**Revista Agrogeoambiental,** Pouso Alegre, v. 11, n. 3, set. 2019. DOI: http://dx.doi.org/10.18406/2316-1817v11n320191352

# Germination of five weed species of Convolvulaceae family under the effect of temperature

Victor Domiciano de Silos Labonia[1]
Jéssica Cursino Presoto[2]
Jeisiane de Fátima Andrade[3]
Saul Jorge Pinto de Carvalho[4]
Ricardo Victoria Filho[5]

## Abstract

Seeds of several weed species have distinct development when germinating under different conditions of temperature, promoting variation on the management system. Thus, this work was carried out with the objective of evaluating the influence of temperature on the germination of five weed species of *Convolvulaceae* family, commonly known as morning glory. The work was performed in termogradient table and constituted by five independent experiments, divided by species, in a factorial combination of nine treatments (temperatures) and two seed dormancy breaking conditions (with or without acid scarification). The weed species were: *Ipomoea triloba, I. hederifolia, I. quamoclit, I. nil* and *Merremia cissoides*. Nine temperature intervals between 15 and 35ºC were evaluated, under 8 hours of daily photoperiod. Experimental design adopted was totally randomized with four replicates. Percentage of germination was evaluated daily; the speed of germination index was calculated for the species. Generally, it was evident that temperatures lower than 17,2 ºC reduced significantly germination of all species, inhibiting germination of *I. quamoclit*. Species demonstrated capacity of germinating on temperatures from 20ºC to 35ºC. Acid scarification of seeds with sulfuric acid was able of increasing significantly the percentage of seed germination.

**Keywords:** Morning glory. Biology. Development. Seeds.

## Introduction

Morning glory (*Ipomoea* spp. and *Merremia* spp.) are among weeds with high importance in agricultural areas of Brazil. These plants belong to Convolvulaceae family and, besides competing by growth resources available in the environment (water, light and nutrients), they also interfere on mechanical harvest, due to their climbing habit (LABONIA et al., 2009; PAZUCH et al., 2015).

These species have successive fluxes of germination, concentrated on the spring and summer months, possibly due to dormancy that is considered a fundamental strategy for seed survival in soils for long periods of time (PAZUCH et al., 2015; SILVA et al., 2016). Thus, one of the major limita-

---

[1] Syngenta Proteção de Cultivos, Gerente de Desenvolvimento de Produtos. victor.labonia@syngenta.com.

[2] Escola Superior de Agricultura "Luiz de Queiroz" (ESALQ/USP), mestranda, engenheira agrônoma. jessica.cursino_02@hotmail.com

[3] Escola Superior de Agricultura "Luiz de Queiroz" (ESALQ/USP), mestranda, engenheira agrônoma. jeisiane.eng.agronomia@gmail.com.

[4] Instituto Federal de Educação, Ciência e Tecnologia do Sul de Minas Gerais (IFSULDEMINAS), *Campus* Machado, Professor Doutor. sjpcarvalho@yahoo.com.br., Rod. Machado-Paraguaçu, Km. 3, Machado (MG), 37750-000.

[5] Universidade de São Paulo/Escola Superior de Agricultura "Luiz de Queiroz" (ESALQ/USP), Professor Titular. rvictori@usp.br.

tion for implanting integrated weed management programs is the lack of information about biology or ecology of weeds. This knowledge is considered essential for developing management systems which are economically and environmentally viable (CARVALHO; CHRISTOFFOLETI, 2007).

Knowledge related to seed germination, such as temperature, causes of dormancy and maximum depth that allows weed germination, associated to appropriate management practices, for example the determination of optimal moment for post-emergence application of herbicides, are important information for adopting viable integrated management systems (MONDO et al., 2010).

