Revista Agrogeoambiental, Pouso Alegre, v. 11, n. 2, jun. 2019. DOI: http://dx.doi.org/10.18406/2316-1817v11n220191285

Production aspects of soybean cultivars in Machado region, south of Minas Gerais, Brazil

Pedro Antonio Pires Lins da Silva[1]

Roberto de Farias Filho[2]

Abstract

Due to its productive potential and importance in human and animal nutrition, soybeans occupy a prominent position in Brazilian economy. Its cultivation in the south of Minas Gerais has been increasing compared to other crops; however, availability of adapted cultivars still low. Therefore, the present research was developed with the aim of evaluating different soybean cultivars productive aspects in Machado region, Minas Gerais, in order to identify cultivars that can be recommended for cultivation in this region. The experimental design consisted of randomized complete block design with four replications and six soybean cultivar treatments (5D6215 IPRO, 5D634 RR, NS 7709 IPRO, NS 7300 IPRO, NS 7667 IPRO and NS 7200 RR). Seeding was conducted in the second week of November/2015. It was verified that Machado region was suitable for soybean cultivation, since all cultivars presented plant height and the first legume height of insertion was favorable to mechanized harvest. Cultivars 5D634 RR, NS 7200 RR and NS 7709 IPRO obtained the best grain yield results with 3.676,62, 3.612,45 and 3.377,90 kg ha^{-1}, respectively. Cultivars 5D6215 IPRO, 5D634 RR, NS 7709 IPRO and NS 7200 RR are within the acceptable levels of lodging for mechanized harvesting. On the other hand, cultivars 5D6215 IPRO and NS 7200 RR demonstrate an emergency speed higher than the other studied cultivars.

Keywords: *Glycine max* (L.) Merrill. Grains Yield. Adaptability.

Introduction

Brazil is the second largest soybean producer in the world. The crop is present in more than 50% of the country cultivation area. Its cultivation began in the southern region of Brazil, more precisely in Rio Grande do Sul; since then, national and international demand for it has been expanding. Official data reveal the 2013/2014 production harvest was estimated at 86.8 million tons of soybeans (Food and Agriculture Organization of the United Nations statistics division - FAOSAT, 2014), while the estimate for 2016/2017 crop indicates a 103 million tons of grain production (United States Department of Agriculture-USDA, 2016).

Increase in production areas and high productivity rates are due to the growing demand for the grain, once it meets several economic needs, such as vegetable oil production, protein based feed, animal production and it works as a source for biofuels. Soy plantation is expected to be a profitable activity in the coming years in Brazil, based on its importance and high future demand; among the

1 Instituto Federal de Educação, Ciência e Tecnologia do Sul de Minas Gerais, *Campus* Machado, graduando em Agronomia. ppireslins@gmail.com. Rua Alemanha nº 400, Bairro Jardim Bizarro, Jundiaí, São Paulo, CEP 13207-500.

2 Instituto Federal de Educação, Ciência e Tecnologia do Sul de Minas Gerais - *Campus* Machado, graduando em Agronomia. robertofarias.agro@hotmail.com.

main grain producers, the United States of America, Argentina and Brazil will not have the capacity to increase their planted area, since they have the need to produce other crops and livestock activities that prevent them from expanding the soybean area (SEDIYAMA et al., 2015). Among the expanding areas, the state of Minas Gerais stands out in the southeast region.

According to National supply company-CONAB's historical series (2016), the state of Minas Gerais, which is the main producer in the Southeast region, increased its soybean production by 64% and 47 % in the last 20 years. The soybean has been expanding in areas previously cultivated with maize, due to the cultivar use which is increasingly precocious, maintaining soybeans in the first crop and maize in the second, in the same year.

One of the reasons that explain the increase of soybean production in the state of Minas Gerais is the advance of genetic modified plants. In Brazil, more than 1.000 registered soybean cultivars between conventional and transgenic can be found, adapted to traditional and new agricultural frontiers (SEDIYAMA, 2015). Several factors can distinguish one cultivar from the other, highlighting cycle, plant height, leaf shape, growth habit and oil content.

