

SUBSTANTIVE EDITING / REWRITING

INTRODUCTION

Subfamily Lamiinae (Coleoptera: Cerambycidae) includes some beetles of economic and ecological importance called "Twig girdlers" (*Oncideres cingulata*) that girdle the branches and trunks of living trees (Linsley, 1959; Calderón-Cortés et al., 2011). These insects earned their name as the female beetles girdle branches for egg-laying. They insert the eggs between the bark and wood, in incisions made with their mandibles (Rice, 1989; Rice, 1995; Lemes et al., 2011).

Among the twig girdlers, the genus *Oncideres* includes the largest variety of species (Monné, 2002), and excluding the American continent, they range from Argentina to the southern United States (Hovore & Penrose, 1982; Rice, 1989; Di Iorio, 1996). In Brazil, this species is widely distributed, having been recorded in all the regions (Peres Filho et al., 1992; Witeck Neto & Link 1997, Coutinho et al., 1998, Martins & Galileo, 2009, Cordeiro et al., 2010, Lemes et al., 2010).

Oncideres ocularis Thomson, 1868, are considered a potential threat to forest plantations, as they damage several tree species of the family Fabaceae, e.g., the black wattle (*Acacia mearnsii* De Wild.). In southern Brazil, *Acacia bonariensis* Hook. & Arn. and *Pithecolobium* sp. Mart. (Volcano & Pereira, 1978; Marinoni, 1979). This girdler is found from Argentina to the South and Southeast of Brazil (Volcano & Pereira, 1978).

Thus far only a few studies have been conducted on the twig girdler, mostly on those found on the host plants in Brazil (Baucke, 1957; Baucke & Bertels, 1966; Marinoni, 1979). Volcano and Pereira (1978) briefly described the characteristics of the biological stages of this insect as adults, as well as their distribution and the host plants they inhabit. The authors also showed the close similarity of this species to *O. impluviata* (Germar, 1824; and Martins, 1981). In both these studies, the authors

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highlighted the difference between the two species as seen in the white pubescence on the sides of the metasternum, which in the case of *O. ocularis*, extends to the sides of the mesosternum. As they are often found occupying the same regions and *O. ocularis* is more difficult to find (Baucke, 1957) these two twig girdlers are sometimes mistaken for each other. Dillon & Dillon (1946) also described the adult males and females of *O. ocularis*, although the other phases were not characterized. Hence, there is a gap in knowledge regarding the biological stages of this insect.

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The objective of this study is to increase the scientific knowledge on the biological characterization of the phases and the ecological girdling and oviposition patterns of *O. ocularis*.

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MATERIALS AND METHODS

Field studies were conducted between November 2009 and March 2011, in four areas. The first study was done in a commercial plantation of *Acacia mangium* Willd. in Coimbra, Minas Gerais (20° 51'24" S and 42° 48'10" W, altitude 720 m, mean annual temperature 19°C and mean annual rainfall between 1300 and 1400 mm) with 3000 trees, 65 months of age, contour planted on a slope and spaced 3 × 2 m apart. Two other planting zones were nearby, with approximately 300 trees of *A. Mangium*, around 30 months of age. The fourth planting site included a consortium of hybrid clones of *Eucalyptus urophylla* S.T. Blake x *E. grandis* W. Hill ex Maiden and 60 trees of *A. mangium* and *Brachiaria* spp. located at Viçosa, Minas Gerais (20° 45' S, 46° 51' W, altitude 689 m, mean annual temperature of 19°C and mean annual rainfall of 1221 mm).

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Between November 2009 and March 2010, and November 2010 and March 2011, the areas were visited weekly to assess the damage and injuries caused by *O. ocularis*, by collecting the freshly fallen or hanging branches due to the girdling effect of the beetle.

The study was conducted in the laboratory of the Universidade Federal de Viçosa, Minas Gerais, Brazil.

The particular species of the twig girdler was determined by taxonomist, Prof. Ubirajara Martins, Museum of Zoology, Universidade de São Paulo (MZUSP), São Paulo, Brazil, where the adult specimens were deposited.

Eggs of the beetle *A. mangium*, were removed from the newly girdled branches to determine the color, shape, dimensions and incubation period. Measurements were obtained using a magnifying glass with an ocular micrometer. These eggs were kept in petri dishes (10 cm diameter and 2 cm height) with distilled water-moistened filter

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Myrmecological News

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2 **Does Diatomaceous earth (silica dioxide) control leaf-cutting ants? *Atta sexdens***
3 ***rubropilosa* (Hymenoptera: Formicidae) in the eucalyptus plantations in Bahia**
4 **State, Brazil**

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6 **Pedro:04/11/13**

7
8 **Abstract**

9 Genus *Atta* includes some of the most important Formicid leaf-cutting ants in forestry,
10 which cause extensive damage to the eucalyptus plantations. *Atta sexdens rubropilosa*
11 (Forel, 1908) (Hymenoptera: Formicidae), one of the chief pests in Brazilian
12 reforestation, can restrict forest productivity by their intensity and constant leaf cutting
13 of the plant leaves at all stages. Therefore, the demand for new products to control the
14 *A. sexdens rubropilosa* populations justifies the study of the utilization of the dry
15 powder formulation of diatomaceous earth (silica dioxide) in the eucalyptus cultivars.
16 The study was conducted using 120 colonies of *A. sexdens rubropilosa* in a four-year-
17 old *Eucalyptus grandis* Hill ex-Maiden x *Eucalyptus urophylla* Blake (Myrtaceae)
18 (*urograndis*) stand, with plants spaced 2.5x3.0 m apart, covering an area of
19 approximately 40 hectares in Caraívas, Bahia State, Brazil. Once these colonies were
20 numbered, their geographical coordinates collected and their areas measured with tape
21 based on their longer length and width, the area of loose soil was calculated and they
22 were divided into classes based on area size. The randomized block experimental design
23 was used with six treatments, including 1, 10, 25 and 50g/m² of diatomaceous earth and
24 6.0g/m² bait with sulfluramid per square meter of loose soil. Five replications were