For beginning the process of germination, seeds demand several internal and external factors. The lack of any of these factors may cause slow germination or even induce seed dormancy (POPINIGIS, 1985; CARVALHO; NAKAGAWA, 2000). According to Castro and Vieira (2001), germination occur within temperature limits, at which there is an optimal value for maximum germination in a short period of time, however, these limits are variable for each weed species. In cases of temperatures above the optimum, denaturation may occur, consequently, loss of enzymatic activity. Considering temperatures below the optimum, seed metabolism is decreased or even paralyzed, reducing germinative process, what exposes seedlings to adverse environmental factors for long periods and reduces total germination (DIAS et al., 2009; ORZARI, 2013).

Therefore, the knowledge of environmental demands weed species germination is fundamental for interpretation of their ecological behavior in field condition, besides enabling the development of strategies to reduce weed seedbank in crop fields (MONDO et al., 2010). In this context, this work was carried out with the objective of evaluating the influence of temperature on the germination of five weed species of Convolvulaceae family.

## Material and methods

The work was composed by five distinct experiments. These experiments were developed at the Laboratory of Seed Analysis of “Luiz de Queiroz” College of Agriculture – University of São Paulo, Piracicaba (SP). In each experiment, one weed species of Convolvulaceae family was evaluated independently. The species were: *Ipomoea triloba, I. hederifolia, I. quamoclit, I. nil* and *Merremia cissoides.*

Seeds of all species were commercially acquired and properly identified. Prior to the experiments, samples were submitted to germination tests to verify the viability of the seeds. Completely randomized experimental design was adopted in all the trials, with four replicates and 25 seeds per plot. Plots consisted of Petri dishes (8 cm of diameter), seeds were distributed into two sheets of germination paper, moistened with water in the ratio of 2.5 times the mass of the dry paper.

Each experiment was installed in factorial scheme 9 x 2, at which 9 corresponds to different ranges of temperature and 2 corresponds to the condition of the seeds, with or without chemical scarification. Nine ranges of temperature between 15 and 35 ºC (treatments) with eight daily hours of photoperiod were evaluated (OLIVEIRA et al., 2005; STOCKMAN et al., 2007). Ranges of temperature were established in a thermogradient table (Van den Berg, Model 890). Seeds were scarified with sulfuric acid adopting intervals of time defined for each species by Azania et al. (2003).

After the experiments were installed, daily evaluations of percentage of germination were performed, the index of germination speed (IGS) was calculated for each replicate in order to allow the application of a multiple comparison test. The calculation of the IGS was based on Maguire (1962):

$$IGS = \sum\left(\frac{NGS}{DAS}\right) \quad (1)$$

at which:
NGS: non-accumulated number of seeds germinated per 100 seeds, in each date of evaluation;
DAS: number of days after the experiment was set up.

Seeds with radicle emission longer than 2.0 mm (CARVALHO et al., 2004; STECKEL et al., 2004) and more than 50% of cotyledonary leaves expanded were considered germinated. Evaluations were performed up to the stabilization of germination. Data were submitted to the application of F test on variance analysis, followed by Tukey's test. Due to variation of temperature registered in each position of thermogradient table, regressions were not adopted for analyzing data, once it was not considered a quantitative variable. All statistical tests were adopted with 5% of significance.

## Results and discussion

Regarding to *Ipomoea triloba*, effects of temperature and dormancy breaking were observed on seed germination, however the interaction of these factors was not significant (TABLE 1). *I. triloba* showed greater capacity of germination on temperatures above 17.1ºC. From this temperature and up to 35ºC, percentage of germination was not different, both for seeds chemically scarified or seeds without treatment overcoming dormancy. Orzari et al. (2013), also studying *I. triloba*, observed higher germination in the temperature of 20.37ºC and higher IGS in the temperature of 25ºC.

Highest index of germination speed (IGS) was reached in temperatures between 23.7 and 35ºC for seeds without chemical scarification, and between 23.7 and 30.2ºC for seeds chemically scarified (TABLE 1). When seeds of I. triloba were scarified, germination was increased significantly, as well as IGS; however, the optimal temperature was concentrated at a lower range of values. Therefore, it may be highlighted that temperatures above 30.2ºC reduced the IGS of scarified seeds.

