Professor Fernanda Lima

IFMG, Campus São João Evangelista, MG

	1 M 7:00 - 7:45	2 M 7:45 - 8:30	Intervalo Manhã 8:30 - 8:45	3 M 8:45 - 9:30	4 M 9:30 - 10:15	5 M 10:15 - 11:00	6 M 11:00 - 11:45	Almoço 11:45 - 13:00	1 T 13:00 - 13:45	2 T 13:45 - 14:30	Intervalo Tarde 14:30 - 14:45	3 T 14:45 - 15:30	4 T 15:30 - 16:15	5 T 16:15 - 17:00	6 T 17:00 - 17:45	Intervalo Vespertino 17:45 - 18:40	1N 18:40 - 19:25	2N 19:25 - 20:10	Intervalo Noite 20:10 - 20:25	3N 20:25 - 21:10	4N 21:10 - 21:55	5N 21:55 - 22:40
Seg				CPE A3A Culturas Perenes					CPE A3B Culturas Perenes			CPE A3B Culturas Perenes										
Ter	ESE AGR 181 PIII - Sala 1																					
Qua					ESE AGR 181 PIV - Sala 3							Reunião										
Qui	APO II A3A Produção			APO II A3A Produção					APO II A3B Produção			APO II A3B Produção										
Sex	Planejamento			Planejamento					Planejamento			Planejamento										
Sáb																						

Horário criado:06/02/2020

aSc TimeTables

Grupo de pesquisa

Grupo de Estudos em Fruticultura (GEFRUT - UFVJM)

Endereço para acessar este espelho: dgp.cnpq.br/dgp/espelhogrupo/1913839358450272

Identificação

Situação do grupo: Certificado

Ano de formação: 2011

Data da Situação: 12/08/2013 15:03

Data do último envio: 20/10/2020 17:04

Líder(es) do grupo: Maria do Ceu Monteiro da Cruz

Área predominante: Ciências Agrárias; Agronomia

Instituição do grupo: Universidade Federal dos Vales do Jequitinhonha e Mucuri - Campus JK - UFVJM

Unidade:

Endereço / Contato

Endereço

Logradouro: Campus JK - Rodovia MGT 367- Km 583

Número: 5000

Complemento:

Bairro: Alto da Jacuba

UF: MG

Localidade: Diamantina

CEP: 39100000

Caixa Postal:

Localização geográfica

Latitude: -18.2417878

Longitude: -43.60350510000001

Contato do grupo

Telefone: (38) 3532-1211

Fax: (38)

Contato do grupo: nefrut.ufvjm@yahoo.com.br

Website: www.ufvjm.edu.br

Repercussões

Repercussões dos trabalhos do grupo

A formação do grupo de pesquisa em Fruticultura surgiu para consolidar as sublinhas de pesquisa atuantes em Propagação, Biotecnologia, Manejo; Melhoramento genético, Fisiologia, Ecofisiologia e qualidade da produção de espécies frutíferas com a colaboração de pesquisadores da EPAMIG, UFLA e UFVJM. A linha de pesquisa em fruticultura visa fortalecer os projetos de pesquisas para a expansão da fruticultura.

Participação em redes de pesquisa

Rede de pesquisa	Website/Blog
Nenhum registro adicionado	

Linhas de pesquisa

Nome da linha de pesquisa	Quantidade de Estudantes	Quantidade de Pesquisadores
Ecofisiologia	4	2
Fisiologia de plantas cultivadas	1	1
Manejo	6	2
Melhoramento genético	0	2
Nutrição de plantas	3	1
Propagação de plantas frutíferas	0	2
Qualidade de Frutas	1	3

Recursos humanos

Pesquisadores	Titulação máxima	Data inclusão
Adelson Francisco de Oliveira	Doutorado	Anterior a abril de 2014
Amanda Gonçalves Guimarães	Doutorado	25/11/2019
Emerson Dias Gonçalves	Doutorado	Anterior a abril de 2014
Enilson de Barros Silva	Doutorado	07/04/2017
José Barbosa dos Santos	Doutorado	Anterior a abril de 2014
Lílian de Araújo Pantoja	Doutorado	Anterior a abril de 2014
Marcus Alvarenga Soares	Doutorado	Anterior a abril de 2014
Maria do Ceu Monteiro da Cruz	Doutorado	Anterior a abril de 2014

Estudantes	Nível de Treinamento	Data inclusão
Cíntia Gonçalves Sena	Mestrado	07/07/2016
Deilson de Almeida Alves	Doutorado	07/04/2017
Dionaton Jose de sousa	Graduação	17/04/2019
Fernanda de Lima Barroso	Doutorado	20/10/2020
Jéssica Oliveira Gaurat	Doutorado	Anterior a abril de 2014
Joao Esdras Lima	Não há formação em andamento	14/08/2014
Maria Isabel Martins Ventura	Graduação	17/04/2019
Núbia Cassiana Santos	Doutorado	24/09/2016

Técnicos	Formação acadêmica	Data inclusão
Nenhum registro adicionado		

Colaboradores estrangeiros	País	Data inclusão
Nenhum registro adicionado		

Egressos

Pesquisadores	Período de participação no grupo
Dili Luiza de Oliveira	De Não informada a 07/04/2017

Pesquisadores	Período de participação no grupo
Jose Darlan Ramos	De Não informada a 07/07/2016
Paulo Cesar de Melo	De Não informada a 07/04/2017
Rodrigo Amato Moreira	De Não informada a 11/09/2017
Roseli Freire de Melo	De Não informada a 07/04/2017
Virna Braga Marques	De Não informada a 07/04/2017

Estudantes	Período de participação no grupo
Adriene Matos dos Santos	De 18/02/2015 a 22/09/2016
Angra Soares Damasceno	De 14/05/2014 a 18/02/2015
Denison Ramalho Fernandes	De Não informada a 07/04/2017
Guilherme Dumbá Monteiro de Castro	De Não informada a 13/07/2017
Heloisa Maria Ferreira	De 14/08/2014 a 07/04/2017
Henrique Martins de Oliveira	De 07/04/2017 a 11/09/2017
Jéssyca Rhayanne Silva de Souza	De Não informada a 22/09/2016
Josimara Mendes Rabelo	De 07/07/2016 a 17/04/2019
Lana Ivone Barreto Cruz	De Não informada a 12/09/2016
Larissa Madureira Martins	De Não informada a 07/07/2016
Letícia Alves Carvalho Reis	De 26/05/2017 a 17/04/2019
Mariana Silva Brandão de Paula	De Não informada a 07/07/2016
Miriã Cristina Pereira Fagundes	De Não informada a 27/05/2017
Mirielle de Oliveira Almeida	De Não informada a 07/07/2016
Pablo Vinicius Macedo Meira	De 13/07/2017 a 17/04/2019
Raoni Pereira de Carvalho	De Não informada a 12/09/2016
Richard Celso Amato Moreira	De Não informada a 14/08/2014

Instituições parceiras relatadas pelo grupo

Nome da Instituição Parceira	Sigla	UF	Ações
Empresa de Pesquisa Agropecuária de Minas Gerais	EPAMIG	MG	

Indicadores de recursos humanos do grupo

Formação acadêmica	Pesquisadores	Estudantes	Técnicos	Colaboradores estrangeiros	Total
Doutorado	8	4	0	0	12

Formação acadêmica	Pesquisadores	Estudantes	Técnicos	Colaboradores estrangeiros	Total
Mestrado	0	1	0	0	1
Graduação	0	1	0	0	1
Outros	0	2	0	0	2

CAMPUS SÃO JOÃO EVANGELISTA

PORTARIA Nº 318, DE 20 DE NOVEMBRO DE 2019

O DIRETOR-GERAL DO INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE MINAS GERAIS - CAMPUS SÃO JOÃO EVANGELISTA, no uso das atribuições que lhe são conferidas pela Portaria nº 1.175, de 20 de setembro de 2019, publicada no Diário Oficial da União de 23 de setembro de 2019, Seção 2, página 30, tendo em vista o Termo de Posse do dia 24 de outubro de 2019; e considerando a Portaria IFMG nº 475, de 06 de abril de 2016, publicada no DOU de 15 de abril de 2016, Seção 2, pág.17, retificada pela Portaria IFMG nº 805, de 04 de julho de 2016, publicada no DOU de 06 de julho de 2016, Seção 2, pág. 22, e pela Portaria IFMG nº 1078, de 27 de setembro de 2016, publicada no DOU de 04 de outubro de 2016, Seção 2, pág. 20, resolve:

Art. 1º. Designar a servidora FERNANDA DE LIMA BARROSO, ocupante do cargo efetivo de Professor de Ensino Básico, Técnico e Tecnológico, matrícula SIAPE nº 1070178, para a função de Coordenadora do Curso Técnico Integrado em Agropecuária do IFMG - Campus São João Evangelista, Função Comissionada de Coordenador de Curso - Código FUC-01.

Art. 2º. Esta Portaria entra em vigor na data de sua publicação.