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Deleted: Leaf-cutting ants of the genus *Atta* are among the most important Formicidae for forestry due to damage on eucalyptus plantations. *Atta sexdens rubropilosa* (Forel, 1908) (Hymenoptera:Formicidae), a major pest in Brazilian reforestations, can limit forest productivity by intense and constant cutting of leaves on plants at all stages. The need for new products to control *A. sexdens rubropilosa* justifies the study of diatomaceous earth (silica dioxide) in dry powder formulation against this pest in cultivated eucalyptus. The study was conducted with 120 colonies of *A. sexdens rubropilosa* in *Eucalyptus grandis* Hill ex-Maiden x *Eucalyptus urophylla* Blake (Myrtaceae) (*urograndis*) stand with four years old, spaced 2.5x3.0meters and with an area of approximately 40 hectares in Caraívas, Bahia State, Brazil. These colonies were numbered, its geographical coordinates collected and their areas obtained with tape based in their longer length and width to calculate the area of loose soil and separated by area size classes. The experimental design was randomized blocks with six treatments (1,10,25 and 50g/m² of diatomaceous earth and 6.0g/m² bait with sulfluramid per square meter of loose soil) with five replications, each with four colonies of this ant. The silicon dioxide was applied as powder in active ant holes of *A.sexdens rubropilosa* and the bait sulfluramid applied in bulk in a localized way. The evaluations were performed at 1,7,15,30,60,90 and 120 days after the application of the products. The control efficiency was corrected by the Abbott formula, the results submitted to analysis of variance and the means were compared with the Tukey test at 5% probability. The control efficiency of *A. sexdens rubropilosa* with silicon dioxide at the concentrations of 1,10,25 and 50g/m² of loose soil ranged from 5.26 to 31.57% from seven to 120 days after the application of the product without difference with the control. The efficiency of the bait with sulfluramid was higher than those of the other treatments. The efficiency of silica dioxide to *A.sexdens rubropilosa* was low and with similar values to the control.

70 done with each of the four colonies of this ant. Powdered silicon dioxide was applied to
 71 the active *A. sexdens rubropilosa* ant holes and sulfluramid was applied in bulk as bait
 72 in a localized manner. Evaluations were conducted at 1, 7, 15, 30, 60, 90 and 120 days
 73 after the products were applied. Using the Abbott formula, the control efficiency was
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 79 higher efficiency than those employing other treatments. The efficiency of silica dioxide
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81 **Keywords:** biological control, *Eucalyptus*, forest pests, monitoring, sulfluramid.

83 Introduction

84 These ants are eusocial insects possessing an advanced agricultural development. Apart
 85 from man, these organisms are the only group to exhibit an advanced understanding of
 86 agriculture, acting as farmers, based on their mutual symbiosis with a fungus, which
 87 began from more than 50 million years before man's existence (1) Species of the genera
 88 *Atta* and *Acromyrmex* Mayr Fabricius (Hymenoptera: Attini: Myrmicinae) are the best
 89 known Formicid ants of the New World, chiefly because of the damages they cause to
 90 agriculture and forestry by plant defoliation (2).

91 These ants have caused an estimated damage to forest plantations such as
 92 eucalyptus, showing an increase from 3.4 million hectares in area in 2005 (3) to
 93 4,873,851 in 2011 (4). Costs incurred for pest control in eucalyptus cultivation include

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Deleted: The damage by ants have been estimated in forest plantations as eucalyptus which area increased from 3.4 million hectares in 2005 (3) to 4,873,851 in 2011 (4). Costs of pest control in eucalyptus in the cultivation include 30% for the control of ants up to the third cycle (5). The total tree defoliation reduced growth of *Eucalyptus grandis* Hillex.Maiden (Myrtaceae) in 11mm in diameter and 0.7m in height, with 13% loss in timber volume at the end of seven years (6). Damage by ants reached about US\$8.26 per eucalyptus tree (7). Total and subsequent defoliations of eucalyptus seedlings showed higher losses in diameter and plant height (8). The integrated management of ants in planted forests in Brazil aims to reduce the cost of controlling these pests with the application of insecticides. This is a requirement of the forest certification and monitoring of these forest pests allows analyzing the interactions between populations of ants and forest productivity (9).

125 30% for controlling them up to the third cycle (5). The total tree defoliation reduced the
 126 *Eucalyptus grandis* Hill ex-Maiden (Myrtaceae) growth to 11mm in diameter and 0.7m
 127 in height, with 13% loss in timber volume by the end of seven years (6). Cost of damage
 128 by the ants went up to about US\$8.26 per eucalyptus tree (7). The total and subsequent
 129 defoliations of the eucalyptus seedlings revealed even higher losses in diameter and
 130 plant height (8). The integrated management of the ants in the planted forests in Brazil
 131 attempts to reduce the cost of pest control by applying insecticides. This is a mandatory
 132 requirement for the forest certification and monitoring of these forest pests which
 133 enables an analysis of the interactions between the ant populations and forest
 134 productivity (9).

135 The ant nests in the cultivated forests show casual spatial distribution
 136 irrespective of nest size, sampling method or region (10), as the queens of these insects
 137 randomly drop into the areas and their nests receive periodic control, which support the
 138 maintenance of random distribution over time (11). The ant colonies in the cultivated
 139 forests are monitored using sampling plans of their numbers utilizing a variety of
 140 methods including worse focus (12), fixed plot size (13), transects (14), quadrants
 141 (14.1), sequential (15) and geostatistics (16).

142 The ant control methods include mechanical, cultural, physical, biological,
 143 behavioral control, as well as resistance of plants in light of the studies on the effect of
 144 climatic factors, predators and parasitoids, pheromones, fungi and the use of chemical
 145 pesticides (17). In the forest sector, the chemicals, mainly used in the baits, have been
 146 found to be the best ant control option (18).

147 However, the ants continue to challenge all the efforts employed to reduce the
 148 extent of the damage they cause, even with the use of more efficient, specific and

Deleted: The spatial distribution of ant nests in cultivated forests is casual, regardless of their nest size, the sampling method and the region (10), because the queens of these insects fall randomly in the areas and their nests receive periodic control, which tends to maintain this random distribution over time (11). The monitoring of ant colonies in cultivated forests is done with sampling plans of their numbers with different methods such as the worse focus (12), plots of fixed size (13), transects (14), quadrants (14.1), sequential (15) and geostatistic (16).

