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# Experience with Descriptors, Registration and Protection of vegetable cultivars: eggplant as a case study

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## ABSTRACT

The Registro Nacional de Cultivares [RNC (National Register of Cultivars)] and the Serviço Nacional de Proteção de Cultivares [SNPC (National Service for Cultivar Protection)] were established by the Ministry of Agriculture, Livestock and Food Supply (MAPA) in 1997. The registration of a cultivar in the RNC allows the production, processing and commercialization of seeds in the country. The right of commercial exploitation, assured by the protection of a cultivar in the SNPC, allows the allocation of resources to public and private breeding programs, and the subsequent launching of new cultivars. The authors' experience with the theme and its relevance to the public and private sectors provided the base for this article, thus sharing the elements considered relevant in the process of establishing descriptors, registration and protection of cultivars in Brazil, using the eggplant as the focus of the case study. Due to the lack of guidelines for protection of *Solanum melongena* cultivars in Brazil, 43 eggplant descriptors of the International Union for the Protection of New Varieties of Plants (UPOV) were evaluated. For the establishment of descriptors, registration and protection of cultivars, relevant factors included: knowledge of the genetic variability of a collection of germplasm and of plant morphology; experience in morphological characterization, assessment of descriptors and crop management in different climatic environments; the tropicalization of descriptors; the time needed for the establishment of descriptors, their approval and adoption by MAPA; the knowledge and compliance with the bureaucratic demands for the effectiveness of the processes; the mobilization of interdisciplinary talents and the support of public research to assist MAPA in the validation of the descriptors.

**Keywords:** *Solanum melongena*, intellectual property, seeds, morphological characterization, genetic breeding.

## RESUMO

### Experiência com Descritores, Registro e Proteção de cultivares de hortaliças: estudo de caso com berinjela

O Registro Nacional de Cultivares (RNC) e o Serviço Nacional de Proteção de Cultivares (SNPC) foram instituídos pelo Ministério da Agricultura, Pecuária e Abastecimento (MAPA) em 1997. O registro de uma cultivar no RNC permite a produção, o beneficiamento e a comercialização de sementes no país. A proteção de uma cultivar no SNPC, por sua vez, assegura o direito de exploração comercial de uso aos seus obtentores, possibilitando o aporte de recursos para programas de melhoramento genético de empresas públicas e privadas e o subsequente lançamento de novas cultivares. A experiência dos autores com o tema e a relevância deste para os setores público e privado forneceram o estímulo para que este artigo fosse escrito, compartilhando, assim, os elementos julgados relevantes no processo de estabelecimento de descritores, registro e proteção de cultivares, usando a berinjela como o foco do estudo de caso. Devido à inexistência de diretrizes para proteção de cultivares de *Solanum melongena* no Brasil, foram avaliados 43 descritores de berinjela propostos pela *International Union for the Protection of New Varieties of Plants* (UPOV). Para o estabelecimento dos descritores, registro e proteção de cultivares foram relevantes o conhecimento da variabilidade genética de uma coleção de germoplasma e da morfologia da planta; a experiência na caracterização morfológica, na aplicação dos descritores e no manejo da cultura em distintos ambientes; a seleção dos descritores aplicáveis em condições tropicais; o tempo necessário para o estabelecimento dos descritores, sua aprovação e adoção pelo MAPA; o conhecimento e cumprimento das exigências burocráticas para a efetivação dos processos e; a mobilização de talentos interdisciplinares e o apoio da pesquisa pública para auxiliar o MAPA na validação dos descritores.

**Palavras-chave:** *Solanum melongena*, propriedade intelectual, sementes, caracterização morfológica, melhoramento genético.

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## ESTABLISHMENT OF CULTIVAR REGISTRATION AND PROTECTION SYSTEMS

Descriptors, registration and protection are closely connected. The

processes of registration and protection have different objectives and procedures, despite RNC (National Register of Cultivars) and SNPC (National Cultivar Protection Service), the two main pillars in the systems, being related from the technical point of view in unifying the

information, to avoid conflicting data regarding the same cultivar. Cultivar registration has been often mixed up with protection.

The authors' experience with the theme (Carvalho *et al.*, 2009) and its relevance to the public and private

sectors provided the stimulus for this article to be written. The objective is to share with the technical-scientific community the knowledge acquired regarding the elements considered relevant in the process of establishing descriptors, registration and protection of cultivars, using eggplant as the focus of the case study.

### Legislation

RNC was established by the Ministry of Agriculture, Livestock and Food Supply (MAPA) by the Ministerial Order No. 527, of December 30, 1997, considering the need to establish mechanisms to organize, systematize and control seed and seedling production and commercialization in Brazil. Currently, RNC is governed by the Law of Seeds and Seedlings No. 10,711, of August 5, 2003, and regulated by the Decree No. 5,153, July 23, 2004 (BRASIL, 2011).

SNPC was created under MAPA by the Law of Cultivar Protection, No. 9,456, of April 25, 1997, regulated by the Decree No. 2,366, of November 5, 1997, being in charge of managing administrative and technical aspects of cultivar protection in the country. SNPC ensures intellectual property rights to the breeders of a new cultivar, defined as a distinct, homogeneous and stable cultivar resulting from plant breeding and/or genetic engineering. Brazil's accession to the International Union for the Protection of New Varieties of Plants (UPOV) was promulgated by the Decree No. 3,109, of June 30, 1999. UPOV, established in 1998, is a global intergovernmental organization with the mission of organizing and promoting an effective system of protection of plant cultivars and with the aim of stimulating the development of new cultivars for the benefit of society (Santos *et al.*, 2012; Brasil, 2018c). In the analysis of the formulation and contents of the Law of Cultivar Protection, Araújo (2010) states that a proper monitoring and a correct evaluation will make it possible to identify the advantageous or harmful aspects of the application of the Law to the agricultural sector.