Regarding the cycle, very early cycle cultivars are generally less productive due to the shorter vegetative and reproductive development period in the field. However, precocity has the advantage of enabling a second crop in the same area. Late cultivars, when sown at the appropriate time, can form more leaves and develop slowly, resulting in higher productivity (SEDIYAMA, 2015).

According to Brazilian Agricultural Research Corporation-EMBRAPA (2010), in a group of cultivars with the same cycle length, those with a longer juvenile period bloomed later; therefore, they show a longer period of growth before they bloom, exhibiting higher plants. For cultivars of indeterminate growth type, what defines the plants high size is that they continue to grow in height for a few weeks after blooming, and they can even double their height in that period.

Genetic improvement programs always aim to select plants with resistance to lodging, but the growing environment has a significant influence on this characteristic. Thus, it must be worked with a suitable population for each cultivar, as well as the indicated location and sowing time to obtain high productivity under low lodging intensity (SEDIYAMA, 2015).

In the southern of Minas Gerais, Rezende and Carvalho (2007), studying the behavior of 45 cultivars, found satisfactory yields, highlighting Vencedora, Paiaguás, Aventis 2056-7, Monarch and FT 2000, which presented production above 3.400 kg ha^{-1}.

Furthermore, Carvalho et al. (2010), studying the behavior of 24 cultivars in two locations, Lavras-MG and Itutinga-MG, during two consecutive years, found cultivars such as Monsoy 8001, Conquista, Vencedora, DM Nobre, Emgopa 315, DM Vitória, M-soy 6101, Preta, UFV 16, Emgopa 316, Santa Rosa, Aventis 7002 and CAC 1 had yields varying from 2.958 to 3.575 kg ha^{-1} for the city of Itutinga (MG), while in Lavras they emphasized the cultivars UFV 16 and M-soy 6101 with yields of 3.553 and 3.543 kg ha^{-1}, respectively.

Batista et al. (2015) observed the behavior of 22 cultivars in Inconfidentes region, south of Minas Gerais, where the cultivars CD 2737 and TMG 1179 RR were superior and with productivity average of 2.400 kg ha^{-1} and 2.830 kg ha^{-1}, respectively.

Research is needed to relate genotype with the environment for the adaptation of a cultivar to a given region, resulting in materials that present satisfactory production and harvesting characteristics. The objective of this research was to evaluate the productive aspects of different soybean cultivars in Machado, Minas Gerais, in order to identify cultivars that can be recommended in the region cultivation.

Material and methods

The present research was conducted in the experimental area at Instituto Federal do Sul de Minas Gerais, *Campus* Machado, coordinates 21° 69" 21" S, 45° 89' 94" W at 862 m altitude, from November 2015 to March 2016. According to Köppen's classification, climate is Cwa, evidencing mild temperatures, with hot and humid summer. The soil was classified as Red Latosol (EMBRAPA, 2006).

The experimental area was cultivated with maize for grain production in the previous harvest, being prepared with a plowing and two harrowing before the experiment sowing.

Seeding was made in a conventional manner on November 13, by hand, based on a population of 340.000 plants per hectare, for all treatments. When sowing, inoculation with ATMO® commercial product was carried out; it was composed of *Bradyrhizobium japonicum* strain in a dosage of 100 mL of commercial product for each 50 kg of seed, in order to favor the biological nitrogen fixation. After 10 days in emergency, slabs were conducted, respecting the expected plant stand.

According to the soil analysis, the base fertilization was 200 kg ha^{-1} of Monoammonium phosphate (MAP) from the 10-50-00 formula, applied in the planting groove, and the cover fertilization was performed with Potassium Chloride at dosage of 150 kg ha^{-1} right after sowing, following Ribeiro et al. (1999) recommendations.