Deleted: The methods of controlling ants include mechanical, cultural, physical, biological, behavioral and resistance of plants with studies on the effect of climatic factors, predators and parasitoids, pheromones, fungi and the use of chemical pesticides (17). Chemicals, mainly incorporated into baits are the best option to control ants in the forest sector (18).

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175 sophisticated equipment. Therefore, the Forest Stewardship Council (FSC) is
176 constrained to identify alternative viable methods of ant control (19).

177 This study aims at assessing the use of diatomaceous earth (silica dioxide) in dry
178 powder formulation in the control of the leaf-cutting ant, *A. sexdens rubropilosa* in the
179 eucalyptus cultivation.

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Abstract

Despite having a laminate structure or one composed of sandwich composite materials, the mechanical behavior can be estimated by methods or analytical relations like the classical laminate theory, based on factors including mechanical properties, fiber percentage, and product methods and etc. Generally, however, these estimates are far removed from the actual experimental results. This research investigates the influence of the product methods and different cores on the buckling and post buckling behaviors of sandwich panels. Each panel was built to suit different product methods, using the hand lay-up or vacuum bag infusion procedure with different cores. To build the panels, a deliberate and informed choice of materials has to be made which can be used in the marine industry, especially for high-speed boats. Sandwich panels are $150 \times 450 \text{ mm}^2$ in dimension, with one simple support and one clamped support. After the tests, the results of the numerical models, which are derived from finite element software, are compared with those of the experimental data. The results represent a combined model which is suitable for simulated buckling and post buckling behavior. After selection of the software model, different parameters were evaluated regarding the link element which has the most efficiency on the numerical results.

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Key Words:

Composite Sandwich Panel, Buckling, Post-Buckling, Vacuum Infusion Procedure

1. Introduction

The marine industry is developing very rapidly, similar to other industries. To cope with the increasing marine transport and ultimate vessel speed etc., engineers need to use optimum product methods and lighter weight materials. Due to the increase in size, speed and reduction in the ship's body, engineers are considering different materials like composites to fulfil the requirements, as mentioned. These materials are largely used in vessels (as well as in other marine structures) as laminate or sandwich panel structures.

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On the other hand, any other loads for example, the buoyancy force, waves and dead weight loads which act upon a vessel's body must be considered; therefore, the structure of the vessel must meet local and global standards. One of these category loads that occurs in a body is the in-plane load. Created by several factors, these loads cause global body deformations, among which hogging and sagging are the major ones. With the appearance of hogging, sagging and in-plane loads, investigation of the buckling and post buckling behavior of the sandwich panels used in the construction of the vessels becomes essential. Despite the laminate structure or one composed of sandwich composite materials, the mechanical behavior can be assessed by specific methods or analytical relations like the classical laminate theory, depending upon the factors such as mechanical properties, fiber percentage, and product methods etc.; however, generally these estimates are far removed from the actual experimental results.

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On the other hand, most classification societies prefer to use experimental equations instead of the classical laminate theory. In this regard, most often classification societies would evaluate the accuracy of their experimental equations or improve the accuracy level of demand by conducting some tests on specimens of the composite structures that are used in the body of the vessel. It is important to note that because the mechanical property and behaviors of the elements are not complicated, the identity of the mechanical behavior mentioned earlier, is one of the deficiencies of the research. Hence, studies that have included this aspect in this field, can debate from three viewpoints: analytical studies, experimental studies and numerical studies.

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Beneficial effects of ascorbic acid and alpha-tocopherol on the locomotor functional recovery of spinal cord injured rats

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ABSTRACT

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Spinal cord injury (SCI) is recognized as one of the main clinical causes of disability in young adults. To date no suitable natural remedy has been identified for SCI management. Therefore, finding new therapeutic agents to enhance neuroprotection post SCI has become a pressing need. The objective of this study was to examine the effects of ascorbic acid and alpha-tocopherol on the locomotor functional recovery of rats with incomplete spinal cord injury. In this study, a total of 80 male Sprague-Dawley rats (180–200 g) were used. Seventy of them were subjected to SCI and given various doses of ascorbic acid and alpha-tocopherol as treatment for 84 days (12 weeks). The remaining 10 rats were used as a control (without SCI, untreated). Spontaneous coordinate activity (SCA), Basso, Beattie, and Bresnahan (BBB) and Tarlov scores were used to assess the locomotor recovery. When compared with the baseline value, all the rat groups tested (i.e. 3, 4, 5, 6, 7 and 8) showed gradual improvements in the SCA, BBB and Tarlov scores at the end of the first week. These improvements were sustained at all time points until the completion of the trial period (week 12). Besides, when compared with disease control, positive improvements were observed in all the groups tested with respect to their SCA, BBB and Tarlov scores throughout the trial period. When the low-dose ascorbic acid and alpha-tocopherol groups were compared with the high-dose ascorbic acid and alpha-tocopherol groups, positive differences were observed in the BBB and Tarlov scores. When compared with the ascorbic acid treatment group significant additional improvements were observed in the alpha-tocopherol groups, especially in the high-dose alpha-tocopherol group. It was, therefore, concluded that the administration of high-dose alpha-tocopherol enhances the SCI-induced locomotor functional recovery as it is more effective than the ascorbic acid.

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Deleted: INTRODUCTION

INTRODUCTION

Spinal cord injury (SCI) is a devastating disease resulting in permanent disability causing extreme anguish to the patients [1]. The ensuing neurological dysfunction and paralysis are proportional to the severity of the trauma itself and is a primary problem in medicine, as it causes a high degree of mortality, severe disability, is expensive to cure, involving extensive rehabilitation and high costs [1]. Thus far, the management of SCI continues to pose a challenge and no definite treatment has been identified to tackle it. However, several studies including experimental modeling are being conducted to enable a better understanding of the anatomical and biological consequences of injury and repair, including testing the effectiveness and the risk-to-benefit ratio of the proposed therapy to help resolve this fundamental problem [2, 3].