### Responsibilities

RNC's purpose is to previously enable species and cultivars (forest,

forage, fruit, annual crops, vegetables and ornamentals, among others) for the production, processing and commercialization of seeds and seedlings throughout the Brazilian territory. New cultivars should be made available quickly to the farmer, as they are the latest advances in plant genetic research. RNC has a fundamental importance for breeding programs to ensure the genetic identity and the varietal quality of cultivars, as well as protecting them from degradation resulting from mechanical mixing, crosses, name or denomination changes, and other accidental events (Carvalho *et al.*, 2009).

SNPC is responsible for analyzing applications and granting cultivar protection certificates to the breeders of a new cultivar, as well as for maintaining the database, keeping live samples for inspection purposes, and monitoring the original characteristics of protected cultivars in the country. In addition, SNPC formulates the guidelines for the tests of Distinctiveness, Uniformity and Stability (DUS) and ensures compliance with international regulations. The cultivar protection certificate

is considered a movable asset and represents the only form of protection of higher plant species in Brazil (BRASIL, 2011).

## REGISTRATION AND PROTECTION OF VEGETABLE CROPS

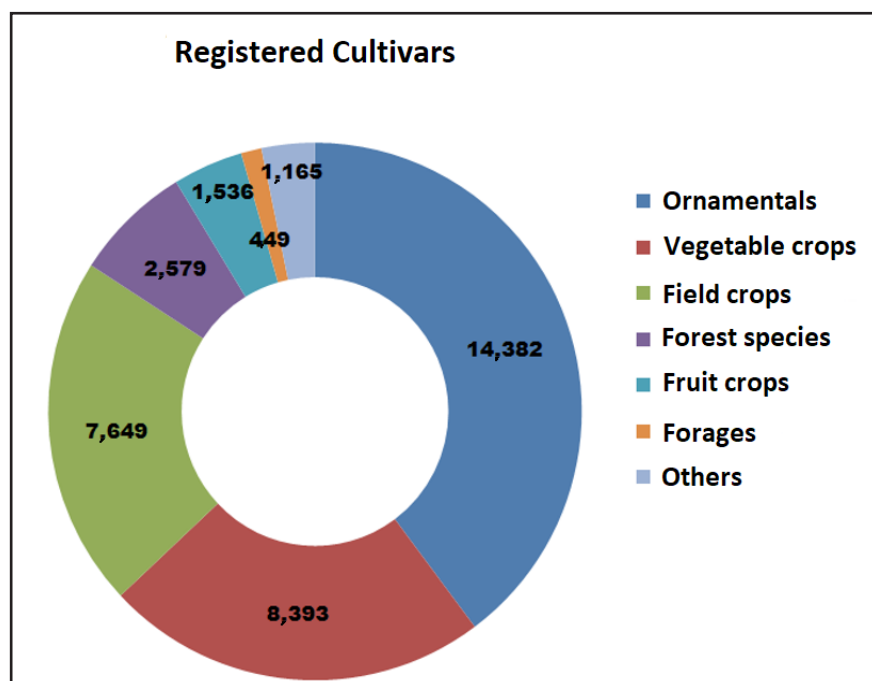
### Registration

The RNC's *Cultivar web* database (Figure 1) indicates that slightly more than 36 thousand cultivars were registered in the system in October 2017. From these, 8,393 were vegetable cultivars, which correspond to 23% of the total number of records (BRASIL, 2018a).

### Protection

To apply for protection, a cultivar has to attend to the following requirements:

- To result from the genetic breeding of species subject to protection in Brazil;
- To have not been commercialized abroad for more than four years, or for more than six years, in the case of grapevines or trees;



**Figure 1.** Number of cultivars registered in the National Register of Cultivars (RNC) of the Ministry of Agriculture, Livestock and Food Supply, from 1998 to 2017. Brasília, Embrapa Hortaliças, 2018.

- To have not been commercialized in Brazil for over a year;
- To be distinct, uniform and stable.

The difference between the application of the request for protection and the protection itself should be emphasized. The protection is valid only after the request is approved by MAPA. Thus, at the end of 2015, 3,796 applications for cultivar protection were submitted and 2,810 cultivar protection certificates were granted. Among the species protected until March 2018 in SNPC's database Cultivar web (BRASIL, 2018b), 16 are vegetables, and those with at least five protected cultivars are shown below (Figure 2).

### Registration and protection efforts

The technical staff and institutions interested in the registration and protection processes have to invest considerable effort to meet all the minimum requirements of RNC and SNPC, respectively. Such effort is linked to the method of multiplication of the cultivar (cloning, open or hybrid pollination) (Figure 3). The effort for registration was estimated by calculating the percentage of registered cultivars of lettuce, potato, carrot,

melon, strawberry, sweet and hot pepper, and tomato, in relation to the total number of requests for these vegetables (BRASIL, 2018a). The same methodology was used to calculate the effort required for protection (BRAZIL, 2018b). The greatest effort for protection was identified in open-pollinated species (such as lettuce), while in relation to registration, hybrids (such as tomato) demanded more effort. Gomes *et al.* (2016), carrying out a survey of registration and protection records of vegetables in MAPA between 1998 and 2014, observed 7,174 registration records for 34 species and 147 protection records for ten species. The highest numbers of registration records were for tomato (1466), *Capsicum* spp. (763), lettuce (604) and melon (588), while for protection, potato and lettuce had the highest figures, namely 57 and 56 records, respectively. The vast majority of registers in RNC and the protection records in the SNPC come from private institutions, with 93.23% and 87.5%, respectively. The public sector reached 226 registers and 18 protection certificates. Among public institutions, Embrapa stands out with 57.22% and 72.22% of records for