**Table 1** – Germination (%) and index of germination speed (IGS) of *Ipomoea triloba* under the influence of temperature.

| Temperature (°C) | Germination (%) | | | IGS | |
|---|---|---|---|---|---|
| | Dormancy Overcome | | Mean | Dormancy Overcome | |
| | Yes | No | | Yes | No |
| **15.5 - 17.1** | 21 | 11 | 16.0 b | 0.53 A e | 0.26 A d |
| **17.2 - 19.3** | 62 | 45 | 53.5 a | 2.62 A de | 1.50 A cd |
| **19.4 - 21.5** | 69 | 37 | 53.0 a | 3.47 A cd | 1.43 B cd |
| **21.6 - 23.6** | 72 | 41 | 56.5 a | 5.57 A bc | 2.37 B bcd |
| **23.7 - 25.8** | 68 | 40 | 54.0 a | 6.74 A ab | 2.91 B abc |
| **25.9 - 28.0** | 69 | 49 | 59.0 a | 8.11 A a | 4.15 B ab |
| **28.1 - 30.2** | 77 | 50 | 63.5 a | 8.67 A a | 4.82 B a |
| **30.3 - 32.4** | 66 | 55 | 60.5 a | 5.71 A b | 4.15 B ab |
| **32.5 - 35.0** | 58 | 43 | 50.5 a | 5.41 A bc | 2.99 B abc |
| **Mean** | 62.4 A | 41.2 B | | --- | --- |
| **$F_{int}$** | | $1.499^{NS}$ | | | 4.075* |
| **$F_{temp}$** | | 16.334* | | | 37.790* |
| **$F_{over}$** | | 83.864* | | | 126.644* |
| **CV** | | 18.97 | | | 23.47 |

$^{NS}$F-test not significant; *Test F significant at 5% of probability. Means followed by upper case letters in the rows or lowercase letters in the columns are not different according to Tukey's test, with 5% of significance.

**Source**: Elaborated by the authors (2019).

Regarding to *I. hederifolia*, interaction of temperature with dormancy overcoming was identified for both germination and IGS, suggesting that biological response of this species in at least one temperature is different as consequence of the treatment for overcoming dormancy (TABLE 2).

Temperatures at which *I. hederifolia* germinated in greater amount (%) and in a quicker way (IGS) were concentrated in the interval between 23.7 and 30.2ºC for seeds without chemical treatment and between 21.6 and 35ºC for seeds scarified (TABLE 2). Similar results were found by Cole and Coats (1973) for *I. purpurea.* These authors observed optimal germination between 20 and 30ºC, besides reduction on germination speed and on dry matter transference from cotyledon to root/hypocotyl when temperatures were below 20ºC.

Increased optimal temperature range for germination promoted by chemical scarification is predicted on literature, since this process enables higher water absorption by the seeds, which results in better conditions of germination and allows greater levels of IGS at lower temperatures (21.6–23.6ºC). Scarification combined to higher temperatures, which accelerate water absorption and biochemical reactions related to the germinative process, resulted on increased IGS at the temperatures of 30.3-32.4 and 32.5-35.0ºC. Constant temperatures below 19.4ºC reduced germinative process of *I. hederifolia*, however, it was not possible to determine the minimal and maximal temperatures which inhibit germination of this species (TABLE 2).

**Table 2**. Germination (%) and index of germination speed (IGS) of *Ipomoea hederifolia* under the influence of temperature.