Weed control was made chemically, using the following active ingredients: Fluazifop-p-butyl (187 g ha^{-1}) and Fomesafen (250 g ha^{-1}) applied approximately fifteen days after emergency and Glyphosate (1,440 g ha^{-1}) when conducting desiccation before harvesting, the two applications were performed with a 0,5 % vegetable oil blend, in a volume of 240 L ha^{-1}.

For pests and disease control, insecticides and fungicides were applied preventively from the V5 phenological stage, totaling four applications until the grain harvest of Thiamethoxam (250 mL ha^{-1}) and Azoxystrobin + Ciproconazole (300 mL ha^{-1}) with vegetable oil at 0,5 % volume concentration of 200 L ha^{-1} applied.

Experimental design

The experimental design was constituted of randomized block design, with four replications, using six soybean cultivars that were recently launched and with potential use in Machado region. These are: 5D6215 IPRO, 5D634 RR, NS 7709 IPRO, NS 7300 IPRO, NS 7667 IPRO, NS 7200 RR. Each plot was constituted of five lines with five meters each, spacing 0,5 m between them, totaling an area of 12,5 m^2 per plot and an experimental area of 300 m^2.

Analyzed Variables

In order to evaluate the different planted cultivars quality and the adaptability, the following evaluations were carried out:

Emergency in seedbed

Four replicates with 50 seeds were sown per treatment in a seedbed under environment condition, being irrigated when necessary. The evaluation was conducted since the first seedlings emergency until their stabilization; emergency speed rate was determined according to the formula proposed by Maguire (1962).

Plant height

Using a graduated ruler, plant height was measured at the time the plants were in R8 phenological stage, ten plants were randomly selected, in each plot within the useful area, considering the distance between the plant collar and the plant highest leaf insertion point sampled. Measurements were taken in centimeters.

First legume height of insertion

It was measured with a graduated ruler when the plants were at R8 phenological stage, ten random plants were selected in each plot within the useful area, considering the distance between the plant collar and the first plant legume insertion point, and it was also taken in centimeters.

Grain productivity

A manual harvest of each plot useful area was carried out, followed by grain weighing and moisture reading by the oven drying method (BRASIL, 2009). Afterwards, the moisture correction to 13 % was done by calculating the humidity break according to the following equation, in order to estimate the productivity in kilograms per hectare.

At which:
QU (%) = Humidity break;
U_i (%) = Initial humidity;
Uf (%) = Final humidity.

Number of pods per plant and number of grains per pod

Ten plants per plot were randomly collected from the experimental area at the time they were identified at the phenological stage of R8. After sampling, the number of pods per plant and the number of grains per pod were counted.

Lodging index

Considering each plot general aspect, the evaluation was conducted according to Bernard et al. (1965), before the harvest when the plants were at R8 phenological stage. It was found grade 1 for all standing plants, grade 2 for plants inclined or slightly bedded, grade 3 for plants moderately inclined or 25-50 % lodged, grade 4 for all plants severely inclined or 50-80 % lodged and grade 5 for plants more than 80 % lodged.

Statistical Analysis

Statistical analysis were performed using Sisvar software (FERREIRA, 2007). Scott-Knott test was applied at 5 % probability level for average comparison.

Results and discussion

It was observed most of the evaluated characteristics obtained significant results for the variables: productivity, plant height, first legume height of insertion, emergency speed rate and lodging. It was not found significance for number of pods per plant and number of grains per pod (TABLE 1).

Table 1. Variance analysis summary for yield (P), plant height (AP), first legume height of insertion (IL), lodging note (Ac), number of pods per plant (NV), number of grains per pod (NG) and emergency speed index (IVE) of six soybean genotypes grown in Machado, MG.

Variation Source	Medium Squares						
	P	AP	IL	Ac	NG	NV	IVE
Cultivars	1143745,45*	260,93*	20,98*	3,76*	ns	ns	0,19*
RSD (%)	7,33	8,43	8,9	21,37	6,84	21,15	5,40

* Significant at 5 % probability level.
Source: Elaborated by the authors (2016).