JOSE ROBERTO DE PAULA

INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DO PARÁ

CAMPUS MARABÁ INDUSTRIAL

PUBLICAÇÃO DO RESULTADO FINAL DO PROCESSO SELETIVO SIMPLIFICADO PARA PROFESSOR SUBSTITUTO DO CURSO TÉCNICO SUBSEQUENTE EM AGRIMENSURA

O DIRETOR GERAL DO CAMPUS MARABÁ INDUSTRIAL DO INSTITUTO FEDERAL DO PARÁ, no uso de suas atribuições legais e considerando a Lei nº 8.745/93 e suas alterações, Lei nº12.772/12, Decreto nº 7.312/10, Portaria nº 1751/2019/GAB, publicada no DOU de 02/08/2019, torna pública a homologação do Resultado Final do Processo Seletivo Simplificado para contratação por tempo determinado de Professor Substituto do curso de Agrimensura, de acordo com o edital nº 18/2019.

Nº DE INSCRIÇÃO	NOME	PROVA DIDÁTICA	PROVA DE TÍTULOS	MÉDIA FINAL	CLASSIFICAÇÃO
00122019	CARMÉLIA ALCANTARA DA ROCHA	84,50	40	71,15	APROVADA

Marabá, 20 de novembro de 2019

JACKSON MOREIRA OLIVEIRA

INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DO PARANÁ

PORTARIAS DE 19 DE NOVEMBRO DE 2019

O Reitor pro tempore do Instituto Federal de Educação, Ciência e Tecnologia do Paraná, no uso da competência que lhe confere a Portaria MEC nº 603 de 08 de julho de 2016, publicada no Diário Oficial da União no dia 11 de julho de 2016, seção 2, página 14, resolve:

Nº 1.549 - Art. 1º Delegar competências aos servidores abaixo discriminados, substitutos eventuais do cargo de Diretor Geral do Campus Capanema, para praticarem atos de gestão orçamentária e financeira na Unidade Gestora 156542 - Instituto Federal do Paraná, Campus Capanema, da seguinte forma:

NOME	SIAPE	SITUAÇÃO
MARCOS FERNANDO SCHMITT	2277147	Titular
CHEILA NUNES DOS SANTOS	2345309	Substituta

Parágrafo único. O Titular atuará como Ordenador de Despesas e a Substituta como Ordenadora de Despesa Substituta na ordem, sem prejuízo do cargo que ocupa, exercendo as atividades designadas nos casos de afastamento, impedimentos legais ou regulamentares do titular. Art. 2° Delegar competências aos servidores abaixo discriminados para praticarem atos de gestão financeira na referida UG:

NOME	SIAPE	SITUAÇÃO
MAURÍCIO RODOLFO KURZ	1148074	Gestor Financeiro
CHEILA NUNES DOS SANTOS	2345309	Substituta

Art. 3º Fica vedado o afastamento concomitante dos servidores indicados sendo necessária a presença na unidade de pelo menos um responsável por cada função, estando o titular sujeito a pena de responsabilização. Art. 4° Esta portaria entra em vigor na data de sua publicação.

Nº 1.550 - Art. 1º Autorizar o afastamento do país ao servidor CARLOS MARCELO ARCHANGELO, SIAPE nº 2782286, Professor do Ensino Básico, Técnico e Tecnológico, lotado no Campus Londrina, para realização de Ação de Desenvolvimento de Ensino, Pesquisa e Extensão, promovido pela Faculdade de Medicina Dentária da Universidade de Lisboa, na cidade de Lisboa/Portugal, no período de 11 de dezembro de 2019 a 11 de fevereiro de 2020, trânsito incluso, com ônus limitado para o IFPR. Art. 2º Esta Portaria entra em vigor a partir da sua publicação.

ODACIR ANTONIO ZANATTA

PRÓ-REITORIA DE GESTÃO DE PESSOAS

PORTARIA Nº 3.618, DE 20 DE NOVEMBRO DE 2019

A Pró-Reitora de Gestão de Pessoas do Instituto Federal do Paraná, no uso da competência que lhe confere a Portaria nº 889, de 18 de julho de 2016, considerando o que consta no processo nº 23411.012352/2019-90 resolve: Autorizar, de acordo com a Lei nº 8745/93, a partir de 21/11/2019 até 20/12/2019, a prorrogação do contrato de MAURICIO FONSECA DA PAZ, contrato 157/2019, como Professor Substituto, com salário correspondente à classe DI, Nível 1, no regime de trabalho de 20 (vinte) horas semanais, para o Campus Campo Largo.

ELIANE APARECIDA MESQUITA

PORTARIAS DE 19 DE NOVEMBRO DE 2019

A Pró-Reitora de Gestão de Pessoas do Instituto Federal do Paraná, no uso da competência que lhe confere a Portaria nº 889, de 18 de julho de 2016, resolve:

N° 3.602 Autorizar, de acordo com a Lei nº 8745/93, a partir de 01/01/2020 até 01/07/2020, a prorrogação do contrato de LIZA MACEDO LOPES, contrato 19/2019, como Professora Substituta, com salário correspondente à classe DI, Nível 1, acrescido de Retribuição pelo Mestrado em Ciências, conforme arts. 16 e 17 da Lei 12.772/12, no regime de trabalho de 40 (quarenta) horas semanais, para o Campus Curitiba. (Processo: 23411.000351/2019-01)

N° 3.603 Autorizar, de acordo com a Lei nº 8745/93, a partir de 01/01/2020 até 30/06/2020, a prorrogação do contrato de SONIA MARIA KALCKMANN DE MACEDO, contrato 93/2019, como Professora Substituta, com salário correspondente à classe DI, Nível 1, acrescido de Retribuição pelo Mestrado em Enfermagem, conforme arts. 16 e 17 da Lei 12.772/12, no regime de trabalho de 40 (quarenta) horas semanais, para o Campus Curitiba. (Processo: 23411.006158/2019-75)

N° 3.604 Autorizar, de acordo com a Lei nº 8745/93, a partir de 01/01/2020 até 30/06/2020, a prorrogação do contrato de FRANCISLENE DE FÁTIMA CORDEIRO PETZ, contrato 137/2019, como Professora Substituta, com salário correspondente à classe DI, Nível 1, acrescido de Retribuição pelo Doutorado em Enfermagem, conforme arts. 16 e 17 da Lei 12.772/12, no regime de trabalho de 40 (quarenta) horas semanais, para o Campus Curitiba. (Processo: 23411.010169/2019-50)

ELIANE APARECIDA MESQUITA

INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE PERNAMBUCO

PORTARIA Nº 1.530, DE 20 DE NOVEMBRO DE 2019

A REITORA, EM EXERCÍCIO, DO INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE PERNAMBUCO, em substituição à Reitora nomeada pelo Decreto de 12 de abril de 2016, publicado no DOU de 13 de abril de 2016, seção 2, página 1, em conformidade com a Lei nº 11.892, de 29 de dezembro de 2008, no uso de suas atribuições legais e estatutárias, resolve:

Nomear o servidor ALLAN DIEGO SILVA LIMA, matrícula SIAPE nº 2225399, CPF nº 053.682.344-81, para exercer o cargo de Diretor de Extensão da Pró-Reitoria de Extensão desta Instituição Federal de Educação, código CD-03, a contar de 20/11/2019. (Ofício nº 525/2019-GR/IFPE)

JULIANA SOUZA DE ANDRADE

RETIFICAÇÃO

Na Portaria nº 1.520, de 18/11/2019, publicada no DOU de 20/11/2019, seção 2, página 28, que nomeou GLAUBER EMANUEL BATISTA MAGALHÃES para o cargo de TÉCNICO EM TECNOLOGIA DA INFORMAÇÃO - ÁREA DESENVOLVIMENTO, em seu preâmbulo, onde se lê "Edital de Abertura nº 125, de 29/08/2016 - DOU de 30/08/2016", leia-se: "Edital de Abertura nº 20, de 28/01/2016 - DOU de 29/01/2016".

INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DO PIAUÍ

PORTARIA Nº 3.856, DE 18 DE NOVEMBRO DE 2019

O REITOR DO INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DO PIAUÍ, no uso de suas atribuições legais e tendo em vista o disposto no OFÍCIO Nº 120/2019/DG/CAVAL/IFPI, de 18/11/2019, resolve:

Reconhecer FRANCISCO ALVES FRAZÃO FILHO, Diretor de Ensino, Código CD-4, do Campus Valença do Piauí, Matrícula SIAPE nº 1959759, como responsável por responder cumulativamente pelo cargo de Diretor-Geral, Código CD-2, do Campus Valença, no dia 07/10/2019, por motivo do afastamento de seu titular, Antenor Fortes de Bustamante, que esteve em gozo de férias, no dia mencionado.

PAULO HENRIQUE GOMES DE LIMA

RETIFICAÇÕES

Na Portaria nº 3.758, de 08/11/2019, publicada no DOU de 11/11/2019, Seção 2, páginas 32 e 33, onde se lê: em regime de Dedicação Exclusiva, leia-se: em regime de 40 (quarenta) horas semanais.

Na Portaria nº 3.762, de 08/11/2019, publicada no DOU de 11/11/2019, Seção 2, páginas 32 e 33, onde se lê: em regime de Dedicação Exclusiva, leia-se: em regime de 40 (quarenta) horas semanais.

INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DO RIO GRANDE DO NORTE

PORTARIA Nº 1.662, DE 20 DE NOVEMBRO DE 2019

O REITOR EM EXERCÍCIO DO INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DO RIO GRANDE DO NORTE, no uso de suas atribuições subdelegadas pela Portaria Ministerial nº 1.373, de 18 de julho de 2019, publicada no Diário Oficial da União de 19 de julho de 2019, CONSIDERANDO o disposto no Decreto nº 7.312, de 22/09/2010, publicado no Diário Oficial da União - DOU nº 183, de 23/09/2010, Seção 1, página 11; com nova redação dada pelo Decreto nº 8.259, de 29/05/2014, publicado no DOU nº 102, de 30/05/2014, Seção 1, página 6, CONSIDERANDO, ainda, o que consta no Processo nº 23421.004442.2019-98, de 18 de novembro de 2019, resolve:

I - Nomear, em caráter efetivo, em virtude de habilitação em Concurso Público, referente ao Edital de Abertura nº 235, de 28/12/2017, publicado no DOU de 02/01/2018, seção 3, páginas 58 a 65 e suas alterações; homologado pelo Edital nº 136 de 04/07/2018, publicado no DOU nº 128, de 05/07/2018, seção 3, páginas 58 a 61, e de acordo com os artigos 9º, Inciso I, e 10º da Lei nº 8.112/1990, de 11/12/1990, o concursado a seguir relacionado:

MARILSON DONIZETTI SILVINO, para exercer o cargo de Professor de Ensino Básico, Técnico e Tecnológico, Disciplina: Administração, Código nº 707001, Classe D I, Nível 1, em regime de Dedicação Exclusiva, em decorrência da vaga de nº 953218, por motivo de vaga distribuída pelo MEC, conforme DOU nº 200, de 15/10/2019, seção 1, página 124.

II - A posse do candidato ora nomeado ocorrerá no prazo de 30 (trinta) dias, contados da publicação deste ato no DOU, conforme § 1º do artigo 13 da Lei nº 8.112/1990, com redação dada pela Lei nº 9.527/1997, e a entrada em exercício ocorrerá no prazo de 15 (quinze) dias após a posse, de acordo com o § 1º do Art. 15 da Lei nº 8.112/1990, com redação dada pela Lei nº 9.527/1997.

MARCOS ANTÔNIO DE OLIVEIRA

PORTARIA Nº 1.664, DE 20 DE NOVEMBRO DE 2019

O REITOR EM EXERCÍCIO DO INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DO RIO GRANDE DO NORTE, no uso de suas atribuições subdelegadas pela Portaria Ministerial nº 404, de 23 de abril de 2009, publicada no Diário Oficial da União de 24 de abril de 2009 e republicada em 7 de maio de 2009, seção 2, página 9, CONSIDERANDO o disposto no artigo 47, inciso III, do Decreto nº 94.664, de 23 de julho de 1987; no Decreto nº 1.387, de 7 de fevereiro de 1995, com a redação dada pelos Decretos nºs 2.349, de 15 de outubro de 1997, e 3.025, de 12 de abril de 1999; e na Portaria MEC

Boletim de Serviço Eletrônico em 13/03/2018

MINISTÉRIO DA EDUCAÇÃO
SECRETARIA DE EDUCAÇÃO PROFISSIONAL E TECNOLÓGICA
INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE MINAS GERAIS
Campus São João Evangelista

Avenida Primeiro de Junho - Bairro Centro - CEP 39705-000 - São João Evangelista - MG
3334122906 - www.ifmg.edu.br

PORTARIA Nº 45 DE 12 DE MARÇO DE 2018

Dispõe sobre a designação de servidores como membros do Colegiado da Área de Ciências Agrárias e Ambientais do IFMG – *Campus* São João Evangelista.

O **DIRETOR GERAL DO INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE MINAS GERAIS – *CAMPUS* SÃO JOÃO EVANGELISTA**, no uso das atribuições que lhe são conferidas pela Portaria nº 1329, de 22 de setembro de 2015, publicada no Diário Oficial da União de 23 de setembro de 2015, Seção 2, página 19, tendo em vista o Termo de Posse do dia 24 de setembro de 2015; e considerando a Portaria IFMG nº 475, de 06 de abril de 2016, publicada no DOU de 15 de abril de 2016, Seção 2, pág.17, retificada pela Portaria IFMG nº 805, de 04 de julho de 2016, publicada no DOU de 06 de julho de 2016, Seção 2, pág. 22, e pela Portaria IFMG nº 1078, de 27 de setembro de 2016, publicada no DOU de 04 de outubro de 2016, Seção 2, pág. 20,

RESOLVE:

Art. 1º. DESIGNAR os servidores docentes **JARBAS MAGNO DE MIRANDA**, Matrícula SIAPE nº 1279627; **ADELITON DA FONSECA DE OLIVEIRA**, Matrícula SIAPE nº 2002354; **ALISSON JOSÉ EUFRÁSIO DE CARVALHO**, Matrícula SIAPE nº 1935460; **ANA CAROLINA FERRARO**, Matrícula SIAPE nº 1650997; **ARNALDO GOMES CAIXETA**, Matrícula SIAPE nº 0049768; **BRUNO OLIVEIRA LAFETÁ**, Matrícula SIAPE nº 1977759; **CAROLINE JUNQUEIRA SARTORI**, Matrícula SIAPE nº 2390366; **CHARLES ANDRÉ DE SOUZA BISPO**, Matrícula SIAPE nº 1674557; **CLAUDIONOR CAMILO DA COSTA**, Matrícula SIAPE nº 1095816; **DOUGLAS DE CARVALHO CARELLOS**, Matrícula SIAPE nº 0054461; **FERNANDA DE LIMA BARROSO**, Matrícula SIAPE nº 1070178; **GRAZIELE WOLFF DE ALMEIDA CARVALHO**, Matrícula SIAPE nº 1870907; **ÍCARO TOURINO ALVES**, Matrícula SIAPE nº 2718780; **IVAN DA COSTA ILHEU FONTAN**, Matrícula SIAPE nº 1218102; **JOÃO PAULO LEMOS**, Matrícula SIAPE nº 2016897; **JOSÉ LAUREANO BARBOSA LEITE**, Matrícula SIAPE nº 1176116; **JOSÉ ROBERTO DE PAULA**, Matrícula SIAPE nº ; **MARCUS EDUARDO DUARTE MAGALHÃES**, Matrícula SIAPE nº 0049773; **MATEUS MARQUES BUENO**, Matrícula SIAPE nº 2390332; **NAILTON JOSÉ SANT'ANNA SILVA**, Matrícula SIAPE nº 1058688; **NATÁLIA RISSO FONSECA**, Matrícula SIAPE nº 2388619; **NILDIMAR GONÇALVES MADEIRA**, Matrícula SIAPE nº 0051894; **PAULO EMÍLIO DE FIGUEIREDO OLIVEIRA**, Matrícula SIAPE nº 1166756; **VICTOR DIAS PIROVANI**, Matrícula SIAPE nº 2145064 para, sob a presidência do primeiro citado, constituírem o Colegiado da Área de Ciências Agrárias e Ambientais do IFMG – *Campus* São João

Evangelista.

Art. 2º. Revogar a Portaria nº 152 de 18 de outubro de 2016.

Art. 3º. Determinar que a presente Portaria seja devidamente publicada no Boletim de Serviços do IFMG - *Campus* São João Evangelista.

Art. 4º. Esta Portaria entra em vigor na data de sua publicação.

Documento assinado eletronicamente por **Jose Roberto de Paula**, **Diretor Geral**, em 13/03/2018, às 09:48, conforme art. 1º, III, "b", da Lei 11.419/2006.

A autenticidade do documento pode ser conferida no site https://sei.ifmg.edu.br/sei/controlador_externo.php?acao=documento_conferir&id_orgao_acesso_externo=0 informando o código verificador **0026202** e o código CRC **646C73EE**.

Boletim de Serviço Eletrônico em 01/07/2020

MINISTÉRIO DA EDUCAÇÃO
SECRETARIA DE EDUCAÇÃO PROFISSIONAL E TECNOLÓGICA
INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE MINAS GERAIS
Campus São João Evangelista
Avenida Primeiro de Junho - Bairro Centro - CEP 39705-000 - São João Evangelista - MG
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PORTARIA Nº 138 DE 01 DE JULHO DE 2020

Dispõe sobre designação de membros do Colegiado do Curso Técnico Integrado em Agropecuária do IFMG - *Campus* São João Evangelista.

O DIRETOR-GERAL DO INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE MINAS GERAIS – *CAMPUS* SÃO JOÃO EVANGELISTA, no uso das atribuições que lhe são conferidas pela Portaria nº 1.175, de 20 de setembro de 2019, publicada no Diário Oficial da União de 23 de setembro de 2019, Seção 2, página 30, tendo em vista o Termo de Posse do dia 24 de outubro de 2019; e considerando a Portaria IFMG nº 475, de 06 de abril de 2016, publicada no DOU de 15 de abril de 2016, Seção 2, pág.17, retificada pela Portaria IFMG nº 805, de 04 de julho de 2016, publicada no DOU de 06 de julho de 2016, Seção 2, pág. 22, e pela Portaria IFMG nº 1078, de 27 de setembro de 2016, publicada no DOU de 04 de outubro de 2016, Seção 2, pág. 20,

RESOLVE:

Art. 1º. DESIGNAR os servidores e discentes como membros do Colegiado do Curso Técnico Integrado em Agropecuária do IFMG - *Campus* São João Evangelista, conforme segue:

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Art. 2º. Revogar a Portaria nº 87 de 11 de abril de 2018.