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Among the leading mechanisms associated with cell death post SCI, excitotoxicity, oxidative stress, inflammatory response and apoptosis are recognized as the potential targets to prevent

¶ Among the leading mechanisms associated to cell death after SCI, excitotoxicity, oxidative stress, inflammatory response and apoptosis are considered potential targets to prevent tissue damage [4]. The critical role of the spinal cord in a broad range of physiological functions is clearly demonstrated by the deficits observed after SCI and by the med... [1]

tissue damage [4]. The crucial role played by the spinal cord in a broad range of physiological functions is clearly evidenced by the deficits observed post SCI and by the medical conditions that arise during the acute and chronic phases post injury [5-7].

To date, the locomotor deficits have been extensively studied, and several techniques have been designed and developed to encourage and accelerate the recovery of locomotor function [8]. This focus on locomotor function has been based on several concerns: its clinical relevance and recurring nature, as well as the fact that it is easily and clearly observed and measured. Several studies have also reported that functional outcomes, which, although they vary greatly, depend upon the size and site of the injury, type and timing of intervention, as well as kind of recovery and plasticity evaluated [9].

Over the recent past, several animal models of SCI have been developed, which have considerably enhanced our understanding of the pathophysiology of this condition [10]. A gamut of approaches to protect the injured spinal cord from secondary pathological processes have been examined experimentally, including the use of antioxidants, membrane stabilizers, glutamate antagonists, anti-inflammatories, caspase inhibitors, calpain inhibitors and other compounds of unclear actions [11-14]. Also, commendable research on the role of free radicals in the occurrence of ischemic damage has been done [15, 16]. In this study, ascorbic acid and alpha-tocopherol, recognized as free radical scavengers, were used to investigate their efficiency in the locomotor recovery of rats subjected to incomplete spinal cord injury.

Results

Body weight

The group 2 rats (disease control group, SCI + saline) showed a gradual decline in body weight from day 2 until day 7 when compared with the baseline value. However, a gradual increase in the body weight as observed from day 8 (second week onwards) which was maintained until the study was completed (Table 2). Similar results were observed in all the groups tested (i.e. 3, 4, 5 and 7), in which the improvements were noted to begin on day 6 for groups 6 and 8. Compared with the low-dose ascorbic acid (group 3) and alpha-tocopherol rat groups (group 5), positive enhancements in body weight were observed in the rats treated with high-dose ascorbic acid (group 4) and alpha-tocopherol (group 6). Further, when compared with the rats given ascorbic acid treatment notable improvements were observed in the body weight in rat groups on alpha-tocopherol, especially in those on high-dose alpha-tocopherol.

BBB score

At the end of the first week, groups 3, 4, 5, 6, 7 and 8 showed gradual improvement in the BBB scores, when compared with the baseline value, which were maintained at all time points until the completion of the trial period (week 12). Compared with the disease control, positive improvements in BBB were observed in all the groups tested. Compared with the rats on low-

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Locomotor deficits have been extensively studied, and numerous techniques designed to promote and accelerate recovery of locomotor function have been developed [8]. This emphasis on locomotor function is based on several considerations: its clinical relevance, its repetitive nature, and the fact that it can be readily observed and measured. Also many studies reported that functional outcomes, however, vary greatly, depending upon size and location of injury, type and timing of intervention, and type of recovery and plasticity evaluated [9]. ¶

¶ In the recent years, several animal models of SCI have been developed, which have considerably advanced our understandings of pathophysiology of this condition [10]. A variety of other approaches to protect the injured spinal cord from secondary pathological processes have been examined experimentally, including antioxidants, membrane stabilizers, glutamate antagonists, anti-inflammatories, caspase inhibitors, calpain inhibitors and other compounds of uncertain mechanism [11-14]. Also, considerable research efforts have been focused on the role of free radicals in the occurrence of ischemic damage [15, 16]. In this study, ascorbic acid and alpha-tocopherol known as free radical scavengers were used to investigate their efficacy in the locomotor recovery of incomplete spinal cord injured rats.

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BBB¶

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At first week end when compared to baseline value, group 3,4,5,6,7 and 8 showed a gradual improvement in BBB scores, and such improvements were maintained at all-time points until the end of the trial period (week 12). Compared to disease control positive improvements in BBB were observed in all test groups. Compared to low doses of ascorbic acid (group 3) and alpha-tocopheral groups (group 5), positive BBB improvements were observed in high doses of ascorbic acid (group 4) and alpha-tocopheral groups (group 6). In addition, whe... [2]

dose ascorbic acid (group 3) and alpha-tocopherol group (group 5), positive BBB improvements were observed in the rats on high-dose ascorbic acid (group 4) and alpha-tocopherol (group 6). Besides, when compared with rats given ascorbic acid treatment, significant additional improvements were observed in the rat groups given alpha-tocopherol, mainly group 6 (i.e. alpha-tocopherol 1000 mg/kg body weight). Compared with the initial weeks, the recovery rates of all the groups tested were lower during last four weeks (i.e. weeks 9-12).

Tarlov score

Compared with the baseline value, groups 3, 4, 5, 6, 7 and 8 demonstrated gradual improvement in the Tarlov scores at the end of the first week, which were maintained at all time points until the trial period was completed (week 12). Compared with the disease control positive improvements in the Tarlov scores were observed in all the groups tested. Compared with the rats on low-dose ascorbic acid and the alpha-tocopherol groups (groups 3 and 5), positive differences were recorded in the Tarlov scores in the rats on high-dose ascorbic acid (group 4) and alpha-tocopherol (group 6). However, when compared with those given ascorbic acid treatment significant additional improvements were observed in the alpha-tocopherol groups, especially group 6 (i.e. alpha-tocopherol 1000 mg/kg body weight). Compared with the initial weeks, the recovery rates of all the rat groups tested were less over the last four weeks (i.e. weeks 9-12).