| **Temperature (°C)** | **Germination (%)** | | **IGS** | |
|---|---|---|---|---|
| | **Dormancy Overcome** | | **Dormancy Overcome** | |
| | Yes | No | Yes | No |
| **15.5 - 17.1** | 8 A b | 6 A c | 0.18 A c | 0.15 A de |
| **17.2 - 19.3** | 22 A b | 11 A c | 0.52 A c | 0.25 A e |
| **19.4 - 21.5** | 64 A a | 42 B b | 2.60 A b | 1.73 B d |
| **21.6 - 23.6** | 77 A a | 55 B ab | 5.91 A a | 3.60 B c |
| **23.7 - 25.8** | 61 A a | 65 A a | 5.53 A a | 5.40 A a |
| **25.9 - 28.0** | 71 A a | 62 A a | 5.61 A a | 5.02 A ab |
| **28.1 - 30.2** | 64 A a | 56 A ab | 5.37 A a | 4.48 B abc |
| **30.3 - 32.4** | 68 A a | 54 B ab | 5.40 A a | 4.07 B bc |
| **32.5 - 35.0** | 74 A a | 49 B ab | 5.63 A a | 3.59 B c |
| **$F_{int}$** | 5.298* | | 4.979* | |
| **$F_{temp}$** | 53.693* | | 96.162* | |
| **$F_{over}$** | 24.625** | | 35.793* | |
| **CV** | 16.67 | | 16.57 | |

*Test F significant at 5% of probability. Means followed by upper case letters in the rows or lowercase letters in the columns are not different according to Tukey's test, with 5% of significance.

**Source**: Elaborated by the authors (2019).

For seeds of *Merremia cissoides* without scarification, higher percentage of germination and higher IGS were reached simultaneously in the range between 25.9 and 35ºC. Temperatures below 25.9ºC reduced the seeds' germination speed (TABLE 3). On the other side, for seeds that received chemical treatment for overcoming dormancy, higher percentage of germination and higher IGS were reached between 23.7 and 32.4ºC. When seeds of *M. cissoides* were scarified, temperatures below 23.6ºC and above 32.5ºC reduced the IGS (TABLE 3).

Regarding to *I. nil*, the effect of temperature and dormancy overcoming were observed on seed germination, however without interaction of these factors (TABLE 4). This species had higher ability to germinate in temperatures above 17.1ºC. From 17.2ºC and up to 32.4ºC, no differences were observed on percentage of germination, for both seeds without chemical treatment and seeds scarified for overcoming dormancy. Similar results were found by Sobrero et al. (2003), who studied *I. nil* submitted to different temperatures. For these authors, this species have adequate germination in the range between 18 and 32ºC. For Morán Lemir (1997), maximum germination of *I. nil* was reached between 19 and 37ºC.

Treatment to overcome dormancy of *I. nil* increased both seed germination and IGS. It was also evident that higher percentage of germination and IGS were reached simultaneously in the range between 21.6 and 32.4ºC. Temperatures above 32.5ºC reduced both variables (TABLE 4).

**Table 3**. Germination (%) and index of germination speed (IGS) of *Merremia cissoides* under the influence of temperature.

| Temperature (°C) | Germination (%) |  | IGS |  |
|---|---|---|---|---|
|  | Dormancy Overcome |  | Dormancy Overcome |  |
|  | Yes | No | Yes | No |
| **15.5 - 17.1** | 21 A b | 2 B d | 0.44 A e | 0.04 A f |
| **17.2 - 19.3** | 56 A a | 21 B cd | 1.36 A de | 0.49 B df |
| **19.4 - 21.5** | 63 A a | 50 B a | 2.05 A cd | 1.57 A cde |
| **21.6 - 23.6** | 60 A a | 40 B abc | 3.55 A bc | 1.99 B bcd |
| **23.7 - 25.8** | 57 A a | 39 B bcd | 4.66 A ab | 1.31 B def |
| **25.9 - 28.0** | 63 A a | 42 B abc | 5.01 A ab | 3.01 B ab |
| **28.1 - 30.2** | 60 A a | 41 B abc | 4.94 A ab | 3.06 B ab |
| **30.3 - 32.4** | 60 A a | 39 B abc | 5.81 A a | 2.85 B abc |
| **32.5 - 35.0** | 55 A a | 44 A ab | 3.93 A b | 3.52 A a |
| $F_{int}$ | 2.127* |  | 6.740* |  |
| $F_{temp}$ | 22.904* |  | 7.556* |  |
| $F_{over}$ | 103.953* |  | 18.642* |  |
| **CV** | 19.91 |  | 21.79 |  |

*Test F significant at 5% of probability. Means followed by upper case letters in the rows or lowercase letters in the columns are not different according to Tukey's test, with 5% of significance.