Art. 3º. Determinar que a presente Portaria seja devidamente publicada no Boletim de Serviços do IFMG - *Campus* São João Evangelista.

Art. 4º. Esta Portaria entra em vigor na data de sua publicação.

Documento assinado eletronicamente por **José Roberto de Paula**, **Diretor(a) Geral**, em 01/07/2020, às 13:33, conforme art. 1º, III, "b", da Lei 11.419/2006.

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PORTARIA Nº 146 DE 03 DE JULHO DE 2020

Dispõe sobre designação de membros do Colegiado do Curso de Bacharelado em Agronomia do IFMG - *Campus* São João Evangelista.

O DIRETOR-GERAL DO INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE MINAS GERAIS – *CAMPUS* SÃO JOÃO EVANGELISTA, no uso das atribuições que lhe são conferidas pela Portaria nº 1.175, de 20 de setembro de 2019, publicada no Diário Oficial da União de 23 de setembro de 2019, Seção 2, página 30, tendo em vista o Termo de Posse do dia 24 de outubro de 2019; e considerando a Portaria IFMG nº 475, de 06 de abril de 2016, publicada no DOU de 15 de abril de 2016, Seção 2, pág.17, retificada pela Portaria IFMG nº 805, de 04 de julho de 2016, publicada no DOU de 06 de julho de 2016, Seção 2, pág. 22, e pela Portaria IFMG nº 1078, de 27 de setembro de 2016, publicada no DOU de 04 de outubro de 2016, Seção 2, pág. 20,

RESOLVE:

Art. 1º. DESIGNAR os servidores e discentes como membros do Colegiado do Curso de Bacharelado em Agronomia do IFMG - *Campus* São João Evangelista, conforme segue:

MEMBRO	SEGMENTO	SITUAÇÃO
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Magnesium-influenced seed potato development and yield

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Magnesium-influenced seed potato development and yield

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ABSTRACT

Seed potato production in systems that provide higher amounts of planted material improves the potato production chain. Planting in a pot or hydroponic system with adequate plant nutrition may increase the seed potato yield. Among the nutrients, magnesium (Mg) has a role in a range of metabolic processes and biochemical reactions in plants, such as chlorophyll formation. Thus, the adequate supply of this nutrient is of fundamental importance. The study aimed to evaluate the effect of Mg dose on morphological characteristics of the plant and seed potato yield in two cultivation systems. Two experiments were installed simultaneously in a greenhouse. In experiment I, the plants were grown in a pot with organic substrate. In experiment II, the plants were cultivated in a hydroponic system, and five doses of Mg were evaluated. No other characteristics evaluated at 21 DAE showed significant response to Mg dose in both experiments, except for Mg content in the fourth leaf dry mass. The doses providing the highest seed potato yield, in units per plant, in experiments I and II were, respectively, 0.0 g dm^{-3} of $MgSO_4$ and 0.96 mmol L^{-1} Mg^{2+}. At these doses, the Mg content in the fourth leaf dry mass were 24.4 and 11.0 g kg^{-1}, respectively. The highest seed potato yield was obtained in the control (without Mg application) in experiment I and with the dose of 0.96 mmol L^{-1} in experiment II.

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hydroponic system; macronutrient; Solanum tuberosum L; substrate

Introduction

Potatoes are propagated by asexual reproduction of seed tubers, which guarantees genetic purity in the production field. The use of quality, healthy, and pure seed tubers is essential to obtain high productivity of tubers for consumption.

In addition to several other factors, the adequate supply of Magnesium (Mg) leads to a high productivity of potatoes (Allison, Fowler, and Allen 2001). Mg is a mineral nutrient with essential functions in plant metabolism. Furthermore, it is an indispensable enzyme activator in photosynthesis, respiration, nucleotide, and carbohydrate synthesis processes (Taiz et al. 2017; Lima et al. 2018).

Chlorophylls are the most abundant natural pigments that occur in leaf chloroplasts and other plant tissues. They are closely related to the photosynthetic efficiency of plants directly affecting their growth and adaptability to different environments. Chlorophylls are molecules formed by complexes derived from porphyrin, with Mg as the central atom (Schoefs 2002). A common response to Mg deficiency is to reduce chlorophyll concentrations, as observed in maize and

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wheat (Mengutay et al. 2013). Mg can be present at up to 35% in chloroplasts according to plant nutritional status (Cakmak and Yazici 2010) and about 25% of total Mg is bound to chlorophyll (Marschner 2012). Therefore, due to the importance of Mg for photosynthesis and redistribution of assimilates, it may affect the yield and quality of potato tuber (Senbayram et al. 2015; Koch 2018).

After being absorbed, Mg moves in response to gradient of water potential generated by transpiration. Therefore, higher concentrations of this nutrient are found in younger tissue. Mg content in potato tubers is conditioned by genetic characteristics as well as soil and climate conditions as the plant grows.

Traditionally, the diagnosis of potato N status is done by determining the N content in the fourth leaf dry mass (Li et al. 2012). There are alternative methods, such as determining the intensity of leaf green color through the color chart, chlorophyll meter and fluorometer, as well as biometric indices or biomarkers proposed by Fontes (2016). Because N is also a structural component of the chlorophyll molecule, the indices used to determine N status may be used for Mg.

The N indices are commonly evaluated with the Dualex and SPAD chlorophyll meters. The Dualex is a portable fluorometer used to estimate isolated and combined chlorophyll and flavonoid indices in real-time (Fontes 2016). The chlorophyll meter (SPAD) is also used to directly determine leaf green intensity, as it provides readings correlating with leaf chlorophyll content (Fontes 2016). In an experiment by Pereira (2001), increasing doses of Mg positively altered the SPAD value reading on newly expanded blades of Guinea grass. Low SPAD values in Tanzania grass leaves are associated with low Mg doses and lead to a reduced chlorophyll concentration in the leaves.

This study aims to verify the influence of Mg dose on biometric characteristics and indices of the fourth seed potato leaf grown in organic substrate and hydroponic system. It also aims to describe visual symptoms caused by deficiency and excess of Mg, as well as to determine the Mg dose to be applied in order to maximize the seed potato yield.

Material and methods

Two experiments were carried out simultaneously, from April to June 2012, in a greenhouse of Agronomy, Federal University of Viçosa, Viçosa, MG, Brazil. Agata potato cultivar was used in both experiments. Naturally germinated seed potatoes ($13-16$ mm in cross diameter) were used as propagation material. Both experiments were installed in a randomized block design with four replications. Each experimental unit consisted of a pot with one plant. The mean minimum temperatures inside the greenhouse for April, May and June were 19, 16 and 15 °C, and maximum 39, 31.5 and 30 °C, respectively.

In experiment I, the treatments consisted of five doses (0.0; 1.8; 3.6; 5.4 and 7.2 g dm^{-3}) of magnesium sulfate ($MgSO_4$). The plants were grown in a polyethylene pot (20 cm in upper diameter and 12 cm in lower diameter and 20 cm in height), containing 3 dm^3 of commercial organic substrate (Tropstrato HT®), composed of pine bark, peat and exfoliated vermiculite enriched with macro and micronutrients. The original substrate had a water retention capacity of 130% (w/w), a density of 490 kg m^{-3} and an electrical conductivity of 0.5 µS cm^{-1} in the 5:1 aqueous extract. The original substrate received a homogeneous pre-planting fertilizer mixture of 2.5 mg dm^{-3} zinc sulfate; 2.5 mg dm^{-3} copper sulfate; 0.25 mg dm^{-3} ammonium molybdate; 2.5 mg dm^{-3} ferrous sulfate and 2.5 mg dm^{-3} manganese sulfate. Furthermore, $MgSO_4$ doses corresponding to each treatment were added to the substrate, plus 3400 mg dm^{-3} superphosphate. Fertilizers were incorporated into the substrate along with potassium chloride (KCl), which was applied 10% (132 mg dm^{-3}) at the planting and 90% (1188 mg dm^{-3}) by fertigation for 15 days from the fifth day after emergence.

Table 1. Concentration of macro and micronutrients in the nutrient solution used in the treatment 3.

Macronutrients	mmol L^{-1}	Micronutrients	µmol L^{-1}
NO_3^-	11.7	$MnSO_4.H_2O$	12.6
NH_4^+	1.3	H_3BO_3	46.0
$H_2PO_4^-$	1.5	$ZnSO_4.7H_2O$	1.3
K^+	6.5	$(NH_4)_6Mo_7O_{24}.4H_2O$	0.1
Ca^{2+}	4.0	$CuSO_4.5H_2O$	0.3
Mg^{2+}	1.25	Fe EDTA	80.0
SO_4^{2-}	2.0		

Experiment II was performed in a hydroponic system, described by Silva Filho et al. (2018). The system consisted of pots (28 cm diameter and 27 cm height) polyethylene with a capacity of 8.5 L. The substrate used was washed sand and expanded clay. The nutrient solution was applied daily. Treatments consisted of five Mg doses (0.0; 0.625; 1.25; 2.5 and 5.0 mmol L^{-1}).