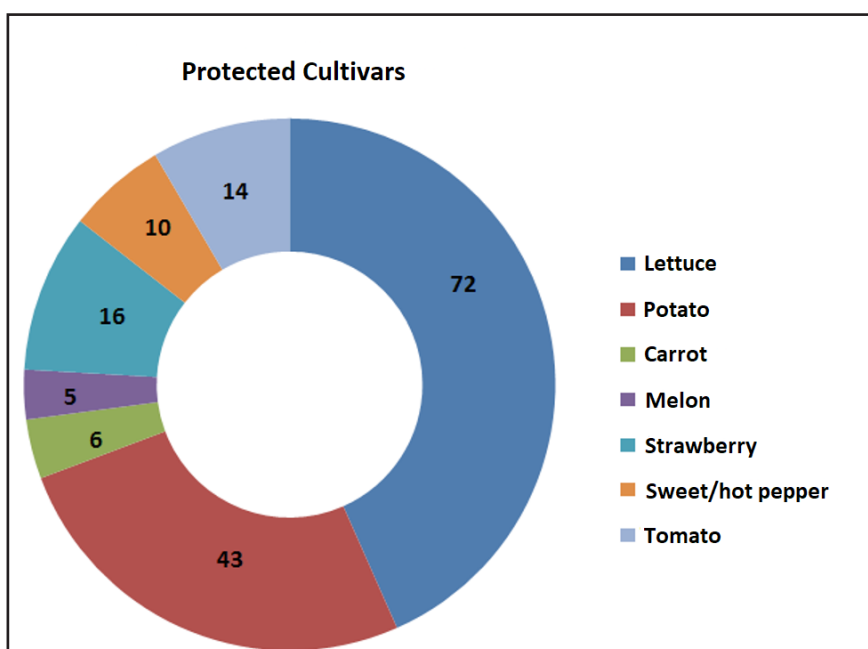
registration and protection, respectively.

## BASIC DIFFERENCES BETWEEN CULTIVAR REGISTRATION AND PROTECTION

Registration is an important instrument to protect farmers from purchasing seeds and seedlings from cultivars not evaluated under Brazilian edafoclimatic conditions. It is a simple and low-cost process if compared to cultivar protection, as well as of easy adoption by both the public and private sectors. On the other hand, cultivar protection can have direct influence over seed costs in open pollination cultivars, since hybrids do not need the legal protection due to their intrinsic biological protection. To protect a cultivar it is not necessary to have it registered. The major beneficiaries of cultivar protection are those with the greatest capacity for developing new products (Castro *et al.*, 2006). Cultivar registration and protection have several distinct aspects (Table 1).

### Procedures

To register a particular cultivar in the RNC it is necessary to previously carry out trials to determine its Value for Cultivation and Use (VCU). These trials assess the intrinsic value of the combination of the agronomic characteristics of that cultivar with its uses in agricultural, industrial and commercial activities, as well as in fresh consumption. According to the standards established to date for plant species, VCU trials are required for 30 species in Brazil. Among the vegetable crops, standards were established only for potatoes. For the other vegetables and for species for which the minimum criteria for VCU determination were not established, cultivar evaluation should be carried out at the user's discretion, followed by filling in a specific form (Form IX), available on MAPA website (<http://www.agricultura.gov.br/assuntos/insumos-agropecuarios/insumos-agricolas/sementes-e-mudas/registro-nacional-de-cultivares-2013->



**Figure 2.** Vegetable species with at least five cultivars protected in the National Service for Cultivar Protection (SNPC) of the Ministry of Agriculture, Livestock and Food Supply, from 1998 to March 2018. Brasília, Embrapa Hortaliças, 2018.

rnc-1/formulários-para-registro-de-cultivares). In addition to the form, a complete set of documents must be submitted per cultivar, namely a letter of referral/application per form and the receipt of payment of the Federal Tax Collection Form (GRU), among others.

For cultivar protection in SNPC, the most important technical requirement are the DUS trials, which will make it possible to prove that the new cultivar is distinguishable from another whose descriptors are known, uniform as to its characteristics in each reproductive

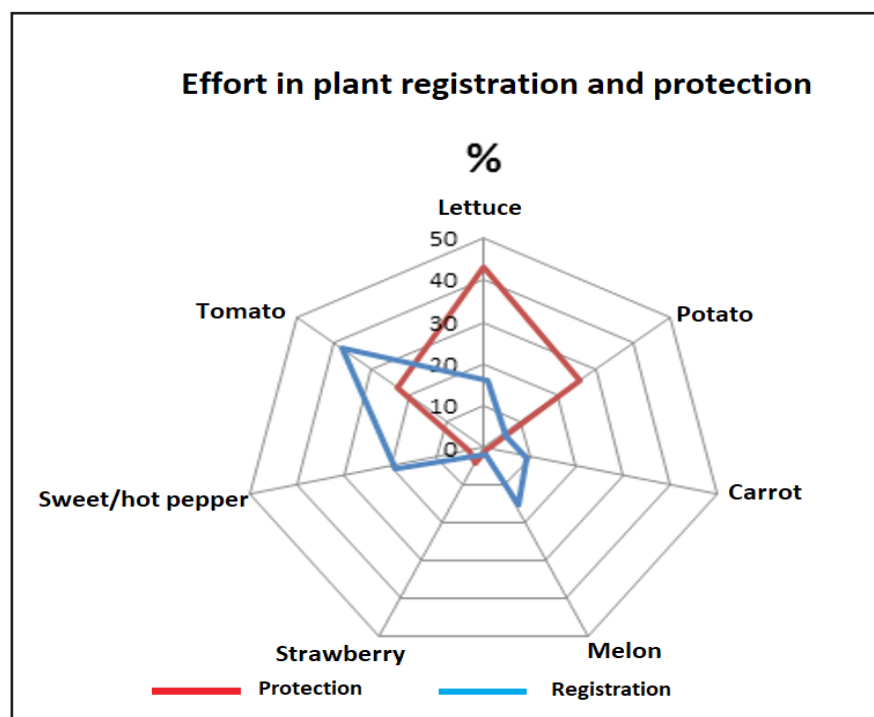
cycle, and stable in terms of displaying the same characteristics over successive generations (BRASIL, 2011). The request for protection of a new cultivar is made by submitting three forms that are available for download on MAPA website (Application form, Technical Report and Cultivar Description Form): <http://www.agricultura.gov.br/assuntos/insumos-agropecuarios/insumos-agricolas/protacao-de-cultivar/formularios-para-protacao-de-cultivares>. It must be emphasized that for cultivar description, the specific form previously published by SNPC should be used (Form 3 - Species in protection regime: instructions of DUS and Table of minimum descriptors). Form 3 is filled with information of the species which the candidate cultivar belongs to.

