13,23 NS
Anthracnose in branches	Incidence (%)	29,84 b	55,71 a
Anthracnose in leaves	Incidence (%)	53,58 NS	24,37 NS
	Severity (%)	10,67 NS	4,87 NS
Botrytis in fruits	Incidence (%)	2,11 NS	3,71 NS
Fruit rust	Incidence (%)	1,35 NS	0,33 NS
Leaf rust	Incidence (%)	10,62 NS	5,05 NS
	Severity (%)	2,73 NS	1,08 NS
Leaf mildew	Incidence (%)	48,15 a	14,64 b
	Severity (%)	9,63 a	3,59b

Source. Own elaboration.

Regarding age ranges, it was observed that, in the municipality of Pamplona, although variations were observed, there was no statistical difference for the variables of anthracnose on leaves, stems and fruit, incidence of Botrytis and rust on fruit, and incidence and severity of rust on leaves. Downy mildew was higher for the range older than 4 years with 29.46 (%) incidence and a severity of 7.77 (%) (Table 2).

Table 2. Incidence (%) and severity (%) of the diseases presented in the blackberry crop

Diseases	Variable	Age range		
		0-2	2-4	More than 4 years
Antracnosis in fruits	Incidence (%)	10,79 NS	18,81NS	12,42 NS
Antracnosis in branches	Incidence (%)	54,52 NS	58,85 NS	57,36 NS
Antracnosis in leaves	Incidence (%)	22,03 NS	17,22 NS	19,52 NS
	Severity (%)	5,31 NS	10,73 NS	13,12 NS
***Botrytis* in fruits**	Incidence (%)	3,13 NS	6,71NS	2,06 NS
Fruit rust	Incidence (%)	0,06 NS	0,01 NS	0,00 NS
Leaf rust	Incidence (%)	1,01 NS	1,62 NS	0,41 NS
	Severity (%)	0,20 NS	0,32 NS	0,08 NS
Leaf mildew	Incidence (%)	13,11b	0,81b	29,46a
	Severity (%)	2,8 b	0,16b	7,77a

Source. Own elaboration.

Based on these results, it is necessary to further investigate the situation of anthracnose in blackberry Uva, since the levels reached in branches are higher than in blackberry Castilla under these conditions, and the incidence in fruits and leaves and the severity in foliage is similar in both varieties, taking into account that Marulanda et al. (2007) state that anthracnose causes losses between 53% and 70% in blackberry Castilla crops in Colombia.

The main diseases present in the Uva blackberry fields sampled in Pamplonita were Botrytis rot, anthracnose on stems, foliage and fruit, and powdery mildew on leaves, since rust was not observed. Regarding the age ranges, it was observed that anthracnose on fruit reached 13.81% in general, but with no statistical difference between the different age ranges. Branch anthracnose reached a value of 44.74% incidence, which can be considered severe, with no difference between age groups. Anthracnose on foliage reached 67.74 % incidence and 13.06 % severity, with statistically higher values in plantations of 0-2 years and more than 4 years of age. In general, Botrytis rot only reached 3.57% in fruit, with no statistical difference between age groups (Table 3).

.

Table 3. Incidence (%) and severity (%) of the diseases in the cultivation of blackberry Grapes in the municipality of Pamplonita and analysis between age ranges.

Diseases	Variable	Municipality	Age range		
		Pamplonita	0-2	2-4	More than 4 years
Antracnosis in fruits	Incidence (%)	13,81	10,30 NS	14,89 NS	14,39 NS
Antracnosis in branches	Incidence (%)	44,74	47,23 NS	43,16 NS	44,89 NS
Antracnosis in leaves	Incidence (%)	67,74	70,03 NS	57,25 NS	74,09 NS
	Severity (%)	13,06	14,05 a	9,66 b	15,02 a
***Botrytis* in fruits**	Incidence (%)	3,57	1,09 NS	5,49 NS	3,18 NS
Leaf mildew	Incidence (%)	75,88	91,61 NS	75,77 NS	70,04 NS
	Severity (%)	14,90	18,20 NS	14,62 NS	13,86 NS

When comparing the municipalities, it was observed that the incidence of anthracnose on fruit and Botrytis rot were similar in the two municipalities under study, although with higher numerical values for Pamplona. The incidence of anthracnose on branches was significantly higher in Pamplona than in Pamplonita, while both the incidence and severity on leaves was higher in Pamplonita than in Pamplona.