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DISCUSSION¶

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Animal models play a critical role in the development of experimental therapies for SCI. Rat model, as the most consistently studied and standardized model, has received much attention by scientists for the assessment of locomotive performance and to determine the functional consequences of the initial injury, spontaneous function recovery and the efficacy of therapeutic strategies [20-23]. Currently, a number of assessment methods, such as BBB locomotor rating scale, modified tarlov scoring system, grid-walk test, narrow beam test and inclined plane test, have been developed to evaluate the movement recovery after SCI [17, 23-26]. Further, locomotor functional outcome in experimental SCI models is the most important factor for evaluating the extent of injury and treatment efficacy. It is directly related to the extent of neuronal damage in the gray matter at the injury site, the loss of ascending and descending axons in the white matter, and the reorganization of the remaining nervous system [27, 28]. The objective of this study was to examine the effects of the ascorbic acid and alpha-tocopherol on locomotor functional recovery of incomplete spinal cord injured rats. From the observations of this present study, SCI reduced the body weight of all the rats in control, disease control and experimental groups rats for the first week (first 7 days) followed by a slow recovery. This is in accordance with previous studies reported that SCI reduced animal body weight. This is partly due to the loss of fluid during the surgical procedure and the great stress exerted on the body at the time of the initial trauma, so the body's metabolism works faster to provide energy and nutrients to help in healing the body and fighting infections. As a result, it helps in decreasing the weight of the animals [29-32]. The results of this study showed that there was gradual recovery over a period of 12 weeks after SCI compared with baseline readings. These observations are in agreement with previous findings [31-34].

Spinal cord injury (SCI) is a devastating disease that leads to permanent disability and causes excessive suffering [1]. The resulting neurological dysfunction and paralysis is proportional to the severity of the trauma itself and it is a fundamental problem in medicine, causes high mortality, severe disability, expensive cure, extensive rehabilitation, and a high economic burden [1]. So far management of SCI is challenging and there has been no definite treatment for it. But numerous studies including experimental modeling are being performed to assist understanding the anatomical and biological consequences of injury and repair, and testing the efficacy and the risk-to-benefit ratio of a proposed therapy performed to assist resolving this fundamental problem [2, 3].

Among the leading mechanisms associated to cell death after SCI, excitotoxicity, oxidative stress, inflammatory response and apoptosis are considered potential targets to prevent tissue damage [4]. The critical role of the spinal cord in a broad range of physiological functions is clearly demonstrated by the deficits observed after SCI and by the medical conditions that develop in the acute and chronic phases after injury [5-7].

Group 2 (disease control group, SCI+saline) showed a gradual decrease in rats body weight at day 2 until day 7 as compared with the baseline value. However, there was a gradual increase in the body weight from day 8 (second week onwards) and this improvement was maintained until the end of the study (Table 2). Similar results were observed in all test groups (i.e 3, 4, 5, 7), the improvements were started on day 6 for group 6 and 8. Compared to low doses ascorbic acid (group 3) and alpha-tocophoral groups (group 5), positive improvements in rats' body weight were observed in high doses of ascorbic acid (group 4) and alpha-tocophoral (group 6). Further, when compared with ascorbic acid treatment notable improvements in rats' body weight were observed in alpha-tocopherol groups, especially rats received high dose of alpha-tocopherol.

BBB

At first week end when compared to baseline value, group 3,4,5,6,7 and 8 showed a gradual improvement in BBB scores, and such improvements were maintained at all-time points until the end of the trial period (week 12). Compared to disease control positive improvements in BBB were observed in all test groups. Compared to low doses of ascorbic acid (group 3) and alpha-tocophoral groups (group 5), positive BBB improvements were observed in high doses of ascorbic acid (group 4) and alpha- tocophoral groups (group 6). In addition, when compared with ascorbic acid treatment, notable added improvements were observed in alpha-tocopherol groups mainly group 6 (i.e alpha tocopherol 1000 mg/kg body weight). Compared to initials weeks, the recovery rates of all test groups rats were less in last four weeks (i.e week 9-12).

II. RELATED WORK

The following sections and sub-section present a review of literature related to the present work.

A. Bilateral Symmetry

Human face has an approximate bilateral symmetry, which has been applied in psychological and anthropological studies, specifically to research the link between facial symmetry and facial attractiveness [5]. Bilateral symmetry has also been successfully applied in face-recognition technologies. Josh and Aggarwal [7] introduced “average-half-face”—a face-recognition technology that uses the symmetrical characteristics of a human face. The average-half-face method has been widely applied to demonstrate a far-better performance as compared to that by full-face recognition method. In their study with bilateral symmetry, Chen et al. [8] used an automated tool to define the face symmetry as per the Gray Level Difference Histogram (GLDH); this method is simpler and more efficient in detecting the symmetry axis. They also defined new matrices for facial symmetry and face recognition, with the potential for furthering research in face-recognition technologies. However, approximate bilateral symmetry is already used for a series of facial-recognition algorithms meant to optimize the accuracy and efficiency of the underlying algorithms, including Linear Discriminant Analysis (LDA) and Direct-LDA (D-LDA). Use of facial symmetric features for optimizing face-recognition in the Null Space LDA (NLDA) framework [5] revealed the potentials of using facial symmetric data for enhancing the accuracy of conventional NLDA. Song et al. [9] proposed a brilliant facial symmetry method for inducing variation in the illumination of a face image by using the mirror-image method for facial recognition. In this method, the original face image was divided into left and right panels, and the variation in the lighting between the two panels was computed. The panel receiving more lighting, as per the pre-defined threshold value, was used to produce the corresponding mirror image. In a similar study, Singh and Nadi [10] used half-face method for facial recognition by applying the vertical symmetry feature of a human face along with the application of principle component analysis (PCA) to both full-face and half-face methods, and reported similar accuracy in both cases for recognizing face images. The half-face method thus offered the advantage of lesser time and resource consumption, along with being invariant to facial expressions.