The macro and micronutrient concentrations in the nutrient solution used in Treatment 3 (1.25 mmol L^{-1}), considered ideal for potato production (according to Martinez and Silva Filho 2006), are shown in Table 1. In Treatment 1, 0.0 mmol L^{-1} of Mg^{2+} was used; in Treatment 2, half of the dose of Treatment 3 was used for Mg^{2+}; in Treatment 4 twice the Mg^{2+} dose used in Treatment 3 was used. Finally, in Treatment 5, a dose four times higher than the Mg^{2+} dose used in Treatment 3 was applied.

The nutrient solution was monitored daily by electrical conductivity and pH measurements. The pH was kept between 5.0 and 5.5 by adding sodium hydroxide (NaOH 1 mol L^{-1}) or hydrochloric acid (10% HCl). The nutrient solution was replaced when the electrical conductivity dropped by 30% in relation to the original, for any treatment. Irrigation was automatically controlled by a digital timer programmed to operate the electric pump for two minutes at 7 am, 10 am, 12 pm, 2 pm, and 4 pm.

In both experiments, evaluations were conducted at 21 and 61 days after emergence (DAE). For the fourth fully expanded leaf of each plant (reference leaf) the following were evaluated: SPAD Index (SPAD 502 - Soil Plant Analysis Development, Minolta Camera Co., Ltd., Japan); chlorophyll (Chl), flavanols (Flv) and N balance index (NBI) determined with the Dualex (Force-A, Orsay, France); length (LFL), width (WLF) and number of leaflets (NFL); leaf thickness (FLT) determined using a digital micrometer; and leaf area (FLA), which was determined using the leaf area meter LI-3100. Finally, fresh (FFLM) and dry (DFLM) masses of the fourth leaf were evaluated. Also, after drying the fourth leaf, dry matter was used to determine Mg (CMg) content after nitroperchloric digestion, according to methodologies described by Malavolta, Vitti, and Oliveira (1997).

At 21 and 61 DAE the following were evaluated in each plant: plant height (PH) (cm), number of stems (NS) and leaves (NL), fresh leaf (FLM), stem (FSM) and root (FRM) mass. Leaves (DLM), stems (DSM) and roots (DRM) were oven-dried at 70 °C, until constant weight, to obtain the dry mass, being expressed in mass per plant (g $plant^{-1}$). At 61 DAE, the seed potato was harvested and the seed potato number (SPN), fresh (SPFM) and dry (SPDM) mass per plant was determined.

The data was analyzed using ANOVA and linear regression using R statistical software (R Core Team (R Core Team, 2019)). To describe potato seed yield and other response parameters to Mg fertilizer doses, quadratic and linear models were adjusted. The regression model was chosen based on biological significance and the significance of the regression coefficients, using the *t*-test ($p < 0.10$). The means of the variables were grouped through the Scott-Knott test ($p < 0.05$) and submitted to Pearson correlation analysis. The significance of the correlation was assessed by the *t*-test ($p < 0.05$).

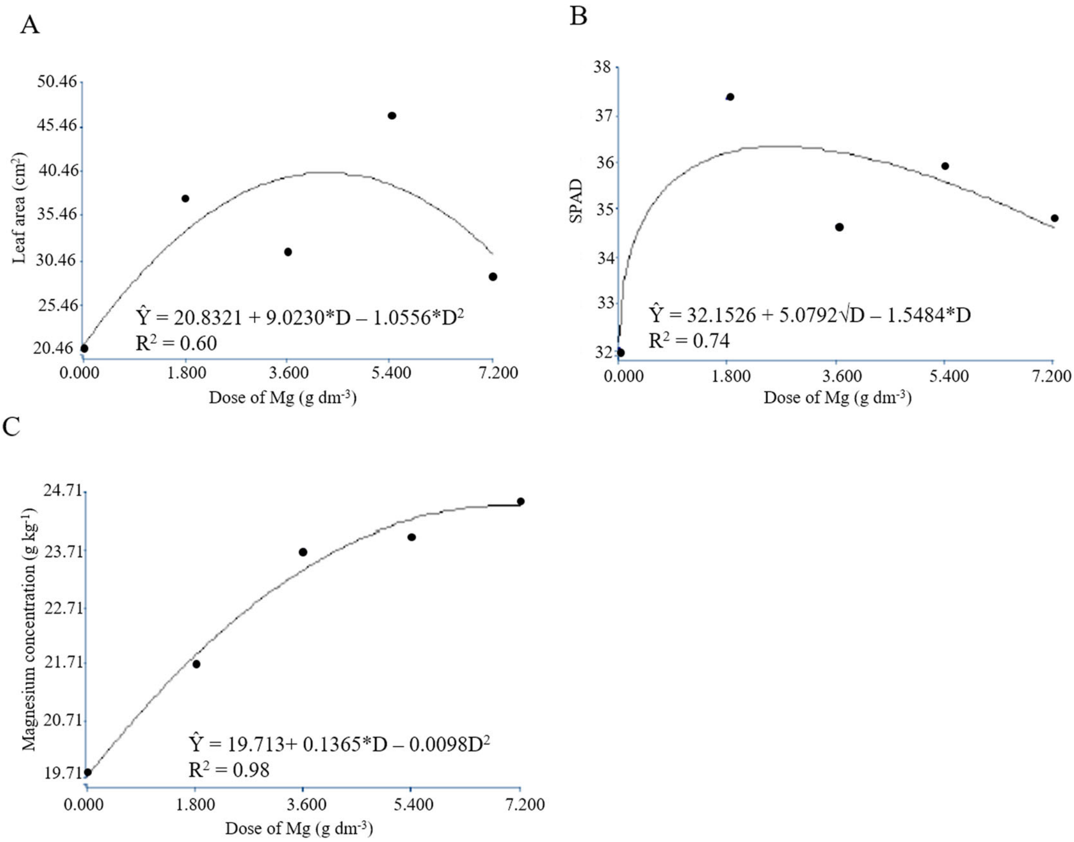

Figure 1. Relationship between leaf area (A), SPAD (B) and magnesium concentration (C) of the fourth leaf and doses of Mg in substrate, at 21 days after emergence. ** and * significant 0.05 and 0.10 probability levels, respectively, by t-test.

Results

The plant height, number of stems, number of leaves, fresh leaves, stems, and roots mass, dried leaves, stems, and roots characteristics evaluated at 21 DAE were not significantly influenced by Mg dose in neither experiment. In other words, the availability of Mg at 21 DAE was not insufficient or excessive for plant development. There was only destructive collection or sampling of the plant at 21 DAE. Perhaps at a later stage of the cycle, Mg dose effects would have been different.

In experiment I, evaluations of the fourth leaf showed an increase in the Mg content (CMg) with the increase of Mg doses in plants grown in organic substrate. The Mg content at 21 DAE followed a quadratic model characterized by increased nutrient content in the tissue with increased Mg dose. There was a significant increase up to a certain point, and then there was a decrease in the FA and SPAD indices at 21 DAE, which peaked at 40.11 cm^2 and 36.31 units for doses 4.27 and 2.69 g dm^{-3} of Mg, respectively (Figure 1). In experiment II at 21 DAE, the indices Chl, Flv and CMg were represented by a quadratic model. These indices were maximized with the supply of 1.25; 3.21 and 2.10 mmol L^{-1} of Mg, respectively (Figure 2).

Characteristics of productivity

In experiment I, models were adjusted to the seed potato number (SPN), fresh (SPFM) and dry (SPDM) mass per plant production indicator variables. A negative effect of Mg dose on the first two variables (fresh and dry mass per plant) was observed. The number of seed potatoes