### Validity and waiver of registration and protection

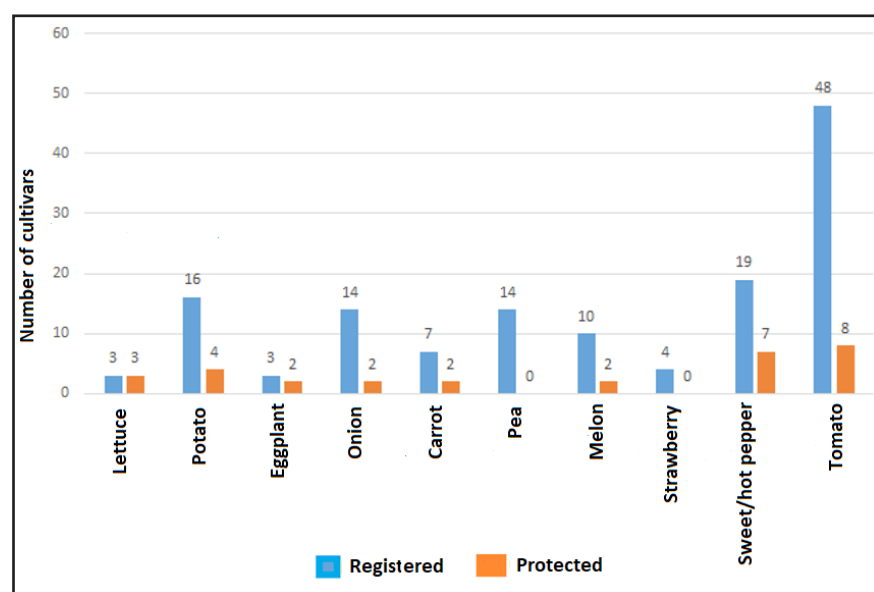
According to Article 11 § 2<sup>nd</sup> of the Law of Seeds and Seedlings (Law No. 10,711/2003), "The continuity of a cultivar registration in the RNC is conditioned to the existence of at least one maintainer, except for cultivars in which the propagating material depends exclusively on importations". The maintainer is the private individual or legal entity who is responsible for making available a minimum stock of propagating material of a cultivar registered in the RNC, preserving its characteristics of genetic identity and varietal purity. The following are waived from registration in RNC:

- Cultivars imported for use in research or to carry out VCU trials, in volumes compatible with the use, with technical justification and according to the specific legislation;
- Cultivars imported exclusively for re-exporting;
- Local, traditional or Creole cultivars, used by smallholders (family farmers), farmers settled by agrarian reform or indigenous populations, which can be registered in the RNC at the discretion of the interested parties, and thus subject to the same rules as for other cultivars.

Cultivar protection generally starts at the date of granting of the Provisional Protection Certificate. The validity



**Figure 3.** Effort expended by the requesting institutions for the registration (RNC/MAPA, from 1998 to October, 2017) and protection (SNPC/MAPA, from 1998 to March 2018) of the main vegetable cultivars. Brasília, Embrapa Hortaliças, 2018.



**Figure 4.** Number of vegetable cultivars registered (RNC/MAPA) and/or protected (SNPC/MAPA) by Embrapa until March 2018. Brasília, Embrapa Hortaliças, 2018.



**Table 1.** Differences between registration and protection of cultivars in Brazil. Brasília, Embrapa Hortaliças, 2018.

	Registration	Protection
Responsible Authority	National Register of Cultivars (RNC)	National Service of Cultivar Protection (SNPC)
Competency	Commercial registration	Protection of breeder rights
Purpose	To enable cultivars for production and commercialization in the country	To recognize the breeder rights; To assure the rights of commercial exploitation (Royalties)
Legal basis	Law of Seeds and Seedlings No. 10.711/2003; Decree No. 5.153/2004	Law of Cultivar Protection No. 9.456/1997; Decree No. 366/1997; Decree No. 109/1999
Technical requirements	VCU <sup>1</sup> trial to species of economic importance	DUS <sup>2</sup> trials

<sup>1</sup>VCU= Value for Cultivation and Use; <sup>2</sup>DUS= Distinctiveness, Uniformity and Stability. Source: BRASIL, 2011.

**Table 2.** Cultivars registered in the RNC/MAPA with names identical to varietal groups of pepper of the genus *Capsicum* that deserve revision. Brasília, Embrapa Hortaliças, 2018.

Cultivar	Nº RNC
Biquinho	21962
Cumari do Pará	21134
Murupi	21131
Peito de Moça	21132
Cayenne	03890
Chapéu de Bispo	04505
Chapéu de Bispo (Cambuci)	05151
Jalapeño	04193
Malagueta	01717
Tabasco	18275
Cumari Verdadeira	21130

Source: BRASIL, 2018a.

**Table 3.** Main advantages of the eggplant hybrid Ciça evaluated in eight Brazilian states and in Argentina compared to other eggplant cultivars planted in Brasília. Brasília, Embrapa Hortaliças, 2018.