B. Harmony-search Algorithm for Face Recognition

A meta-heuristic global optimization algorithm—harmony-search algorithm (HSA)—was inspired by the music improvisation process [11]. Every human facial point provides some vital information. Psychological evaluation of a face [12] has demonstrated that some of the facial features are distinguishable and more helpful in accurately identify a face. Harmony Search (HS) is a flexible, efficient, and simple method that has been effectively and successfully applied in optimization issues of recognition accuracy [13], including in TSP problem [11], scheduling issue of a multiple dam system [14], and for structural optimization [15]. In this domain, HS has also been used for feature selection to show improvement in recognition accuracy [16,17]. Furthermore, Sawalha and Doush [17] proposed a novel HS-based feature-selection algorithm, in which the feature vectors were first extracted by PCA and then applied to search the feature space for the optimal feature subset. They reported superior results in using HS-based feature

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selection algorithm for obtaining precise recognition with minimal numbers of features. Furthermore, the recognition accuracy result of this method was comparable to that of the standard PCA using the highest Eigen values in the classification. Recently, HAS was successfully applied to improve the results of the conventional Elastic Bunch Graph Matching (EBGM) technique in face recognition [18]. We found that HAS could also be used in the conventional EBGM to automatically search the best landmarks on a face image, rather than label the same manually. Our results demonstrated that the proposed automatic method can improve the face recognition rate of the conventional EBGM approach.

C. One Sample per Person Problem Occlusion

The difficulty in handling variations in occlusion is a major limitation of the currently available face-recognition methods because face images are often prone to occlusion and other common variations such as illumination and expressions. Moreover, using fewer samples for each subject makes it difficult to achieve accurate recognition rate. However, as use of lesser number of samples for a subject incurs lesser costs of storage and processing, several face-recognition systems prefer the same. Accordingly, performance of a face system is degraded only when there is only one training image available per subject. Recently, much research is being done to resolve the above-mentioned problems in face recognition [19–22].

In this section, we have reviewed and classified the typical occlusions encountered in face-recognition technologies. The existing occluded face approaches are of two types; holistic and part-based. In the holistic approach, the face image is treated as the whole entity, while, in the part-based approach, only the local regions are considered [?]. Moreover, in part-based approaches, the face image is divided into various local regions; each of this region is then processed independently to discard data of supposedly occluded areas. Another approach for resolving occlusion issues is to detect the occluded areas and then either reconstruct or discard the same. The method proposed in this study only applies the optimized symmetrical partial face graphs. We plan to study the part-based approach in greater detail in the future. In this direction, Martinez’s Localization Algorithm (MLA) [23] is an innovative contribution toward recognizing partially occluded faces based on a probabilistic face-recognition approach. MLA method used only one training sample per subject for recognizing faces prone to factors such as partial occlusion, imprecise localization, and the presence of expressions. In this approach, the face image was segmented into k local regions and then analyzed locally to resolve partial face occlusions and other such variation issues. Next, eigenspace was constructed for each subregion and a weighting scheme (associated with the emotional state of the target local region) was adopted for robustness against expression variations. This method is however limited by the involvement of manual localization of the local features.

Alternatively, graphic-based methods can be used for effective processing of partially occluded faces or for reducing the number of samples per subject to one. Graph Laplace (GL) technique allows construction of a complete face image [24] by treating an occluded face image as a signal sequence to be matched with other face images in the database using the Sparse Representation (SR). SR-based classification allows selection of the regions most similar to the occluded regions from among the samples to reconstruct the missing parts of the face image; this approach is especially effective for heavily occluded images. Furthermore, use of sunglasses and scarves has provided improvement in the rate of face recognition against occlusions. The face-recognition

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rate was found to be insensitive to the occlusion size. In addition, the GL technique was deemed appropriate for repairing images that lacked sufficient information, except for the need to fill in the occluded patches, which would add to the cost of the operation. For example, if the searched patches were inaccurate, the output may seem contaminated with artifacts on the repaired image. Toward resolving the need for one sample per subject, EBGM approach seemed suitable as it could represent the whole face image as one graph [3]. In this approach, known local facial features such as the eyes, tip of the nose, and borders of the mouth are manually selected and labeled as landmarks. Then, a bunch graph is created for the general representation of the face. Then, a face graph is constructed to represent each of the selected image as per the labeled landmarks. The nodes of the face graph are placed at the landmark locations, wherein each node contains a jet extracted from the corresponding location. Once the face graph is completely constructed, the original face image is discarded. For each node of the face graph, the similarity between the face graph and its corresponding bunch graph is computed based on the jet similarities. By maximizing the similarity therein, the optimal face graph could search the target face. Another approach for face recognition with only one face image involved the use of a doubly nonlinear mapping kernel PCA (DKPCA) that utilizes the Gabor wavelets to extract facial features [25]. DKPCA can transform and recognize a face. However, although the DKPCA method can efficiently handle the one sample per subject issue, it does not address the occlusion issue. Alternatively, another approach to handle occlusions is to detect and the discard the occluded regions by using the two-dimension PCA (2D PCA) approach [26]. This approach projects the face image into a subspace, where each image row corresponds to one feature of the face. K-NN and 1-NN classifiers are used to identify the occluded parts of the face image by checking for similarity between parts of the trained and tested images, followed by elimination of the data of the detected occluded regions from the similarity calculation. This method is limited by the fact that discarding the occluded rows can result in loss of data, which can be discriminative for the recognition process. The most recent method toward resolving the occlusion issue was Wroght et al.'s [27] algorithm based on sparse representation that helped predict occlusion deemed manageable by the recognition algorithm. This algorithm can help predict selection of the most appropriate training images in order to maximize the robustness of occlusion detection. Accordingly, all training images plus asparse error due to occlusion can be combined to represent the test image as a sparse linear image. This innovative approach addresses two general face-recognition problems: feature extraction and gaining robustness against occlusion. Venkat et al. [4] proposed a novel approach to recognize occluded faces—Psychophysically Inspired SImilarity MApping (PISIMA), which processes local facial components instead of a holistic processing as the former has proven to be an efficient face-recognition approach for recognizing occluded faces.