**Source**: Elaborated by the authors (2019).

**Table 4**. Germination (%) and index of germination speed (IGS) of *Ipomoea nil* under the influence of temperature.

| Temperature (°C) | Germination (%) |  |  | IGS |  |
|---|---|---|---|---|---|
|  | Dormancy Overcome |  | Mean | Dormancy Overcome |  |
|  | Yes | No |  | Yes | No |
| **15.5 - 17.1** | 26 | 20 | 23.0 d | 0.69 A e | 0.53 A d |
| **17.2 - 19.3** | 58 | 36 | 47.0 ab | 2.04 A cde | 1.21 B cd |
| **19.4 - 21.5** | 49 | 41 | 45.0 ab | 1.72 A de | 1.60 A bc |
| **21.6 - 23.6** | 59 | 47 | 53.0 ab | 3.73 A ab | 2.54 B ab |
| **23.7 - 25.8** | 61 | 44 | 52.5 ab | 3.81 A ab | 2.84 B a |
| **25.9 - 28.0** | 68 | 42 | 55.0 a | 4.62 A a | 2.69 B a |
| **28.1 - 30.2** | 59 | 43 | 51.0 ab | 4.82 A a | 2.97 B a |
| **30.3 - 32.4** | 50 | 43 | 46.5 ab | 3.30 A abc | 2.95 A a |
| **32.5 - 35.0** | 41 | 24 | 32.5 cd | 2.36 A bcd | 1.23 B cd |
| **Mean** | 51 A | 37 B |  | --- | --- |
| $F_{int}$ | $1.568^{NS}$ |  |  | 2.932* |  |
| $F_{temp}$ | 53.426* |  |  | 33.895* |  |
| $F_{over}$ | 13.412* |  |  | 53.103* |  |
| **CV** | 18.48 |  |  | 21.71 |  |

$^{NS}$F-test not significant; *Test F significant at 5% of probability. Means followed by upper case letters in the rows or lowercase letters in the columns are not different according to Tukey's test, with 5% of significance.

**Source**: Elaborated by the authors (2019).

Evaluating the experiment with *I. quamoclit*, the highest values of germination and IGS were reached for temperatures between 25.9 and 32.4ºC considering seeds without scarification, and between 23.7 and 35.0ºC for seeds scarified for dormancy overcoming. Even in this case, chemical scarification of *I. quamoclit* seeds was responsible for increasing germination and IGS, as well as increasing the amplitude of optimal temperature for germination (TABLE 5).

*I. quamoclit* have higher ability to germinate at temperatures above 19.3ºC, which are in agreement to Horak and Wax (1991). These authors, studying *I. pendurata*, recorded germination values above 90% in temperatures from 20ºC, that were hardly reduced at lower temperatures. Crowley and Buchanan (1980) observed that *I. hederacea* germinates at 16ºC, however it requires temperatures of at least 20ºC for maximum germination. For *I. quamoclit*, temperatures below 17.2ºC inhibited germinative process, suggesting this temperature is the minimum to occurrence of germination of this species (CARVALHO; NAKAGAWA, 2000). Maximum temperature for seed germination was not identified (TABLE 5).

**Table 5**. Germination (%) and index of germination speed (IGS) of *Ipomoea quamoclit* under the influence of temperature.