Advantages	Places <sup>1</sup>	Citations (%)
High yield	PR, RJ, SP, PE, RR, SC and Argentina	66
Excellent fruit quality	PR, PE, SC, RJ and RR	53
Resistance to diseases	PR, SC, SP, MG, RJ, RR and Argentina	43
Excellent market acceptance	PR, RJ and MT	23
Earliness	PR, MT and Argentina	10
Good performance	SC, SP and PR	10
Resistance to pests	PR and Argentina	7

<sup>1</sup>MG= state of Minas Gerais; MT= state of Mato Grosso; PE= state of Pernambuco; PR= state of Paraná; RJ= state of Rio de Janeiro; RR= state of Roraima; SC= state of Santa Catarina; SP= state of São Paulo. Source: Ribeiro & Reifschneider, 1999.

period is 15 years, except for grapevines and fruit, forest and ornamental trees, including in each case their respective rootstock, for which protection lasts for 18 years. Once the validity of the right of protection expires, the cultivar falls

into public domain and no other right may obstruct its free use (BRASIL, 2011; 2018c).

The following cases are exempt from the rights of the owner of the protected cultivar, and thus are waived of paying

royalties or requesting authorization of the holder of the protection:

- Farmers who save planting material for his/her own use;
- Smallholder farmers who produce seeds and distribute them through donation or exchange with other smallholders;
- Breeders, that is, any legal entity or individual engaged in plant breeding, provided the protected material is used to develop scientific research or in plant breeding.

### Some bottlenecks

The authors' experience suggests that the main bottlenecks for registration and protection of vegetable cultivars include: the time spent in the processes, internal procedures of the institution that end up further burdening the already complex processes, the inadequacy of part of the plant descriptors, and choosing a name for the cultivar. The latter point deserves a deeper reflection.

The name selected for the cultivar is very important for the process of protection and commercialization of seeds. In Decree No. 2,366/1997, which regulates the Law of Cultivar Protection (Law No. 9,456/1997), Article 7, defines that the holder of the protection right cannot use as name a designation that: does not allow the identification of the cultivar; is susceptible to induce error or confusion as to the cultivar origin, source, characteristics, value or identity, or as to the breeder identity; is identical or may be confused with another name which identifies a pre-existing cultivar of the same or similar species; refers only to common attributes of other cultivars of the same species; is part of a botanical or common name of a

genus or species; reproduces in whole or in part a brand of product or service linked to the plant area, or to the area of use of the cultivar, or a well-known brand (BRASIL, 2011).

The name of the cultivar candidate for protection should be different from names of pre-existing cultivars of the same or similar species, including at international level. In Brazil, a query must be made in the Cultivar web database of RNC and SNPC (BRASIL, 2018a; 2018b), and in other countries in the UPOV database (<http://www.upov.int/pluto/en/>) to check for pre-existing names. The consultation should also be carried out in the database of the National Institute of Industrial Property (INPI) (<http://www.inpi.gov.br/>), to confirm if the name can be used for the new genotypes.

However, some cultivars registered in the RNC have names which are identical to botanical or common names of a genus or species, extending to varietal groups. Thus, this designation seems to contradict Article 7 of Decree No. 2,306/97, which should have made the protection of such cultivars unviable. In this context, we can mention several pepper cultivars registered in the RNC with names which are similar to the types of peppers found in the Brazilian diversity (Table 2) and need to be reviewed by MAPA (BRASIL, 2018a).

## EMBRAPA: REGISTRATION AND PROTECTION

Embrapa (Brazilian Agricultural Research Corporation) has established a set of corporative norms to regulate aspects related to the registration and protection of the cultivars developed by the institution, such as norm 037.013.002.002 of September 25, 2017 (EMBRAPA, 2017b). This norm systematizes procedures and criteria regarding applications for the intellectual property of innovation assets (products, methodologies, etc.) abroad, as well as the maintenance of assets of intellectual property (registration and protection of cultivars, among others).

In 2016, Embrapa had about 100 plant breeding programs and more

than 1,700 cultivars (EMBRAPA, 2017a). New cultivars with commercial interest developed at Embrapa are registered to ensure their genetic identity and varietal quality. Cultivars are also protected to guarantee breeder rights and to foster public-private partnerships in all phases of the cultivar development process, from research to seed distribution to the market. In addition, the resources mobilized with the rights over the developed cultivars allow the partial or total sustainability of the breeding programs and the subsequent launching of new cultivars of interest for the Brazilian agribusiness. Several vegetable cultivars were registered and/or protected by Embrapa (Figure 4). It is interesting to note that Embrapa's registration and protection efforts for this set of vegetables differ substantially from the general effort shown in Figure 3, which shows the consolidation of efforts of both the public and private sectors (Gomes *et al.*, 2016; BRASIL, 2018ab). This suggests the need for evaluating and reviewing the institutional strategy in this sector.

## CASE STUDY: EGGPLANT

Eggplant (*Solanum melongena* L.) was taken as a case study because Embrapa Hortaliças has been working with the species for more than 30 years and, particularly, due to the success achieved with its first launched cultivar, the simple hybrid Ciça. The lines that produce the hybrid needed to be registered and protected, following Embrapa regulations.