There was a difference in productivity for the cultivars observed, among them 5D634 RR, NS 7200 RR and NS 7709 IPRO with grain yield averages of 3.676,62 kg ha^{-1}, 3.612,45 kg ha^{-1} and 3.377,90 kg ha^{-1}, respectively (TABLE 2).

According to 2015/2016 crop latest survey, national productivity averages and the state of Minas Gerais averages were 2.870 and 3.220 kg ha^{-1}, respectively (CONAB, 2016). Therefore, it can be stated that averages found for cultivars in Machado region are higher than the national average and the average for the state of Minas Gerais.

Table 2. Yield (P) average results of six soybean genotypes grown in Machado (MG).

Cultivars	Average
	P (kg ha^{-1})
5D634 RR	3.676,62 a
NS 7200 RR	3.612,45 a
NS 7709 IPRO	3.377,90 a
NS 7300 IPRO	3.008,12 b
NS 7667 IPRO	2.730,82 b
5D6215 IPRO	2.315,72 c

Averages followed by the same letter do not differ by Scott-Knott's test at 5 % probability.
Source: Elaborated by the authors (2016).

Grain yield is greatly influenced by several environmental factors, such as humidity, temperature and photoperiod, which vary through the seasons. High yields can be obtained when environmental conditions are favorable at all development stages (GUIMARÃES, 2006). The 2015/2016 summer crop in Machado region, Minas Gerais, was marked by heavy rainfall in January and February, which caused loss of soybean plants by tipping and defoliation in some plantations, consequently, influencing final yield.

Souza et al. (2015) evaluated the performance of 13 cultivars in Machado region, Minas Gerais, and they obtained satisfactory results with the materials 97R73 RR, BMX DESAFIO RR and LG 60177 IPRO, reaching yields averages from 4,692 to 5,376 kg ha^{-1}. In Lavras, Minas Gerais, Batista et al. (2015) during the agricultural year 2014/2015 achieved good productivity averages with cultivars 7338 IPRO (4,420 kg ha^{-1}), LG 60177 IPRO (4,383 kg ha^{-1}) and 7209 IPRO (4,346 kg ha^{-1}).

All studied cultivars obtained plant height suitable for mechanized harvesting. It was also verified that plant heights varied from 81 to 103 cm, and the cultivars 5D634 RR and NS 7200 RR, which presented better yields also obtained higher plant height. In Inconfidentes, southern region of Minas Gerais, Batista et al. (2015) evaluated 22 soybean materials and obtained plants with height varying from 79 to 113 cm, all compatible with mechanized harvesting.

According to Sediyama et al. (2015), plant height depends on the growth type, habit, and the sowing season. Proper plant height results in a more efficient harvest and it can also influence production components with a direct effect on productivity. Plant heights between 60 and 120 cm are, therefore, considered suitable for harvest mechanization (REZENDE; CARVALHO, 2007).

Cultivar averages of first legume insertion height (TABLE 3) were presented as satisfactory for mechanized harvest. According to Marcos Filho (1986), the cultivar chosen for cultivation in a given locality must present a first legume height of insertion of at least 10 to 12 cm; however, for most of soybean crop conditions, satisfactory height is around 15 cm, although more modern harvesters can make a good harvest with plants presenting a 10 cm legume insert.

The evaluated cultivars obtained between 13,96 and 20,18 cm of first legume height of insertion; cultivars 5D634 RR, NS 7709 IPRO, NS 7300 IPRO and NS 7667 IPRO presented the highest height results, all above 18 cm. The results found in the present experiment were superior to those found by Vernetti Junior et al. (2010), who evaluated, during the 2011/2012 agricultural year, twenty-six groups of cultivars from the maturation 6 group, with insertion of 9,3 cm pods, which are not appropriate for mechanical harvesting. In another situation, Cordeiro Junior et al. (2016) in Pindorama, São Paulo, evaluated cultivar NS 7667 IPRO, the same used in the current study, under no-tillage system, they found first legume height of insertion averages near to 14 cm. According to Sediyama (1972), environmental factors such as humidity, light and photoperiod can affect the first legume height of insertion.