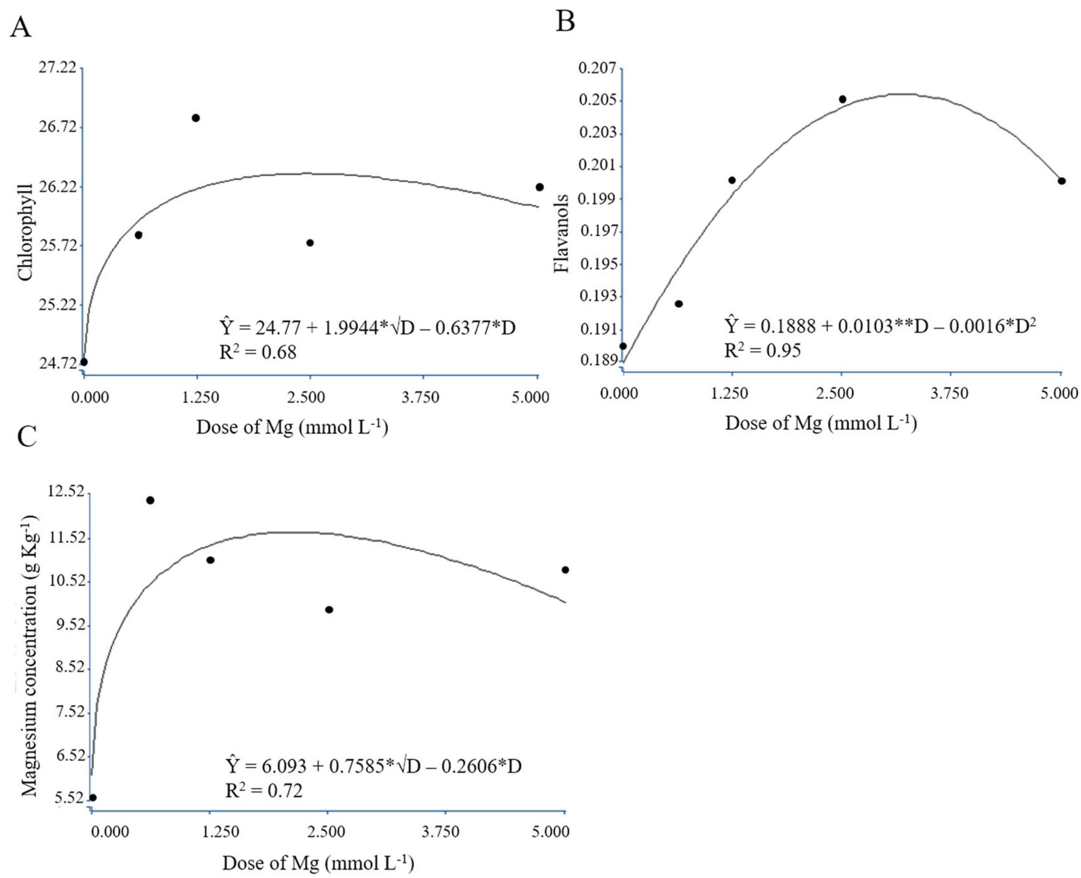

Figure 2. Relationship between chlorophyll (A), flavanol (B) and magnesium concentration (C) of the fourth leaf and doses of Mg in the hydroponic system, at 21 days after emergence. ** and * significant 0.05 and 0.10 probability levels, respectively, by t-test.

produced varied quadratically from 8.82 to 4.52 units per plant for doses of 0.0 and 7.2 g dm^{-3} of $MgSO_4$, while fresh seed potato mass varied linearly 134.42 to 76.51 g $plant^{-1}$ (data not shown). In organic substrate, the increase in Mg doses decreased the production of seed potatoes (SPN and SPFM). In experiment II, in hydroponics, the SPN, SPFM and SPDM variables increased and then decreased, influenced by Mg doses. The response equations for the variables had a maximum point of 5.84 unity $plant^{-1}$; 314.60 and 53.37 g for doses 0.96; 2.12 and 2.20 mmol L^{-1}, respectively. The control provided the lowest tuber yield in both fresh and dry mass. The models for the relationship between Mg dose and the described variables are shown in Table 2.

Only the Mg content in the fourth leaf dry mass was significantly influenced by the Mg dose in both experiments at 21 DAE. The highest seed potato yield, in units per plant, were obtained with the control (without Mg application) in the experiment I and with 0.96 mmol L^{-1} Mg in the experiment II. At these doses, the CMg in the fourth leaf dry mass at 21 DAE was 19.7 and 11.0 g kg^{-1}, respectively.

Selecting indices for diagnosing plant magnesium status

In experiment I, only the plant height (PH) variable showed significant correlation with the fourth leaf CMg at 21 DAE (Figure 3A). There was a negative correlation between PH and CMg

Table 2. Equations adjusted for the seed potato number (SPN), fresh (SPFM) and dry (SPDM) mass, as a function doses of Mg in substrate and hydroponic system.

Characteristic	Unity	Equation adjusted	R^2
Substrate			
SPN	ud planta^{-1}	$Y^a = 8.8214 - 0.9543^{**}D + 0.0496D^2$	0.95
SPFM	g planta^{-1}	$Y^a = 134.42 - 8.0425^{***}D$	0.98
SPDM	g planta^{-1}	$Y^a = 19.0113 + 5.5704\sqrt{D} - 2.9972^{*}D$	0.81
Hydroponic system			
SPN	ud planta^{-1}	$Y^a = 4.0636 + 3.6304\sqrt{D} - 1.8512^{*}D$	0.71
SPFM	g planta^{-1}	$Y^a = 105.26 + 286.99^{***}\sqrt{D} - 98.36^{**}D$	0.95
SPDM	g planta^{-1}	$Y^a = 13.025 + 54.15^{**}\sqrt{D} - 18.27^{**}D$	0.92

***, ** and *significant 0.01, 0.05, and 0.10 probability levels, respectively, by *t*-test, D = dose of Mg in g dm^{-3} and mmol L^{-1}, substrate and hydroponic, respectively.

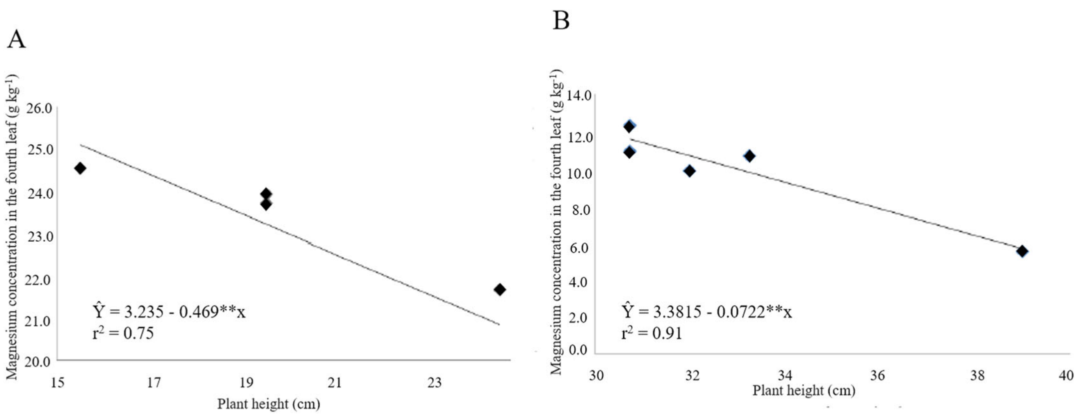

Figure 3. Relationship between the magnesium concentration in the fourth leaf and the plant height, in the substrate (A) and hydroponic system (B), at 21 days after emergence. ** and * significant 0.05 and 0.10 probability levels, respectively, by t-test.

indicating that low Mg availability leads to higher plant growth in height. There was a negative correlation between PH and CMg. In experiment II, there was a positive significant correlation between Chl and CMg at 21 DAE. There was also a significant negative correlation between CMg in the fourth leaf and the variables PH, FLM, FRM, DLM, DRM, FLT and NBI at 21 DAE (Table 3), indicating that the lack of Mg in solution may cause plant breakdown as a way to adapt to the nutrient deficiency. As a result, the PH characteristic was selected and is shown in Figure 3B.

Selecting indices for seed potato yield prognosis at 21 DAE

In experiment I, the seed potato number (SPN) obtained at harvest correlated positively with the PH variable and negatively with the FFLM, DFLM, NBI and CMg variables (Table 4). SPFM can be predicted by the variables PH, DFLM, NBI and CMg. The AP variable correlated positively with the SPFM and negatively with the other variables. The correlation between SPDM and PH and FLT was positive while with CMg it was negative. The SPN, SPFM and SPDM indices all correlated significantly and positively with PH. Therefore, PH is a good biometric characteristic to be used in predicting seed potato yield in organic substrate. In contrast, CMg correlated negatively with the three yield indices (SPN, SPFM, SPDM), indicating an inverse relationship between CMg and seed potato yield in organic substrate. Some of the selected relationships, such as Mg concentration in the fourth leaf with SPN and SPFM, as well as PH with SPDM are shown in Figure 4.

In experiment II, the seed potato number (SPN) produced correlated positively and significantly with the variables FLM, FRM, and DLM evaluated at 21 DAE. SPN also presented a

Table 3. Estimates of Pearson's simple linear correlation coefficients between characteristics evaluated at 21 DAE.

Characteristic of the plant	Concentration of Mg in the fourth leaf		Characteristic of the fourth leaf	Concentration of Mg in fourth leaf	
	Substrate	Hydroponic system		Substrate	Hydroponic system
PH	−0.86*	−0.95***	FLT	−0.56	−0.81**
NH	0.30	0.12	LFL	0.12	−0.19
NF	−0.15	0.55	WFL	0.31	−0.32
FSM	−0.61	−0.48	NFL	−0.04	0.36
FLM	−0.39	−0.80**	FLA	0.51	0.54
FRM	−0.03	−0.95***	FFLM	0.65	0.10
DSM	0.28	−0.27	DFLM	0.76**	−0.11
DLM	0.47	−0.96**	NBI	0.75**	−0.73*
DRM	−0.24	−0.93***	Chl	0.15	0.78*
			Flv	0.06	0.39
			SPAD	0.45	−0.28

Characteristic of the plant: plant height (PH), number of stem (NS) and leaves (NL), fresh leaf (FLM), stem (FSM) and root (FRM), dry (DLM), stems (DSM) and roots (DRM). Characteristic of the fourth leaf: thickness (FLT), length (LFL), width (WFL), number of leaflets (NFL), leaf area (FLA), fresh (FFLM) and dry (DFLM) masses, index nitrogen balance (NBI), chlorophyll (Chl), flavanols (Flv), SPAD with the concentration of Mg in the fourth leaf, in plants cultivated in the substrate and hydroponic system.
***, ** and *significant 0.01, 0.05, and 0.10 probability levels, respectively, by *t*-test.

Table 4. Estimates of Pearson's simple linear correlation coefficients between characteristics assessed at 21 DAE.