### The history of the hybrid Ciça

Embrapa Hortaliças has an eggplant germplasm collection started in 1986 from the introduction of lines of the breeding program of the Universidade Federal Rural do Rio de Janeiro (Federal Rural University of Rio de Janeiro), provided by the late Prof. Raul de Lucena Duarte Ribeiro. Currently, the collection has 348 accessions and was used as the genetic basis for the development of the eggplant hybrid Ciça, with multiple disease resistance (Reifschneider *et al.*, 1993). Since

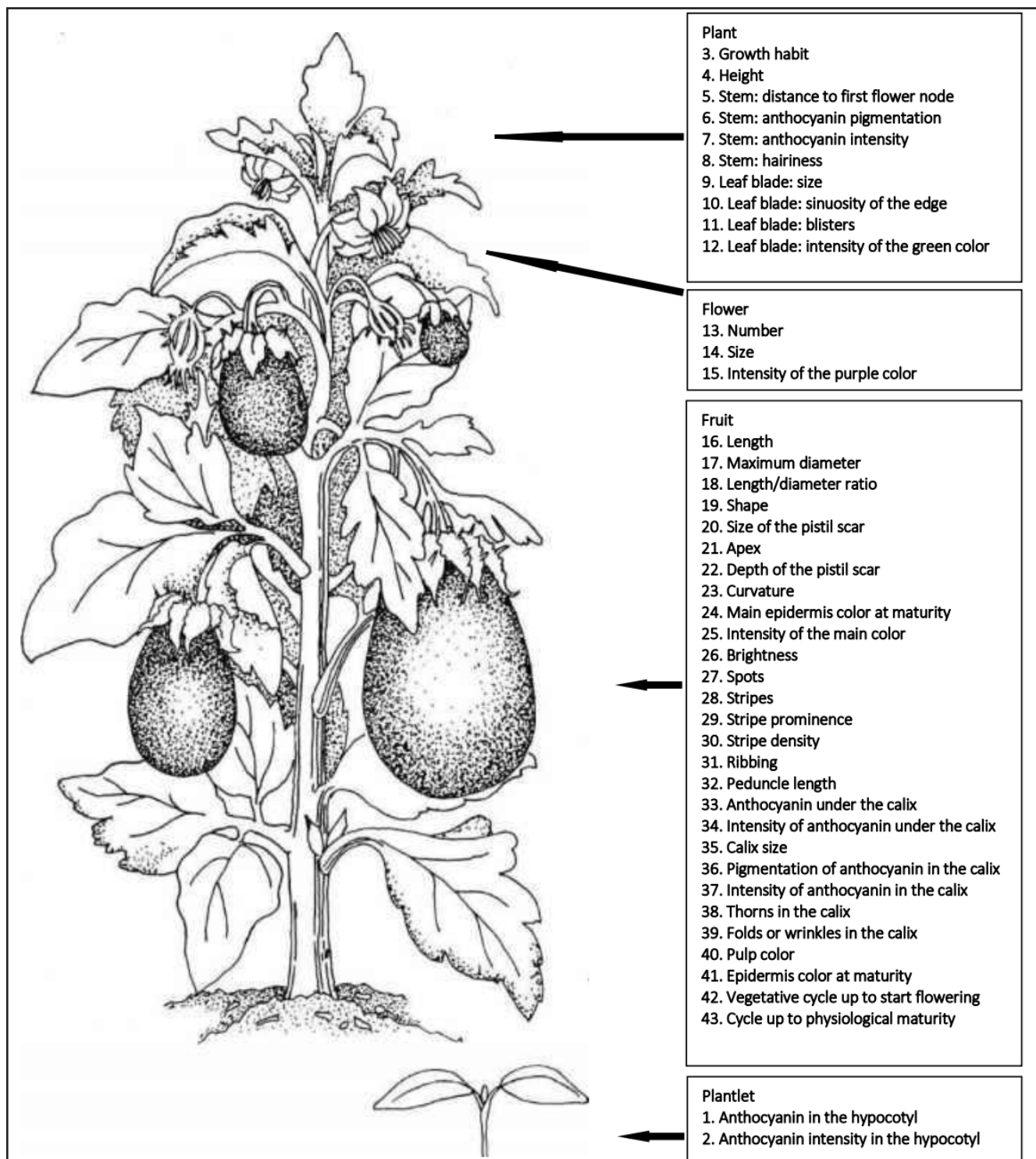
the beginning, there was a substantial effort on the characterization of the accessions in the germplasm collection for disease resistance. As a result, several accessions carrying resistance to important eggplant diseases were identified (Wood & Reifschneider, 1985; Morgado *et al.*, 1992; Boiteux & Charchar, 1996; Oliveira *et al.*, 2014). This underlines the importance of the collection for the breeding of eggplant.

Hybrid Ciça was released in 1991 (prior to the existence of the cultivar registration and protection legislation) by Embrapa Hortaliças, with resistance to anthracnose (*Colletotrichum*) and to fruit-rot (*Phomopsis*), fungal diseases that caused severe losses and even limited eggplant crops in Brazil (Reifschneider *et al.*, 1993). In addition to resistance to these diseases, hybrid Ciça has shown high yields in several regions of the country (around 120 tons of fruits per hectare), excellent fruit quality (dark purple color, intense brightness, oblong-elongated shape) and long postharvest conservation. It may be considered a hybrid of long shelf-life.

In evaluations carried out by technical staff and farmers in the South, Southeast, Midwest, Northeast and North regions of Brazil, as well as in Argentina, Paraguay and Costa Rica, the hybrid Ciça had good performance, mainly due to the high yields, excellent fruit quality, resistance to diseases, earliness and greater commercial acceptance by both seed companies and farmers. The performance of hybrid Ciça was praised by most evaluators, and three characteristics were recorded as the most important: productivity, fruit quality and disease resistance (Table 3). The high productivity of the hybrid was recorded in 66% of evaluators' citations, excellent fruit quality in 53%, and disease resistance in 43% (Ribeiro & Reifschneider, 1999). Demand for seeds remains high in 2018 (Galhardo LC, Agrocincin Ltda., personal information).

### Low availability of seeds of hybrid Ciça in the market

Despite its positive evaluation by experts and farmers in the different regions of Brazil, the commercial production of the eggplant hybrid has been declining due to the low



**Figure 5.** Morphological descriptors of eggplant (*Solanum melongena* L.) distinctiveness, uniformity and stability (DUS) trials from the International Union for the Protection of New Varieties of Plants (UPOV). Infographic of the authors. Drawing obtained in [https://www.grovida.us/vegetable/images/836\\_46\\_94-vegetable-plant.jpg](https://www.grovida.us/vegetable/images/836_46_94-vegetable-plant.jpg)

availability of seeds in the market. Up to 2015, Embrapa was responsible for the seed production of hybrid Ciça.