Leaf and fruit rust was only observed in Pamplona, and although incidence and severity were low, there was a statistical difference between the two municipalities. The incidence and severity of powdery mildew in Pamplonita was higher than in Pamplona with 75.88 % and 14.90 %, respectively (Table 4).

Future research will have to delve deeper into the behavior of crop diseases in the same varieties (especially blackberry grapes) and similar conditions, to find a better explanation for this behavior, which could be due to a problem of farmer management rather than climatic or genetic.

Table 4. Incidence (%) y severity (%) of the diseases in the municipalities of Pamplona and Pamplonita.

Diseases	Variable	Pamplona	Pamplonita
Antracnosis in fruits	Incidence (%)	13,23 NS	13,81 NS
Antracnosis in branches	Incidence (%)	55,72 a	44,74 b
Antracnosis in leaves	Incidence (%)	44,37 b	67,74 a
	Severity (%)	11,41 b	14,06 a
***Botrytis* in fruits**	Incidence (%)	3,71 NS	3,57 NS
Fruit rust	Incidence (%)	0,33	0,00
Leaf rust	Incidence (%)	5,05	0,00
	Severity (%)	1,08	0,00
Leaf mildew	Incidence (%)	14,64 b	75,88 a
	Severity (%)	3,59 b	14,90 a

No influence of altitude was observed on the incidence of Botrytis rot and fruit anthracnose in blackberry grapes in both municipalities, although anthracnose incidence exceeded 13%. The incidence of anthracnose on branches was significantly higher in cold weather than in warm weather, which may be influenced by management, since both the incidence and severity of anthracnose on foliage was higher for the mid-climate altitude. Rust was only observed in cold weather, as previously mentioned in all the varieties present in Pamplona. Powdery mildew powdery mildew was higher in warm weather where it reached an incidence of 72.49 % and a severity of 10.22 % with a statistical difference with cold weather (Table 5).

Table 5. Incidence (%) and severity (%) of the diseases in the blackberry Grape crop according to altitude in the municipality of Pamplonita.

Diseases	Variable	Cold weather	Average climate
Antracnosis en frutos	Incidence (%)	13,23 NS	13,81 NS
Antracnosis en ramas	Incidence (%)	55,72 a	44,74 b
Antracnosis en hojas	Incidence (%)	44,37 b	67,74 a
	Severity (%)	11,41 b	14,06 a
Botrytis en frutos	Incidence (%)	3,71 NS	3,57 NS
Roya en Fruto	Incidence (%)	0,24 a	0,00 b
Roya en hojas	Incidence (%)	3,02 a	0,00 b
	Severity (%)	0,67 a	0,00 b
Mildio en hojas	Incidence (%)	49,65 b	72,49 a
	Severity (%)	10,22 b	14,17 a

As observed, the only disease that was influenced by altitude was powdery mildew, with higher incidence and severity levels in cold weather.

According to the results obtained in the present research, the incidence of anthracnose in the three varieties and in the two municipalities and the two thermal floors stands out, which is similar to the research carried out by Hernández et al. (2018) where it is reflected that the highest incidence in diseases was anthracnose with 34.8% which was attributed to the present rainfall. On the other hand, Botrytis rot in fruits did not have significant values in terms of incidence, giving low results that did not exceed 5%, as opposed to the results of the research conducted by García (2019) in Ecuador, where more than 50% incidence was obtained for Botrytis in fruits.