Characteristic of the plant	SPN		SPFM		SPDM	
	Substrate	Hydroponic system	Substrate	Hydroponic system	Substrate	Hydroponic system
PH	0.80**	−0.61	0.92***	−0.97***	0.95**	−0.93***
NH	−0.56	0.21	0.15	0.26	−0.33	0.23
NF	0.06	−0.17	0.17	0.70*	0.54	0.58
FSM	0.54	−0.61	0.60	−0.68	0.31	−0.61
FLM	0.33	0.91***	0.38	0.69	0.11	0.64
FRM	0.07	0.75*	0.02	0.80**	−0.38	0.70*
DSM	0.02	−0.38	−0.01	−0.51	−0.13	−0.60
DLM	−0.61	0.75*	0.57	0.82**	−0.51	0.73*
DRM	0.31	−0.82**	0.24	−0.88**	−0.25	−0.71*
Fourth leaf						
FLT	0.47	−0.07	−0.59	−0.71*	0.87**	−0.77*
LFL	−0.29	−0.49	−0.03	−0.44	0.50	−0.40
WFL	−0.45	−0.48	−0.20	−0.58	0.35	−0.46
NFL	−0.45	−0.29	0.19	0.18	0.35	0.12
FLA	−0.60	0.15	−0.38	0.24	0.16	0.15
FFLM	−0.74*	−0.31	−0.55	−0.15	−0.01	−0.20
DFLM	−0.84**	0.00	−0.71*	−0.46	−0.31	−0.50
NBI	−0.88**	−0.24	−0.74*	−0.87**	−0.14	−0.65
Chl	−0.36	0.23	−0.15	0.76*	0.50	0.94***
Flv	−0.38	−0.22	−0.29	0.66	0.08	0.74*
SPAD	−0.58	−0.45	−0.39	−0.22	0.28	0.19
CMg	−0.94***	0.60	−0.95***	0.92***	−0.68*	0.83*

Characteristic of the plant: plant height (PH), number of stem (NS) and leaves (NL), fresh leaf (FLM), stem (FSM) and root (FRM), dry (DLM), stems (DSM) and roots (DRM). Characteristic of the fourth leaf: thickness (FLT), length (LFL), width (WFL), number of leaflets (NFL), leaf area (FLA), fresh (FFLM) and dry (DFLM) masses, index nitrogen balance (NBI), chlorophyll (Chl), flavanols (Flv), SPAD and concentration Mg fourth leaf (CMg) with the number of tubers (SPN), the fresh mass of tuber (SPFM) and dry mass of tubers (SPDM) in substrate and hydroponic system.
***, ** and *significant 0.01, 0.05, and 0.10 probability levels, respectively, by *t*-test.

negative correlation with DRM evaluated at 21 DAE. There was a significant correlation between SPFM and PH, NFL, FRM, DLM, DRM, FLT, NBI, Chl and CMg at 21 DAE. Likewise, SPDM can also be predicted with the variables PH, FRM, DLM, DRM, FLT, Chl, Flv and CMg evaluated at 21 DAE. Some of the selected relationships, such as DLM with SPN and PH with SPFM are shown in Figure 5.

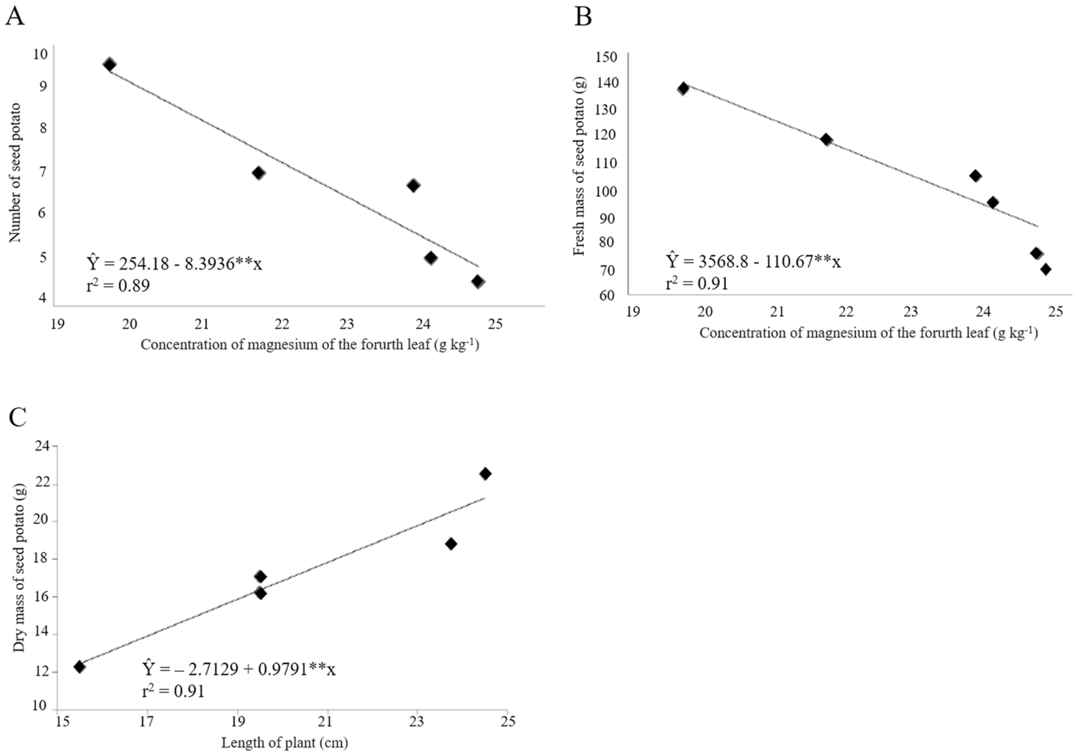

Figure 4. Equation to prognosis the seed potato number (A) and fresh mass (B) at harvest by evaluating the magnesium concentration present in the fourth leaf and dry mass of seed potato (C) at harvest by the evaluation of plant height, in the substrate. ** and * significant 0.05 and 0.10 probability levels, respectively, by t-test.

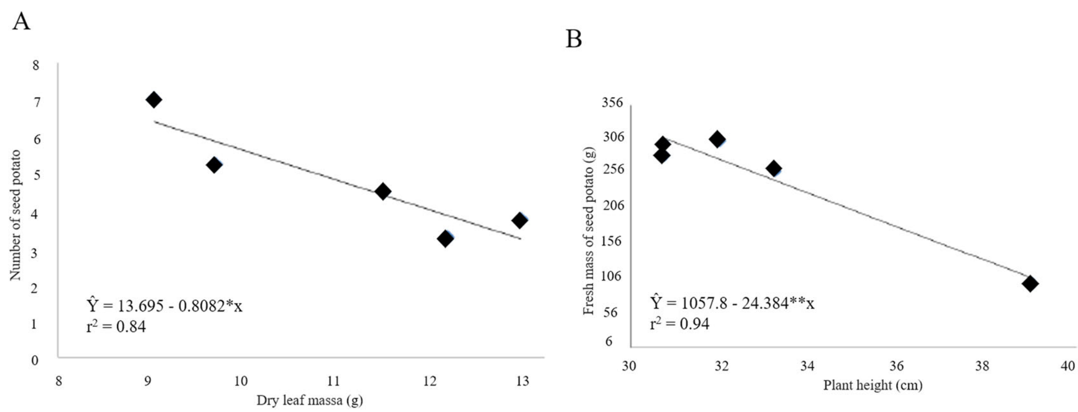

Figure 5. Equation to prognosis the seed potato number in the harvest by the evaluation of the fresh mass of leaves (A) and fresh mass of seed potato in the harvest by the evaluation of the fresh mass of the leaf (B) in the hydroponic system. ** and * significant 0.05 and 0.10 probability levels, respectively, by t-test.

Discussion

Symptoms of deficiency or excess of Mg were not observed in the potato cultivated in organic substrate (Experiment I). In Experiment II, the substrate used was washed sand and at 40 DAE the presence of *Alternaria solani* was observed in all plants cultivated without Mg. There were no visual symptoms of nutrient excess in Experiment I, but there was a negative effect of Mg dose on characteristics, like SPN and SPFM.

Classic symptoms of Mg deficiency are chlorosis between the ribs, inverted “v” formation in the petiole, formation of small fruits and falling leaves. Mg deficient plants are more susceptible to *Alternaria solani*, the soil fungus causing Potato blight. Together with *Phytophthora infestans* (late blight), is one of the main potato crop diseases, with a higher incidence in periods of high thermal amplitude.

Mg is a regulator of physiological processes that influences the susceptibility or resistance to plant diseases. This macronutrient is a structural component of the middle lamella and of the chlorophyll molecule. It is also essential to maintaining ribosome structure and is associated with cell growth, mitosis, high protein levels, carbohydrate metabolism, and oxidative phosphorylation. It is involved in energy transfer reactions, respiration, and nucleic acid synthesis (Marschner 2012). All these processes are involved in the response of the plant to disease (Horsfall and Cowling 1980). Mg deficiency during plant growth reduces the structural integrity of the middle lamella and the energy production required for defense and inactivation of pathogenic metabolites.

Even though Mg is a major nutrient required in small amount for the potato cultivation (Paula, Fontes, and Nogueira 1986), it needs to be made available in an adequate amount for high crop yield. It is recommended that the substrate contain at least 8.0 $mmol_c$ dm^{-3} Mg (Fernandes, Soratto, and Silva 2011). The substrate used to conduct Experiment I was an organic substrate enriched with macro and micronutrients. The analysis of the substrate revealed that it contained about 13 $mmol_c$ dm^{-3} Mg. Therefore, the amount of Mg present in the substrate was sufficient for plant development, even in the control.