However, in 2016 there were adjustments in the renewal of Embrapa's

management mechanisms and structures. The then Embrapa Produtos e Mercado, currently the Secretariat for Innovation and Business (SIN), started licensing private companies for producing

and commercializing basic seeds of Embrapa's cultivars, with the objective of reducing costs and operational efforts of the institution with these activities (EMBRAPA, 2017a). It is too early to



tell whether the changes were positive or not.

### Protection of lines for licensing seeds to private-sector companies

Prior to making seeds of the parental lines of the hybrid Ciça available to seed companies in the private sector through public offers, the institutional decision was to protect the lines to secure the breeder's rights and exclusive commercial exploitation to Embrapa. However, the request for protecting the lines in the SNPC could not be immediately achieved due to the lack of guidelines for protecting eggplant cultivars in Brazil.

To protect a cultivar from a species which does not have published descriptors (Form 3 - Protected Species: DUS Instructions and Table of Minimum Descriptors), as it is the case for the eggplant in Brazil, the interested party should contact the SNPC technical staff and request the preparation of a document with the guidelines of DUS Instructions and Table of Minimum Descriptors for the species of the cultivar candidate to protection. SNPC only starts preparing the document upon the manifestation of the parties interested in protecting cultivars of such species, mainly due to the high costs of drafting and publishing DUS guidelines (BRASIL, 2011).

The experience with morphological characterization and evaluation of disease resistance in eggplant at Embrapa Hortaliças allowed the research center to assist and support the SNPC (BRASIL, 2015) in preparing the Table of Minimum Descriptors for the DUS trials of eggplant cultivars. Forty-three morphological descriptors recommended for eggplant by UPOV, of which Brazil is a signatory, were validated.

### Descriptors

A descriptor is defined as a morphological, physiological, biochemical or genetically inherited molecular trait used to discriminate cultivars. Descriptors are the basis for DUS trials and their selection must consider the existing genetic variability and, at the same time, their capacity to differentiate one cultivar from another.

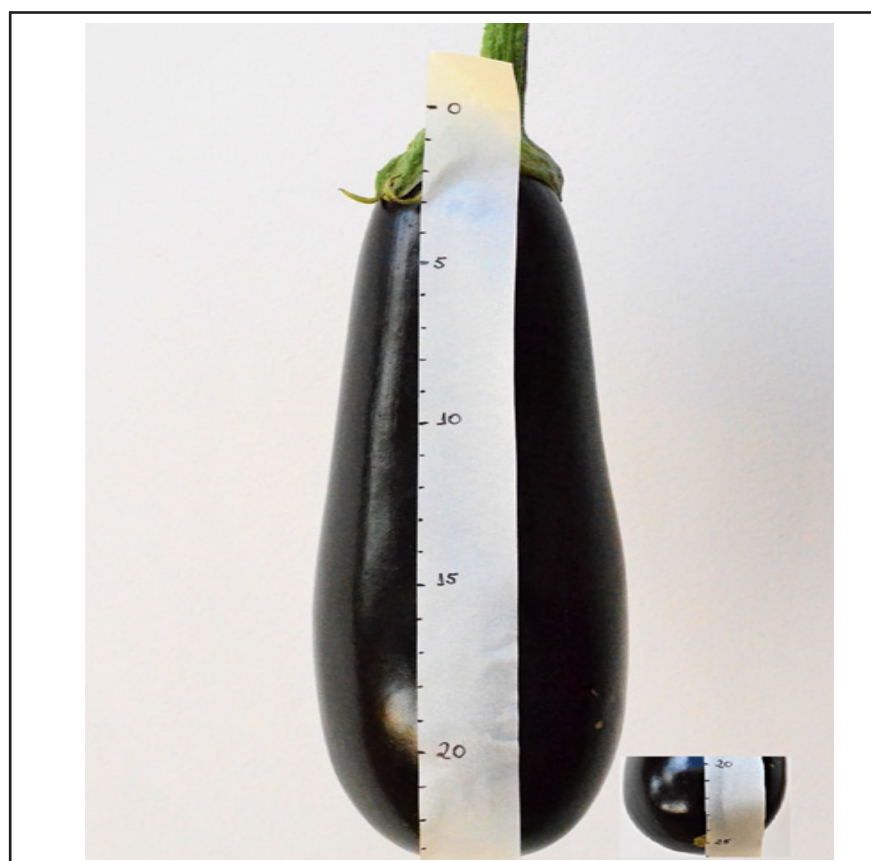
They are called Minimum Descriptors because they are not exhaustive, e.g., other characteristics can be added, as far as they are fundamental for the distinction among cultivars. In this context, a cultivar is considered distinct when its differences are consistent upon comparison to the others (BRASIL, 2011). In Brazil, when the cultivar to be protected belongs to a species without descriptors published by the SNPC, but having a DUS guideline published by UPOV, this document is taken as the basis for drafting the Minimum Descriptors for the DUS trials in the country (BRASIL, 2018a).

### Evaluation of the UPOV descriptors recommended for eggplant

Forty-three morphological descriptors proposed by UPOV (UPOV, 2002) were evaluated and validated in the experimental field of Embrapa Hortaliças, in Brasília, from 2014 to 2015. Out of the 43, there were 32 qualitative and 11 quantitative descriptors; 2 inherent to seedlings, 10

to the vegetative part, 3 to flowers and 28 to fruits (Figure 5). The characteristics are evaluated in categories ranging from two levels (for example fruit stripes: absence/presence) to five (fruit curvature: very mild, mild, medium, intense and very intense).