The Bayesian network model can capture the local features of the horizontal subregions from facial images based on the data obtained from psychological testing; however, this approach requires more than one sample per subject. Chen and Gao [28] proposed an approach in which Stringface representation was constructed to integrate the relational organization of intermediate-level features (line segments) into a high-level global structure (string), providing a face image as a string that is processed into defined complex discontinuous features of a human frontal face. The authors later updated the Stringface representation by grouping the low-level feature letters into intermediate-level words [29]. Then, based on their relational organization, the grouped words were integrated into high-level sentence strings. The two faces were then matched by comparing two Stringfaces through a string-to-string matching scheme. This method can identify

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even the most discriminative local parts (substrings), and the substring matching ability enables resolving of the occlusion problem.

In conclusion, part-based technologies was found to be more effective in recognizing faces under uncontrolled conditions such as occlusions using only one sample image per subject. Moreover, reconstruction-based approaches were not found to be effective in the presence of large occlusions. Detection and discarding of the occluded areas often result in loss of vital information, which may give discriminative results and add bias to the overall recognition rate. In this study, we applied the bilateral symmetry feature of the human face and HS-based optimization method for optimizing the accuracy of recognition by selecting the appropriate features from a face image under study.

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Multi-brid DBI Inflation

We extended the multi-brid idea to the multi-field separable model with a non-canonical kinetic term, mainly the DBI model. Assuming a specific surface for the end of inflation and introducing new fields enabled us to find an explicit expression for a number of e-folds in terms of the new fields. By using N formalism, we arrived at cosmological parameters. We considered the DBI model for two different limits, viz., the speed limit and constant sound speed.

Introduction

The inflation theory offers an intelligent approach to the basic problems of cosmology. According to this theory, a rapid expansion era in the universe enlarges its physical length to nearly 60 times the original size; this rapid expansion solves the old problems encountered in cosmology, such as flatness, horizon and monopole issues.

The fluctuation of the inflaton, the field which drives inflation, induces variations in the energy density in such a manner that the curvature fluctuations of the power spectrum are nearly scale invariant. There are several cosmological observations which support this theory. Recently, the Planck satellite observed the Cosmic Microwave Background anisotropy and its polarization with a small angular resolution; its results concur with predictions of the inflation theory, in general. Although the experimental tests support inflation from the theoretical perspective, a proper understanding of the nature of the factors that produces the inflation is still unclear. In the simplest model, one field, the inflaton which is minimally coupled to gravity, rolls very slowly, in a very flat potential. The flatness of the potential is essential to achieve sufficient inflation. One way to relax this condition is to change the dynamics of the inflaton. When the kinetic term in the Lagrangian point of this field is non-canonic, the slow-roll condition is not necessary anymore. For example, when we have a Dirac-Born-Infeld (DBI) field, there is fast-roll inflation. Brane inflation is an example of this model in which the radial distance between a pair of D3- and anti-D3-brane takes on the role of the inflaton. In general, it is possible to get inflation from a general class of non-standard kinetic terms, which is called k -inflation; in this model, the inflation can exist even in the absence of the potential.

However, the existence of more than one field can relax many limits on the single-field models. In the multi-field models, co-operation between the

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fields can produce inflation, even if each field is not able to drive the inflation by itself, in such a way that the e-folding number and curvature perturbation are proportional to the number of fields.

Regardless of the model of inflation, this era must end at some time. For example, a waterfall mechanism can cease inflation on a specific surface in field space, which is called the end of inflation surface. By using the equation of end of inflation surface, the e-folding number can be expressed explicitly in terms of the fields; this concept is known as multi-brid. We generalize this idea to the separable multi-field models, assuming a general equation for this surface in terms of fields at t_f .

The rest of this paper is organized as follows: in Section 1, we present our set-up for separable models. In the second Section, we use N formalism to arrive at the observational parameter. In Section 3, we apply this method to the multi-speed DBI in the speed limit, and in Section 4, it is applied to DBI with constant sound speed.

The Model

We consider a separable action for N number of scalar fields with the non-canonical kinetic term; the action is given by S , where X is the kinetic term of ϕ . Consider a spatially flat FRW background, where the variation of action produces the field. As the fluctuation of each field is characterized by its own sound speed, this is a "multi-speed" model.

We are interested in extending the multi-brid idea to the model described above, in which the inflation ends by a waterfall mechanism on a specific surface, by defining new fields that move radially in the field space. The equations of motion are solvable, which enables the evolution of new fields in terms of the number of e-folds. Using N formalism, the observational parameters such as spectral index and non-Gaussianity are produced.

Rewriting the equation of motion as $\ddot{\phi} + 3H\dot{\phi} + V'(\phi) = 0$, leads us to introduce new fields as follows: χ , each χ is a function of t through ϕ given by the Friedmann equations and H . In terms of these new fields, the equation of motion can be expressed very simply as, $\ddot{\chi} + \mathcal{M}^2\chi = 0$.

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The right-hand side is identical for all the fields; therefore, for each I and J we have, $\delta\phi_I = \delta\phi_J$.

This indicates that in the space of the ϕ the motion is radial.


For later convenience, the time variable is changed to the number of e-folds. The minus sign shows that the number of e-folds is backward in time (at the end of inflation, it vanishes). From (0) , in terms of ϕ , the equation of motion for ϕ becomes, $\ddot{\phi} + 3H\dot{\phi} = -V'(\phi)$ which can be solved as $\dot{\phi} = \sqrt{2V(\phi)}$.

It is worth mentioning that there is also another term contributing in N , $\delta\phi$. This is derived from the fact that the end of the inflation surface is not a constant energy density surface, if we assume that the universe is radiation dominated. Immediately after the end of inflation, it is expressed by $\rho = \rho_{\text{end}}$, where ρ is the density, " f " and " c " refer to the end of the inflation surface and the surface of constant energy, respectively. Throughout the rest of the paper this term is ignored.