There was no effect of Mg dose on growth variables, PH, NFL, NS, in the hydroponic system measured at 21 DAE. Probably the Mg contained within the seed potato was sufficient to supply the initial need of the plants. However, as early as 21 DAE, the plants began to show chlorosis (measured by Chl). It was shown by Boaro et al. (1996) that even low Mg levels can maintain the adequate development of common beans due to the nutrient reserve in the seed. This could happen in potatoes, using seed potato or even sprout as propagating material.

At 21 DAE, there was an increase of Mg content in the fourth leaf with the increase of Mg doses in plants grown in organic substrate. It followed a quadratic model characterized by increased nutrient content in the tissue with increased Mg dose. A similar pattern was observed by Moreira (2008) when using minitubers and sprouts as propagative material. In hydroponic cultivation, the Mg content in the fourth leaf was optimized with the dose 2.10 mmol L^{-1} Mg. Excessive Mg in solution may have compromised nutrient absorption by the roots.

Root absorption of Mg depends on several factors such as soil solution ion concentration and Mg absorption efficiency. This is closely linked to plant growth and development which is influenced by several factors, mainly management, water availability, respiration intensity, temperature, light intensity, and volume of substrate available to the roots. Absorption, transport, assimilation, and accumulation of nutrients are integral parts of this complex organization. Thus, there is interdependence between crop growth rate and nutrient accumulation rate (Fontes 2001).

Assuming that the 21 indices determined at 21 DAE, except CMg, are evaluative indices of plant N status, it can be seen that the influence of Mg dose on the indices for diagnosing plant N status depends on the substrate. In organic substrate, models were adjusted to the characteristics FLA and SPAD with Mg doses. The FLA and SPAD indices peaked at 40.11cm^2 and 36.31 units for the doses 4.27 and 2.69 g dm^{-3} of Mg, respectively. The result found for FLA differs from that observed for common bean plants, where plants grown at low Mg levels presented higher FLA as an adaptation to the low nutrient solution (Boaro et al. 1996). In a study on Tanzania grass, exponential model was observed, and only very low doses of Mg were not sufficient for the plant to develop normally (Consolmagno Neto 2007).

In a study with tomatoes, there was no response from higher Mg doses regarding leaf chlorophyll content (Mógor et al. 2013). In corn, when testing different sources and doses of Mg, there was no significant effect on the leaf chlorophyll index (Silva et al. 2016). Therefore, it is hypothesized that in order to reduce the stress of absorbing excess Mg at the high doses, plants store excess ions in vacuoles, not associated with chlorophyll molecules (Gao, Zhao, and Jiang 2015).

Using organic substrate from another commercial brand, Moreira (2008) noted an increase in the number of seed potatoes as $MgSO_4$ doses increased, regardless of the propagation material. The maximum number of seed potatoes produced using mini tubers and sprouts as propagation material were 9.8 and 3.4, respectively. Furthermore, the authors did not find significant effect of Mg dose on fresh and dry masses of tubers grown under protected conditions (Moreira 2008) or under field conditions (Allison, Fowler, and Allen 2001) which is in accordance with the results obtained in this study.

Applying $MgSO_4$, commonly known as Epsom salts ($MgSO_4.7H_2O$) may or may not positively influence certain plant characteristics including yield (Costa et al. 2010). In the case of Experiment I, there was marked $MgSO_4$ excess, mainly at the higher doses resulting in lower SPN, SPFM and SPDM values.

Some studies reported a negative effect of $MgSO_4$ on plants such as the reduction of pulp thickness and diameter of melon fruits (Costa et al. 2010); reduced K in potato leaves and tubers without affecting yield (Laughlin 1966); reduction in common bean and soybean leaf area (Boaro et al. 1996; Nascimento et al. 2009) and decreased corn yield (Rheinheimer et al. 2005). There are several reasons why there are few reports of negative effects of $MgSO_4$.

In an experiment, when the response obtained is a quadratic curve, that is, both lack and excess of Mg^{2+} and $SO_4{}^{2-}$ are harmful to plants. In nutrient solution, Silva, Venegas, and Ruiz (2002) showed that excess sulfates (K_2SO_4, $(NH_4)_2SO_4$ and $MgSO_4$) induced soybean plants to absorb large amounts of sulfur, partly concentrating in leaves, characterizing luxury consumption, and largely accumulating or precipitating on the surface of the roots as calcium sulfate. Excess sulfur results in deleterious injuries of the plants such as potato leaf injuries with decreasing leaf area and interference in assimilate partition from leaves to other plant organs (Petitte and Ormrod 1988). However, the results obtained with sulfur, $CaSO_4$ and $MgSO_4$ application can lead to different results.

In Experiment II, the seed potato number (SPN), fresh (SPFM) and dry (SPDM) mass variables were influenced by the Mg doses in solution, the response equations for the variables had a maximum point of 5.84 units plant^{-1}; 314.60 and 53.37 g for doses 0.96; 2.12 and 2.20 mmol L^{-1}, respectively. The control dose provided the lowest seed potato fresh and dry mass. When evaluating the effect of Mg application in deficient soils in Long Island, there was a difference in tuber yield (kg ha^{-1}). However, when the control (Mg dose 0.0) was compared with the other levels, there was no significant difference between levels (Sawyer and Dallyn 1966).

The hydroponic SPN, SPFM and SPDM production indices followed square root models, indicating that both lack and excess Mg reduce potato yield. The effect of absorbed Mg on potato plant tuber yield is related to photosynthesis and partition of assimilate, other factors such as temperature, photoperiod, nutrient availability and hormonal combinations influence the potato tuberization process (Jackson 1999).

Selecting indices for diagnosing magnesium status in potato plants

The index used to diagnose the potato plant Mg status depended on the substrate. In Experiment I, using the organic substrate, the indices correlating with CMg were PH, DFLM and NBI. Correlation between PH and CMg was negative, indicating that low Mg availability leads to greater plant growth in height. Plants cultivated in nutritional imbalance usually etiolate, trying to compensate for deficiency with higher light absorption (Boaro et al. 1996).

In Experiment II, in hydroponics, there was a positive and significant correlation between Chl and CMg at 21 DAE. There was also a significant negative correlation between CMg in the fourth leaf and the variables PH, FLM, FRM, DLM, DRM, FLT and NBI at 21 DAE, indicating that the absence of Mg in solution can cause plant breakdown as a way of adapting to nutritional deficiency.

Selecting for seed potato yield prognosis

Seed potato yield can be quantified by seed potato number and fresh mass. However, under experimental conditions it is also common to evaluate their dry mass. An index efficient of predicting seed potato production per plant was not found. In Experiment I, the number of seed potatoes obtained at harvest correlated positively with the PH variable and negatively with the FFLM, DFLM, NBI and CMg variables. Milagres (2011) did not observe any index capable of predicting the production of seed potato, cultivar Agata, in organic substrate at 21 DAE.

In hydroponic system (Experiment II), SPN produced correlated positively and significantly with the variables fresh leaf (FLM), root (FRM), and dry leaf (DLM) mass evaluated at 21 DAE. The SPN also correlated negatively with the DRM evaluated at 21 DAE. Silva Filho (2011) selected FLA, NFL, DFLM, DRM and SPAD as prognostic indices of seed potato production in hydroponics at 21 DAE.

The PH index was the only one capable of predicting the production of fresh and dry mass of seed potatoes per plant in both experiments at 21 DAE. However, correlation between PH and CMg in the organic substrate experiment was positive, while for the hydroponics experiment the correlation was negative. Milagres (2011) also noted that the PH characteristic can predict SPFM seed potato yield at 21 DAE.

In experiment I, SPFM can be predicted by the variables PH, DFLM, NBI, and CMg. The AP variable was positively correlated with SPFM, for the other variables the correlation was negative. SPDM can also be predicted by evaluating the AP, FLT, and CMg indices. The correlation between SPDM and PH, and FLT was positive while with CMg it was negative. The SPN, SPFM, and SPDM indices all correlated significantly and positively with PH. Therefore, PH is a good biometric characteristic in predicting seed potato yield in organic substrate. In contrast, CMg correlated negatively with the three yield indices, indicating an inverse relationship between the CMg and seed potato yield in organic substrate. As Mg was supplied as $MgSO_4$, excess sulfur may also have contributed to the decrease in production.

In experiment II, there was a significant correlation between SPFM and the characteristics PH, NFL, FRM, DLM, DRM, FLT, NBI, Chl, and CMg at 21 DAE. In hydroponics, Silva Filho (2011) selected the characteristics FLA, NFL, DFLM, DSM, and DRM as predictive indices of seed potato production in SPFM. Similarly, SPDM can also be predicted with the variables PH, FRM, DLM, DRM, FLT, Chl, Flv, and CMg evaluated at 21 DAE. Yield prediction based on early evaluations of plant biometric characteristics may be useful for crop planning and the commercialization of the seed potatoes produced.

Conclusions

The doses of Mg tested in this study did not influence the biometric characteristics or the fourth leaf indices. Also, Mg deficiency was not observed in the plants. The optimal dose of Mg for hydroponics cultivation is 0.96 mmol L^{-1}.

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