In relation to anthracnose, it is necessary to maintain a close vigilance with the increase of blackberry plantations, predominant in this research, since it is suggested that it causes notable losses in blackberry crops of Castilla in Colombia (Marulanda et al., 2007). In a blackberry Castilla crop in the parish of Maldonado, municipality of La Vega, Cundinamarca" higher incidence rates of Colletotrichum in fruit of up to 34.8% were reported; (Hernández et al., 2018).

In the present investigation, symptoms were more evident on the foliage. This disease increases its incidence when precipitation decreases and when conditions of high temperatures (20 to 30 °C) and relative humidity above 97% are present (ICA, 2011). It is also suggested that in greenhouse crops or under prolonged summer conditions, powdery mildew can grow profusely on the leaf surface producing a whitish growth or white powdery mildew (Mora *et al.,* 2020).

As can be seen, higher temperature conditions favor the incidence and severity of powdery mildew, which explains why incidence and severity levels were significantly higher in warm weather.

With respect to Botritys in the blackberry crop of Castilla, in Ecuador, it was observed that, although they were generally found in the fruits, there were also affectations in flowers and stems to a lesser degree, which was attributed to excessive rainfall and climatic conditions (García, 2019) but that was not present in the present research. It is also referred that warm to very hot and dry weather contributes to reduce or stop the development and spread of the disease (Quinatoa, 2015).

It is suggested that Botrytis is favored by a wide range of temperatures between 10 °C and 22 °C (Saldarriaga et al., 2017), which

could explain the lack of difference between cold and warm weather. For the municipality of Pamplona, historical temperatures from August to November are reported to range between monthly minimums of 10.8 ◦C and 17.9 ◦C (Climate Data, 2023), while for the municipality of Pamplonita it is suggested that the historical average temperature is conditioned by its relief, with an average of 10 °C in the highest areas and 22° C in the lowest areas (Alcaldía de Pamplonita, 2020).

Yepes et al. (2007) studied blackberry rusts in Colombia and Ecuador and reported 22 species of Gerwasia attacking different species and varieties of R. glaucus and R. robustus (synonymy of R. floribunfdus), while Zuluaga et al. (2008) suggest that the molecular classification of the different species that attack blackberry in Colombia should be deepened, so taking into account the present results and the fact that Gobernación de Huila (2008) and Agrosavia (2020) consider rust to be of economic importance, it is advisable to verify in future research what has been observed in relation to the effect of rust on blackberry grapes and, if necessary, to undertake molecular diagnostics.

CONCLUSIONES

The most representative diseases in the three varieties of blackberry in both Pamplona and Pamplonita were: anthracnose on foliage, fruit and stems;

Botritys on fruit and powdery mildew on foliage.

In Pamplona, less anthracnose was observed on foliage, but more on branches. The incidence and severity of powdery mildew was lower in this municipality..

In Pamplonita, anthracnose on the foliage presented a higher incidence and severity with prevalence between 2 and 4 years of age.

In blackberry grape, branch anthracnose was significantly higher in cold weather and lower in foliage in medium weather.

REFERENCIAS BIBLIOGRÁFICAS

Acosta, M., Viera, W., Jackson, T., & Vásquez, W. (2020). Alternativas tecnológicas para el control de *Botrytis* sp. en mora de Castilla (*Rubus glaucus*). *Enfoque UTE, 11*(2). Obtenido de https://doi.org/10.29019/enfoque.v11n2.521.

Agrios N, G. (2005). Fitopatología, Limusa S.A de C. V. México. P 358, 403, 404.

Agrosavia. (2020). Tecnología para el cultivo de la mora (*Rubus glaucus* Benth.). https://editorial.agrosavia.co/index.php/publicaciones/catalog/view/46/79/827-1

Alcaldía de Pamplonita. (2020). Plan de Desarrollo 2020-2023. Unidos somos mas. http://www.pamplonita-nortedesantander.gov.co/noticias/plan-de-desarrollo-20202023-samuel-mejia-araque

Anaya-Andrade, Jonathan Esmith, González-Pedraza, Ana F, Castellano-González, Leónides. (2020). Contaminación con elementos traza en suelos cultivados con hortalizas. Revista @limentech, Ciencia y Tecnología Alimentaria ISSN 1692-712 ISSN Impreso 1692-7125./ ISSN Electrónico 2711-3035. Volumen 18 N° 2. Pp: 67 -86.