| Temperature (ºC) | Germination (%) | | IVG | |
|---|---|---|---|---|
| | Dormancy Overcome | | Dormancy Overcome | |
| | Yes | No | Yes | No |
| **15.5 - 17.1** | 0 A b | 0 A b | 0.00 A d | 0.00 A e |
| **17.2 - 19.3** | 1 A b | 3 A b | 0.04 A d | 0.09 A de |
| **19.4 - 21.5** | 68 A a | 27 B a | 3.15 A c | 1.09 B cde |
| **21.6 - 23.6** | 73 A a | 28 B a | 3.77 A bc | 1.20 B cd |
| **23.7 - 25.8** | 74 A a | 30 B a | 5.29 A ab | 1.75 B bc |
| **25.9 - 28.0** | 78 A a | 36 B a | 5.75 A a | 2.42 B ab |
| **28.1 - 30.2** | 74 A a | 29 B a | 6.17 A a | 2.17 B abc |
| **30.3 - 32.4** | 74 A a | 46 B a | 5.59 A ab | 3.24 B a |
| **32.5 - 35.0** | 77 A a | 29 B a | 6.24 A a | 1.91 B bc |
| $F_{int}$ | 10.218* | | 11.239* | |
| $F_{temp}$ | 230.934* | | 53.455* | |
| $F_{over}$ | 52.311* | | 240.328* | |
| **CV** | 21.84 | | 24.24 | |

*Test F significant at 5% of probability. Means followed by upper case letters in the rows or lowercase letters in the columns are not different according to Tukey's test, with 5% of significance.

**Source**: Elaborated by the authors (2019).

These results contribute for understanding the germination of Convulaceae species in the soil, as well as in field condition. Working with the same weed species, Labonia et al. (2009) observed lower emergence of seedlings due to greater depth of the seeds in the soil, with or without straw covering. In this case, germination of all the species was reduced due to greater seeding depth, mainly when seeds were positioned 40 mm under the soil. The layer of straw and the positioning of the seed in the soil profile interfere on the radiation that seeds may receive and, also, on temperature at which seeds will be exposed. Environments with lower radiation and lower thermal amplitude are less favorable to seed germination (CHRISTOFFOLETI et al., 2007).

## Conclusions

Morning glory species have differential response to temperature effects, being able to germinate at a wide range of temperature. In general, significant reduction on germination was observed at temperatures lower than 17.2ºC, which inhibited germination of *I. quamoclit.* At temperatures between 20 and 35ºC, all the species demonstrated adequate capacity of germination, being potentiated when seeds were submitted to chemical scarification with sulfuric acid. The fastest germination occurred at temperatures between 25.9 and 30.2ºC, however it was not possible to estimate the maximum temperature that inhibits seed germination.

## Germinação de cinco espécies de plantas daninhas da família Convolvulaceae sob influência da temperatura

### Resumo

Sementes das diversas espécies vegetais possuem desempenho variável quanto à germinação em diferentes condições de temperatura, causando alterações nos sistemas de manejo. Assim sendo, este trabalho foi realizado com o objetivo de avaliar a influência da temperatura na germinação de cinco espécies de plantas daninhas da família Convolvulaceae, comumente conhecidas como cordas-de-viola. O trabalho foi desenvolvido em mesa termogradiente e constou de cinco experimentos, separados por espécie, em esquema fatorial entre nove tratamentos (temperaturas) e duas condições de superação de dormência (presente ou ausente). As espécies de plantas daninhas foram: *Ipomoea triloba, I. hederifolia, I. quamoclit, I. nil e Merremia cissoides*. Avaliaram-se nove intervalos de temperatura entre 15 e 35°C, sob oito horas de fotoperíodo diário. Adotou-se o delineamento inteiramente casualizado, com quatro repetições. Diariamente, foi avaliada a porcentagem de germinação das sementes, com a qual foi gerado o Índice de Velocidade de Germinação (IVG). De modo geral, temperaturas abaixo de 17,2ºC reduziram significativamente a germinação das sementes de todas as espécies, chegando a inibir por completo o processo germinativo de *I. quamoclit*. As espécies possuem adequada capacidade de germinação em temperaturas superiores a 20ºC e inferiores a 35ºC. A escarificação química com ácido sulfúrico aumentou a porcentagem de sementes germinadas.
**Palavras-chave:** Corda-de-viola. Biologia. Desenvolvimento. Sementes.