Table 3. Plant height (AP) and first legume height of insertion (IL) averages of six soybean genotypes grown in Machado (MG).

Cultivars	Average	
	AP (cm)	IL (cm)
NS 7200 RR	103,17 a	17,63 b
5D634 RR	95,22 a	20,18 a
NS 7709 IPRO	89,1 b	19,72 a
NS 7667 IPRO	86,95 b	19,3 a
NS 7300 IPRO	83,16 b	18,9 a
5D6215 IPRO	81,72 b	13,96 b

Averages followed by the same letter do not differ in the column by the Scott-Knott test at 5 % probability.
Source: Elaborated by the authors (2016).

Cultivar seeds must have good genetic purity, physical, high vigor and sanity. The use of quality seeds is essential to reach high yields (SEDIYAMA et al., 2015).

In the present experiment, it was prioritized to identify the obtained seeds quality and their behavior along different cultivars emergency. Vanzolini and Carvalho (2002) stated that in lower seed lots, lower emergency and consequently lower emergency speed were observed, evidencing the best seed quality with a high emergency speed rate.

There was significant difference between the cultivars tested for emergency speed rate. According to Table 4, it is possible to observe the cultivars 5D6215 IPRO and NS 7200 RR were characterized by the greater emergency speed. Despite being characterized by a higher emergency speed, cultivar 5D6215 IPRO did not show superiority in relevant characteristics such as productivity.

Table 4. Emergency speed index (IVE) average results of six soybean genotypes grown in Machado (MG).

Cultivars	Average
	IVE
5D6215 IPRO	3,8 a
NS 7200 RR	3,67 a
NS 7300 IPRO	3,42 b
NS 7667 IPRO	3,34 b
NS 7709 IPRO	3,3 b
5D634 RR	3,27 b

Averages followed by the same letter do not differ in the column by the Scott-Knott test at 5 % probability.
Source: Elaborated by the authors (2016).

Lodging resistance is a key feature in achieving cultivar high productivity, and it is linked to plant height. Very tall and very thin stalks tend to lodging relatively easily, which can lead to grain losses during harvesting (SEDIYAMA, 2009). In the present research, notes comprised between 1 and 4 were observed as indicated in Table 5, and the cultivars 5D6215 IPRO, 5D634 RR, NS 7709 IPRO and NS 7200 RR were characterized with lower lodging scores ranging from 1,75 to 2,75.

According to Bernard et al. (1965) methodology, the outstanding cultivars group has shown to be slightly lodged, with less than 20% of their lodged plants, which values are within acceptable levels for mechanized harvesting. For the other evaluated cultivars, a satisfactory result for mechanized harvesting was not found. In Lavras, southern Minas Gerais, Carvalho et al. (2010) evaluated the performance of 24 cultivars obtaining good lodging results for all evaluated materials, with average variation grades between 1,00 and 2,00.

Table 5. Lodging average results (Ac) of six soybean genotypes grown in Machado (MG).

Cultivars	Average
	Ac
NS 7709 IPRO	1,75 a
5D6215 IPRO	2,25 a
NS 7200 RR	2,25 a
5D634 RR	2,75 a
NS 7667 IPRO	3,75 b
NS 7300 IPRO	4,25 b

Averages followed by the same letter do not differ in the column by the Scott-Knott test at 5 % probability.
Source: Elaborated by the authors (2016).