Avendaño Robayo Juan Pablo; Mosquera Téllez Jemay (2022). Procesos de agricultura urbana y autogestión comunitaria para el desarrollo de huertas caseras en el municipio fronterizo de Cúcuta. Revista @limentech, Ciencia y Tecnología Alimentaria. ISSN Impreso 1692-7125 ISSN Electrónico 2711-3035. Volumen 20 N° 2. Pp: 41 – 65

Cancino-Escalante, G.O., Sánchez-Montaño, L.R., Quevedo-García, E. y Díaz-Carvajal, C. *(2011)*. Caracterización fenotípica de accesiones de especies de *Rubus* L. de los municipios de Pamplona y Chitagá,

región Nororiental de Colombia. *Universitas Scientiarum, 16(3): 219-233.*

Calapiña, O., & Chacón, C. (2020). Propagación in vitro del cultivo de mora sin espinas (*Rubus glaucus* Benth) en el cantón Cevallos provincia Tungurahua. *Trabajo de grado.* Universidad Técnica de Cotopaxi. Obtenido de http://repositorio.utc.edu.ec/bitstream/27000/6930/1/UTC-PIM-000271.pdf

Climate Data (2023). Clima Pamplona Colombia. https://www.google.com/search?q=Tecnologia+para+el+cultivo+de+mora&rlz=1C1GCEB_enCO974CO974&oq=Tecnologia+para+el+cultivo+de+mora&aqs=chrome..69i57j33i160l3j33i22i29i30j33i15i22i29i30l2.38443783j0j15&sourceid=chrome&ie=UTF-8

García, C. L. (2019). Identificación de los principales daños causados por *Botritys* en el cultivo de mora de Castilla (*Rubus glaucus* Benth), en la parroquia de Maldonado, cantón Tulcán, provincia del Carchi. *Trabajo de grado. Universidad Tecnica de Babahoyo*. Obtenido de http://dspace.utb.edu.ec/bitstream/handle/49000/6462/E-UTB-FACIAG-ING%20AGRON-000172.pdf?sequence=1&isAllowed=y

González, Y., Manzano, O., & García, O. (2019). Puntos críticos de la cadena productiva de la mora (*Rubus glaucus* Benth), en el municipio de Pamplona, Colombia. *Revista de Investigación Desarrollo e Innovación, 10*(1), 9-22. Obtenido de https://dialnet.unirioja.es/servlet/articulo?codigo=7418246

Gobernación de Huila (2007). Manual técnico de la producción limpia del cultivo de la mora *Rubus glaucus* en el departamento del Huila. Secretaría de Agricultura. Neiva. Colombia. http://biblioteca.minagricultura.gov.co/cgi-bin/koha/opac-detail.pl?biblionumber=18828

Guevara-Cuasapud Lorieth A.; Gómez-Barrera Milton. (2020). Reconocimiento de metabolitos secundarios presentes en las hojas de *Ilex guayusa Loes.* Revista @limentech, Ciencia y Tecnología Alimentaria. ISSN 1692-712 ISSN Impreso 1692-7125./ ISSN Electrónico 2711-3035. Volumen 18 N° 1. Pp: 22 – 33.

Cámara de Comercio de Bogotá. (2015). Manual de mora. Bogotá, Colombia. 54p.