## References

AZANIA, A. A. P. M.; AZANIA, C. A. M.; PAVANI, M. C. M. D.; CUNHA, M. C. S. Métodos de superação de dormência em sementes de *Ipomoea* e *Merremia*. **Planta Daninha,** v. 21, n. 2, p. 203-209, 2003. Disponível em: http://dx.doi.org/10.1590/S0100-83582003000200005. Acesso em: 03 jul. 2018.

CARVALHO, N. M.; NAKAGAWA, J. **Sementes:** ciência, tecnologia e produção. 4. ed. Jaboticabal: FUNEP, 2000. 588p.

CARVALHO, S. J. P.; CHRISTOFFOLETI, P. J. Influência da luz e da temperatura na germinação de cinco espécies de plantas daninhas do gênero *Amaranthus*. **Bragantia**, v. 66, n. 4, p. 527-533, 2007. Disponível em: http://dx.doi.org/10.1590/S0006-87052007000400001. Acesso em: 03 jul 2018.

CARVALHO, S. J. P.; LOPEZ-OVEJERO, R. F.; MOYSÉS, T. C.; CHAMMA, H. M. C. P.; CHRISTOFFOLETI, P. J. Identificação de biótipos de *Bidens spp*. resistentes aos inibidores da ALS através de teste germinativo. **Planta Daninha**, v. 22, n. 3, p. 411-417, 2004. Disponível em: http://dx.doi.org/10.1590/S0100-83582004000300011. Acesso em: 03 jul. 2018.

CASTRO, P. R. C.; VIEIRA, E. L. **Aplicações de reguladores vegetais na agricultura tropical**. Guaíba: Agropecuária, 2001. 132 p.

CHRISTOFFOLETI, P. J.; CARVALHO, S. J. P.; LÓPEZ-OVEJERO, R. F.; NICOLAI, M.; HIDALGO, E.; SILVA, J. E. Conservation of natural resources in Brazilian agriculture: implications on weed biology and management. **Crop Protection**, v. 26, n. 3, p. 383-389, 2007. Disponível em: https://doi.org/10.1016/j.cropro.2005.06.013. Acesso em: 03 jul. 2018.

COLE, W. S.; COATS, C. E. Tall morningglory germination response to herbicides and temperature. **Weed Science,** v. 21, n. 5, p. 443-446, 1973.

CROWLEY, R. H.; BUCHANAN, G. A. Response of *Ipomoea* spp. and smallflower Morningglory (*Jacquemontia tamnifolia*) to temperature and osmotic stresses. **Weed Science,** v. 28, n. 1, p. 76-82, 1980.

DIAS, A. C. R.; CARVALHO, S. J. P.; BRANCALION, P. H. S.; NOVEMBRE, A. D. L. C.; CHRISTOFFOLETI, P. J. Germinação de sementes aéreas pequenas de trapoeraba (*Commelina benghalensis*). **Planta Daninha**, v. 27, n. especial, p. 931-939, 2009. Disponível em: http://dx.doi.org/10.1590/S0100-83582009000500006. Acesso em: 03 jul. 2018.

HORAK, M. J.; WAX, L. M. Germination and seedling development of bigroot Morningglory (*Ipomoea pandurata*). **Weed Science**, v. 39, n. 3, p. 390-396, 1991.

LABONIA, V. D. S.; CARVALHO, S. J. P.; MONDO, V. H. V.; CHIONATO, M. G.; VICTORIA FILHO, R. Emergência de plantas da família Convolvulaceae influenciada pela profundidade da semente no solo e cobertura com palha de cana-de-açúcar. **Planta Daninha**, v. 27, n. especial, p. 921-929, 2009. Disponível em: http://dx.doi.org/10.1590/S0100-83582009000500005. Acesso em: 03 jul. 2018.

MAGUIRE, J. D. Speed of germination – aid in selection and evaluation for seedling emergence and vigor. **Crop Science**, v. 2, n. 2, p. 176-177, 1962. Disponível em: https://eurekamag.com/pdf/014/014195562.pdf. Acesso em: 03 jul. 2018.