For number of pods, it was not observed significant difference between treatments (TABLE 6). However, Perini et al . (2012) evaluated BRS-282, BRS-246 RR, Potência RR and BRS-284, they found average number of pods per plant varying from 40 to 50. For number of grains per pod, there were no significant differences between the different cultivars analyzed either. In general, all cultivars presented from 1 to 2 grains per legume. There are few research papers describing the number of grains per legume interaction in soybean plants. The Cooperative Extension Service Ames- CESA (1994) states the number of grains per legume has substantial genetic control, therefore, little variation.

Table 6. Number of grains per pod (NG) and number of pods per plant (NV) average results of six soybean genotypes grown in Machado (MG).

Cultivars	Average	
	NG	NV
NS 7200 RR	1,87 a	55,74 a
NS 7667 IPRO	1,95 a	45,18 a
NS 7300 IPRO	2,07 a	41,25 a
5D634 RR	2,26 a	40,18 a
5D6215 IPRO	2,04 a	38,94 a
NS 7709 IPRO	2,14 a	35,80 a

Averages followed by the same letter do not differ in the column by Scott-Knott test at 5 % probability.
Source: Elaborated by the authors (2016).

Conclusions

Cultivars 5D634 RR, NS 7200 RR and NS 7709 IPRO obtained the best grain yield results.

Cultivars 5D6215 IPRO, 5D634 RR, NS 7709 IPRO and NS 7200 RR are within the acceptable levels of lodging for mechanized harvesting.

Cultivars 5D6215 IPRO and NS 7200 RR are characterized by the higher speed of emergency.

Based on the results, soybean cultivars 5D634 RR, NS 7200 RR and NS 7709 IPRO are recommended for the studied region, once it achieves superior productivity and acceptable lodging levels for mechanized harvesting.

Aspectos produtivos de cultivares de soja para região de Machado (MG), Brasil

Resumo

Em virtude do potencial produtivo e da grande importância na alimentação humana e animal, a soja ocupa uma posição de destaque na economia brasileira. O seu cultivo no sul de Minas Gerais vem ganhando espaço, porém sofre com pouca disponibilidade de cultivares adaptadas. Assim, o presente trabalho foi desenvolvido com o objetivo de avaliar os aspectos produtivos de diferentes cultivares de soja para região de Machado, Minas Gerais, a fim de identificar cultivares que possam ser recomendadas para o cultivo na região. Utilizou-se do delineamento experimental de blocos ao acaso com quatro repetições, cujos tratamentos foram seis cultivares de soja (5D6215 IPRO, 5D634 RR, NS 7709 IPRO, NS 7300 IPRO, NS 7667 IPRO e NS 7200 RR). A semeadura foi realizada na segunda semana de novembro de 2015. Verificou-se que a região de Machado se mostrou apta para o cultivo da soja, pois todos os cultivares apresentaram altura de planta e altura de inserção de primeiro legume favoráveis à colheita mecanizada. Destacam-se os cultivares 5D634 RR, NS 7200 RR e NS 7709 IPRO que obtiveram os melhores resultados de rendimento de grãos com 3.676,62, 3.612,45 e 3.377,90 kg ha^{-1}, respectivamente. Os cultivares 5D6215 IPRO, 5D634 RR, NS 7709 IPRO e NS 7200 RR encontram-se dentro dos níveis aceitáveis de acamamento para colheita mecanizada. Os cultivares 5D6215 IPRO e NS 7200 RR demonstram um maior índice velocidade de emergência em relação aos outros cultivares estudados.

Palavras-chave: *Glycine max* (L.) Merrill. Rendimento de grãos. Adaptabilidade

References

BATISTA, E. C.; PEREIRA, J. L.; SOUZA, L. T.; BRANDÃO, W. M.; SOUZA, T. T.; SOUZA, D. F.; SILVA, F. B. Caracterização agronômica de cultivares de soja para o Sul de Minas Gerais no Município de Inconfidentes. In: JORNADA CIENTÍFICA E TECNOLÓGICA DO IFSULDEMINAS, 7., 2015. Poços de Caldas. **Resumo**...Poços de Caldas, 2015.