Gobernación de Norte de Santander (2014). El Plan Estratégico Departamental de Ciencia, Tecnología e Innovación del

Norte de Santander (PEDCTI) 2014-2024. https://www.google.com/search?q=El+Plan+Estrat%C3%A9gico+Departamental+de+Ciencia%2C+Tecnolog%C3%ADa+e+Innovaci%C3%B3n+del+Norte+de+Santander+2014-2024&rlz=1C1GCEB_enCO974CO974&oq=El+Plan+Estrat%C3%A9gico+Departamental+de+Ciencia%2C+Tecnolog%C3%ADa+e+Innovaci%C3%B3n+del+Norte+de+Santander+2014-2024+&aqs=chrome..69i57.47334941j0j15&sourceid=chrome&ie=UTF-8

Colombiaverde (2022). Pisos térmicos de Colombia y sus cultivos. https://colombiaverde.com.co/geografia/agricultura/pisos-termicos-colombianos-y-sus-cultivos/

Hernández, D., Árdila, S., Díaz, J., Perilla, M., Cubillos, D., Serrano, J., Pulido, N. (2018). Caracterización de agentes causales de enfermedades en el cultivo de mora (*Rubus glaucus*) en la finca manantial en la vereda Sabaneta, municipio de La Vega, Cundinamarca. *Ciencias agropecuarias,* *4*(1), 9-17. doi:https://doi.org/10.36436/24223484.239

ICA. (2011). *Manejo fitosanitario del cultivo de la mora.* Medidas para la temporada invernal: https://www.ica.gov.co/getattachment/b7e061eb-ebd3-4f80-9518-c771712405eb/-nbsp3bmanejo-fitosanitario-delcultivo-de-la-mora.aspx

Infoagro. (2022). *El cultivo de la Mora*. Obtenido de https://www.infoagro.com/documentos/el_cultivo_mora.asp

Marulanda, M. L., Isaza, L., & Ramírez, A. M. (2007). Identificación de la especie de Colletotrichum responsable de la antracnosis en la mora de castilla en la región cafetera. *Scientia et technica*, *13*(37), 585-590. https://revistas.utp.edu.co/index.php/revistaciencia/article/view/4187#:~:text=La%20antracnosis%2C%20causada%20por%20diferentes,y%20caracterizar%20el%20agente%20causal

Ministerio de Agricultura de Colombia y Desarrollo rural – MADR. (Marzo de 2021). Cadena Productiva de la Mora. *Dirección de Cadenas Agrícolas y forestales*. Obtenido de https://sioc.minagricultura.gov.co/Mora/Documentos/2021-03-31%20Cifras%20Sectoriales.pdf

Mora, A., Pardo, F., & Bastidas, H. (2020). Diagnóstico patológico en mora de Castilla *Rubus glaucus* Bentham

(Rosales:Rosaceae). *Orinoquia*, *24*(2), 27–32. https://doi.org/10.22579/20112629.632

Quinatoa, N. (2015). Evaluación del control de *Botrytis* (*Botrytis cinerea*) en el cultivo de mora (*Rubus glaucus* Benth) mediante el uso de *Trichoderma yemas* en la comunidad de Misquillí de la parroquia Santa Rosa, provincia de Tungurahua. Universidad Técnica de Ambato.Facultad de Ciencias Agropecuarias, Ambato Ecuador. 83 p.

Saldarriaga, A., Franco, G., Díaz, C. A., & Múnera, G. E. (2017). Manual de campo para reconocimiento, monitoreo y manejo de las enfermedades de la mora (*Rubus glaucus* Benth.). *Corpoica*. Obtenido de https://www.researchgate.net/profile/German-Franco/publication/319547501_Manual_de_campo_para_reconocimiento_monitoreo_y_manejo_de_las_enfermedades_de_la_mora_Rubus_glaucus_Benth/links/59b2c08c0f7e9b37434ea361/Manual-de-campo-para-reconocimiento-monitoreo

Yepes, M. S., Cardona, V. M. P., & Céspedes, P. B. (2007). Especies de Colombia, Ecuador y Peru pertenecientes al género *Gerwasia Raciborski* del orden Uredinales. *Caldasia*, *29*(1), 105-120.

Zuluaga, C., Buriticá Céspedes, P., & Marín-Montoya, M. (2009). Generalidades de los Uredinales (Fungi: Basidiomycota) y de sus relaciones filogenéticas. *Acta Biológica Colombiana*, *14*(1), 41-56.