MONDO, V. H. V.; CARVALHO, S. J. P.; DIAS, A. C. R.; MARCOS FILHO, J. Efeitos da luz e temperatura na germinação de sementes de quatro espécies de plantas daninhas do gênero *Digitaria*. **Revista Brasileira de Sementes**, v. 32, n. 1, p. 131-137, 2010. Disponível em: http://dx.doi.org/10.1590/S0101-31222010000100015. Acesso em: 03 jul. 2018.

MORÁN LEMIR, A. H. Especies de *Ipomoea* (*Convolvulacea*e) mas frecuentes en cultivos de soja de la provincia de Tucumán. **Malezas,** v. 17, n. 1, p. 71-77, 1989.

OLIVEIRA, L. M.; CARVALHO, M. L. M.; SILVA, T. T. A.; BORGES, D. I. Temperatura e regime de luz na germinação de sementes de *Tabebuia impetiginosa* (Martius ex A. P. de Candolle) Standley e *T. serratifolia* Vahl Nich – Bignoniaceae. **Ciência e Agrotecnologia,** v. 29, n. 3, p. 642-648, 2005.

ORZARI, I.; MONQUERO, P. A.; REIS, F. C.; SABBAG, R. S.; HIRATA, A. C. S. Germinação de espécies da família Convolvulaceae sob diferentes condições de luz, temperatura e profundidade de semeadura. **Planta Daninha**, v. 31, n. 1, p. 53-61, 2013. Disponível em: http://dx.doi.org/10.1590/S0100-83582013000100006. Acesso em: 03 jul. 2018.

PAZUCH, D.; TREZZI, M. M.; DIESEL, F.; BARANCELLI, M. V. J.; BATISTEL, S. C.; PASINI, R. Superação de dormência em sementes de três espécies de *Ipomoea*. **Ciência Rural**, v. 45, n. 2, p. 192-199, 2015. Disponível em: http://dx.doi.org/10.1590/0103-8478cr20120665. Acesso em: 03 jul. 2018.

POPINIGIS, F. **Fisiologia da semente.** 2. ed. Brasília: AGIPLAN, 1985. 289p.

SILVA, C. B.; OLIVEIRA, M.; DIAS, J. F.; ZANIN, S. M. W.; SANTOS, G. O.; CÂNDIDO, A. C. S.; PERE, M. T. L. P.; SIMIONATTO, E.; MIGUEL, O. G.; MIGUEL, M. D. Atividade alelopática dos lixiviados de *Asemeia extraaxillaris* (Polygalaceae) sobre o crescimento de *Ipomoea cordifolia*. **Revista Brasileira de Plantas Medicinais**, v. 18, n. 1, supl. 1., p. 215-222, 2016. Disponível em: http://dx.doi.org/10.1590/1983-084X/14_093. Acesso em: 03 jul. 2018.

SOBRERO, M. T.; FIORETTI, M. N.; CHAILA, S.; AVILA, O. B.; OCHOA, M. C. Factores que influyen sobre la germinación de *Ipomoea nil* (L.) Roth. **Agrosur**, v. 31, n. 2, p. 60-68, 2003. Disponível em: http://mingaonline.uach.cl/scielo.php?pid=S0304-88022003000200006&script=sci_arttext. Acesso em: 03 jul. 2018.

STECKEL, L. E.; SPRAGUE, C. L.; STOLLER, E. W.; WAX, L. M. Temperature effects on germination of nine *Amaranthus* species. **Weed Science,** v. 52, n. 2, p. 217-221, 2004. Disponível em: https://www.jstor.org/stable/4046908. Acesso em: 03 jul. 2018.

STOCKMAN, A. L.; BRANCALION, P. H. S.; NOVEMBRE, A. D. L. C.; CHAMMA, H. M. C. P. Sementes de ipê-branco (*Tabebuia roseo-alba* (Ridl.) Sand. – BIGNONIACEAE): temperatura e substrato para o teste de germinação. **Revista Brasileira de Sementes,** v. 29, n. 3, p. 139-143, 2007.

**Received**: July 3, 2018
**Accepted**: September 4, 2018