Some criteria should be taken into account when selecting characteristics to be used as descriptors in DUS guidelines, such as: a) to result from a particular genotype or combination of genotypes and not from environmental effects; b) to be sufficiently consistent and replicable in a specific environment; c) to show enough variation among cultivars to allow for distinctiveness; d) the assessment procedures should be clearly and objectively defined; e) meet the uniformity requirement; f) meet the stability requirement. Although a descriptor does not need to have commercial value or merit, commercial characteristics can be used as descriptors if they can satisfy the criteria listed above. The use of the descriptors is based on the judgment of the evaluators,



**Figure 6.** Assessment to determine the maturity of eggplant fruits using masking tape. Brasília, Embrapa Hortaliças, 2018.



so it is important that they have extensive experience with the crop, in addition to observing the variation resulting from the influence of the environment.

Among the 43 UPOV eggplant descriptors tested, 39 were validated for use in the protection of eggplant cultivars in Brazil. Four fruit descriptors (size and depth of the pistil scar and stripe prominence and density) were discarded and should not be used in DUS trials. These descriptors suffer strong environmental effect and/or are difficult to be assessed, making them susceptible to errors.

## MINIMIZING THE RISKS IN THE USE OF THE DESCRIPTORS

### Determination of the fruit maturity point

It is very important to avoid errors in the assessment and interpretation when evaluating the descriptors. Due to the difficulty in identifying the fruit maturity point, different methodologies were tested to establish the ideal point for assessing the 28 morphological descriptors of fruits recommended by UPOV. The following were considered as indicators (proxy) of full maturity: color of the fruit pericarp, soluble solids, seed texture, flower tagging before anthesis, and fruit measurement until growth ceases.

The methodology found to be most efficient, effective, precise and of best use – presented below in detail – was fruit measurement until it stops growing, because the exact moment when the eggplant fruit reached maturity coincided with the completion of its growth. Alternatively, the fruit maturity point can also be assessed by seed color and texture, but these observations are more subjective. Color of the fruit pericarp, concentration of soluble solids and flower tagging before anthesis did not provide practical and consistent results. It is important to note that specific research activity was required to minimize errors.

### Methodology for the assessment of mature fruits

The assessment of fruit descriptors in eggplant should be made at fruit maturity, namely when the fruit stops growing. The maturity point can be identified by measuring the fruit at various stages of its development up to the point when growth stops. The following methodology is proposed:

1. Perform selfing on 20 plants (2 or 3 self-fertilizations per plant) on the same day to control the date of pollination and fruit development. Repeat selfings at 15-day intervals, as prevention in case of abortion of flowers or self-fertilized fruits;

2. From the 20 self-fertilized plants, measure the first fruits (2 to 3) of 10 plants, approximately 20 days after self-fertilization. For a more precise assessment of growth cessation, it is suggested to fix a tape, graduated in centimeters, at the base of peduncle insertion of the eggplant fruit up to the style scar, to monitor fruit growth (Figure 6). For some slow-growing genotypes, it is recommended to use silicone to fix the tape;

3. Fruits should be assessed at 3 to 5-day intervals until fruit growth stops. At this point, seeds will have a light color, and seed coats will be soft;

4. Observing and recording data of fruit descriptors before the maturity point affects mainly quantitative descriptors, such as fruit length and maximum diameter, since fruits are still in the growing phase. On the other hand, when performed after maturity, it affects the assessment of qualitative characteristics, for example, fruit brightness, epidermis color at maturity, and texture.

## LEGAL FRAMEWORK FOR THE PROTECTION OF EGGPLANT CULTIVARS

Most of the eggplant morphological descriptors proposed by UPOV and validated at Embrapa Hortaliças are suitable as minimum descriptors for the distinction of eggplant cultivars for protection purposes in Brazil. The validated descriptors served as a basis for SNPC to prepare the Table of

Minimum Descriptors and the guidelines for performing DUS trials of eggplant cultivars, allowing the publication of the document with the guidelines for eggplant cultivar protection in the Federal Official Gazette (BRASIL, 2015).

The publication of the guidelines of the DUS trials is a practical guide for Brazilian breeders that aims to ensure the harmonized performance of trials of new eggplant cultivars. The guide identifies the characteristics to be assessed by means of the Table of Descriptors, and how to assess them, in addition to providing the uniformity and stability standards.

### DUS trials for protection of the lines of eggplant hybrid Ciça

After the publication of the guidelines for protection of eggplant cultivars, DUS trials were carried out in the experimental field of Embrapa Hortaliças to evaluate if the eggplant lines CNPH 006 and CNPH 791, parental lines of the hybrid Ciça, met the technical requirements, according to the criteria established by SNPC. These lines were protected by SNPC through the granting of the certificates No. 20170222 (CNPH 791) and No. 20170159 (CNPH 006), which secures to Embrapa the right to commercially explore their use for a period of 15 years (BRASIL, 2018b).

## LESSONS LEARNED

The process of continuous study, the recommendation to MAPA and the final acceptance of descriptors for protection of eggplant cultivars allowed the authors to learn a series of lessons, which may be valuable to Brazilian researchers in case of facing similar situations. The main lessons learned are:

- The knowledge of the species variability gained from a representative germplasm collection is essential in choosing the morphological descriptors to distinguish cultivars in DUS trials;
- Knowledge of plant morphology is critical to accurately describe its characteristics;
- Experience in morphological

characterization and assessment of the descriptors are fundamental for both the registration and the protection processes;

- Experience with the crop in different climatic environments is essential for cultivar characterization;

- There is a need for adjustments, i.e., selection of descriptors which are functional in tropical conditions;

- The time required for the establishment of the descriptors and their approval and adoption by MAPA is significant, not less than a year;

- Knowledge of and compliance with the bureaucratic requirements of the different institutional levels for executing the processes;

- The support of public research is important to assist MAPA in the validation of descriptors, and;

- It is essential to mobilize talents, in an interdisciplinary approach, for the registration and protection of cultivars.

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