Suppose the end of inflation surface is known, for example, a waterfall mechanism terminates the inflation on a specific surface. This surface is determined by a relation between the fields in q space at ϕ as $\phi = \phi(q)$. By using this relation and the radial motion in the q space, it is possible to arrive at the variation of the ϕ s in terms of the variation in the q s. Throughout the rest of the paper we restrict ourselves to two fields which allow us to make some precise calculations. As the ϕ s are not independent, at the end of inflation, there is only one degree of freedom in principle that can be characterized by only one parameter, which is denoted by θ . Therefore, the ϕ s are functions of θ , and a variation of θ which gives, $\delta\theta$. Rewriting this equation as $\phi = \phi(\theta)$, the equation given above can be expanded as follows: $\dot{\phi} = \dot{\phi}(\theta) + \delta\dot{\phi}(\theta)$, where $\dot{\phi}(\theta)$ and $\delta\dot{\phi}(\theta)$ refer to the first- and second-order variations, respectively. Up to the second order, the variation of ϕ can be obtained from the variations of θ , with $\dot{\phi}$ and $\delta\dot{\phi}$ being the first and second derivatives of ϕ with respect to θ , equating the first-order and second-order terms of (0) , respectively, which gives the $\dot{\phi}$ and $\delta\dot{\phi}$. Substituting (0) in (0) gives, $\ddot{\phi} + 3H\dot{\phi} = -V'(\phi)$, where $\ddot{\phi}$, there is a similar expression for $\delta\ddot{\phi}$.

Assume that an attractor solution exists and $\dot{\phi}$ is applicable. The explicit expression of ϕ in terms of θ s allows us to compute $\dot{\phi}$ in terms of field's variation. We assume slow variations at the horizon exit to ignore the $\delta\dot{\phi}$.

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Substituting \$\$ in \$\$ and \$\$'s variation, for \$\$s variation as \$\$, gives \$\$\$. The second-order variation of θ is as follows: \$\$, we have replaced \$\$ with \$\$.


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Sorption-desorption behavior of imazethapyr and imazapic on six Brazilian soils.

^aDepartment of Chemistry, Universidade de Viçosa, Viçosa, CEP 36570900, Brazil.

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ABSTRACT

The characterizing of sorption-desorption for imazethapyr and imazapic, in six agricultural soils was performed, to assess the availability of these pesticides in pollution processes. In this pursuit, the batch equilibration method was used and high performance liquid chromatography. The magnitude of K_f values ranging from 0.44 to 1.63 L kg⁻¹ for imazethapyr and 0.12 to 1.25 L kg⁻¹ for imazapic indicate weak sorption in the evaluated soils. Soil pH (5.1 to 6.1) and iron oxide, were the main factors affecting the sorption of both herbicides. A high percentage of desorption (\approx 70%) was found in Entisol, Dystric Plinthosol, Red-Yellow Latosol (both herbicides), and Eutric Gleysol (only imazapic) soils, which implied the leaching risks of these imidazolinone herbicides into groundwater. Lower desorption (\approx 50%) was found in Humic Cambisol and Red Argisol (both herbicides), and (\approx 50%) in Eutric Gleysol (only imazethapyr) soils, indicating that these herbicides could potentially injure the sensitive rotational crops.

Keywords: Imazethapyr, imazapic, sorption, desorption.

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1. Introduction

Herbicides represent a wide range of properties and chemical groups and have physicochemical characteristic variables affecting their interaction with soil colloids. This interaction results in the agronomic efficiency or inefficiency of the herbicide, as well as the environmental impact with regard to contamination of the soil, surface water, and groundwater by undesirable residues of the not-completely degraded herbicide, during the cycle of the main crop [Loux and Reese, 1993; Loux et al., 1989; Stougaard et al., 1990].

In recent times Imidazolinone (IMI) herbicides are widely used in agricultural crops of relevant importance, to control several weed species, such as, red rice (*Oryza sativa* L.) in Clearfield® (IMI-tolerant crops) production systems, and reduce the production costs [Menezes et al., 2009; Sudianto et al., 2013; Gianelli et al., 2014]. They are widely used because of their low application rates, decreased environmental impact, and selectivity in a wide range of crops. The mechanism of action involves inhibition of the acetohydroxyacid synthase (AHAS) enzyme responsible for the biosynthesis of branched-chain amino acids in plants [Duggleby et al., 2008; Tan et al. 2006; Sudianto et al., 2013].

All IMI herbicides have an achiral imidazole moiety in their molecular structure, but they differ in structure in the second heterocycle (Fig. 1). These herbicides have the presence of two enantiomers as a common characteristic and their biological activity is usually the result of the preferential reactivity of only one enantiomer [Ramezani et al., 2010].

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Herbicide behavior in soils greatly depends on the sorption–desorption phenomena and a knowledge of these processes is important to predict their mobility in the soil. Sorption controls the availability of herbicides to the plant, the rate of degradation by soil microorganisms, and the movement of the chemical through the soil profile [Bresnahan et al., 2000]. It is usually characterized by using the batch equilibration method, to determine the sorption distribution coefficients (K_d) or Freundlich coefficients (K_f), which measure the extent of interaction of the chemical with the soil and its components [Ahmad and Rahman, 2009].

The intensity and extent of sorption depend on the physicochemical properties of the soil, such as, pH, organic matter (OM), texture, moisture, and temperature, as also the molecular characteristics of the pesticide [Bresnahan et al., 2000; Ahmad and Rahman, 2009; Che et al., 1992; Green, 1974; Oliveira Jr. et al., 2001].

The amphoteric nature (presence of both acidic and basic functional groups) of IMI herbicides allows them to exist in anionic, neutral or cationic forms, depending upon the pH of the environment. When the soil pH is greater than the pK_a , the anionic form of these herbicides predominates ($-COO^-$) and this form is weakly bound or repulsed by negative charges of the soil colloids, resulting in low sorption to neutral and high pH soils [Che et al., 1992; Green, 1974; Oliveira Jr. et al., 1999; Aichele and Penner, 2005]. Consequently, the soil pH may affect the persistence of these herbicides in the environment and may have carry-over effects in the subsequent cultures [Loux and Reese, 1993; Bresnahan et al., 2000].

Furthermore, it has been reported that the IMI herbicides show a high potential for leaching because of their relatively low pK_a values [Gianelli et al., 2014; Oliveira Jr. et al., 2001; Oliveira Jr. et al., 1999].

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Fig. 1. Chemical structures of imazethapyr (A) and imazapic (B); cationic form, neutral form, and anionic form.