BERNARD, R. L.; CHAMBERLAIN, D. W.; LAWRENCE, R. D. (Eds.). **Result of the cooperative uniform soybeans tests**. Washington: USDA, 1965. 134 p.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. **Regras para análise de sementes**. Brasília, 2009. 399 p.

CARVALHO, E. R.; REZENDE, P. M.; OGOSHI, F. G. A.; BOTREL, E. P.; ALCANTARA, H. P.; SANTOS, J. P. Desempenho de cultivares de soja [Glycine max (L.) Merril] em cultivo verão no Sul de Minas Gerais, **Ciência e Agrotecnologia**, Lavras, v. 34, n. 4, p. 892-899, jul./ago., 2010.

COOPERATIVE EXTENSION SERVICE AMES (CESA). **How a soybean plant develops**. Ames: Iowa State University of Science and Technology, 1994. 20p.

COMPANHIA NACIONAL DE ABASTECIMENTO (CONAB), **Acompanhamento de safra de grãos**, **SAFRA 2015/2016**, n. 12, setembro, 2016. Disponível em http://www.conab.gov.br/OlalaCMS/uploads/arquivos/16_09_09_15_18_32_boletim_12_setembro.pdf. Acesso em: 10 set. 2016.

COMPANHIA NACIONAL DE ABASTECIMENTO (CONAB). **Series Históricas**. 2016. Disponível em: http://www.conab.gov.br/conteudos.php?a=1252&t=2. Acesso em: 10 set. 2016.

CORDEIRO JUNIOR, P. S.; FINOTO, E. L.; MARTINS, M. H.; SOUSA, J. B. L.; SOUSA NETO, J. Características agronômicas de cultivares de soja RR1 e RR2 cultivadas em argissolo sob sistema de plantio direto na reforma de cana crua. In: WORKSHOP AGROENERGIA MATÉRIAS-PRIMAS, 10., 2016. Ribeirão Preto. **Resumo.** Centro de Convenções da Cana, Ribeirão Preto, 2016. Disponível em: http://www.infobibos.com/Agroenergia/CD_2016/Resumos/ResumoAgroenergia_2016_052.pdf Acesso em: 12 set. 2016.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA (EMBRAPA), **Tecnologias de produção de soja Região Central do Brasil 2011**. Paraná: Embrapa Soja, 2010. p. 255.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA (EMBRAPA). **Sistema brasileiro de classificação de solos**. 2. ed. Rio de Janeiro, 2006. p. 304.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS STATISTICS DIVISION (FAOS). **Production quantities of Rice, paddy by country 2014.** Disponível em: http://faostat3.fao.org/browse/Q/QC/E. Acesso em: 2 out. 2016.

FERREIRA, D. F. **Sisvar 5.1 - Análises estatísticas por meio do Sisvar para Windows**. Lavras, Universidade Federal de Lavras, 2007.

GUIMARÃES, F. S. **Cultivares de soja [Glycine max (l.) Merrill] para cultivo de verão na região de Lavras-MG**, Lavras, UFLA, 2006. p. 44.

MAGUIRE, J. D. Speed of germination aid in selection and evaluation for seedling and vigour, **Crop Science**, Madison, v. 2, n. 2, p. 176-177, 1962.

MARCOS FILHO, J. **Produção de sementes de soja**. Campinas: Fundação Cargill, 1986. p. 86.

PERINI, L. J.; FONSECA JÚNIOR, N. S.; DESTRO, D.; PRETE, C. E. C. Componentes da produção em cultivares de soja com crescimento determinado e indeterminado, **Semana: Ciências Agrárias**, Londrina, v. 33, supl. 1, p. 2531-2544, 2012.

REZENDE, P. M.; CARVALHO, E. A. Avaliação de cultivares de soja [*glycine max* (L.) Merrill] para o Sul de Minas Gerais, **Ciência e Agrotecnologia**, Lavras, v. 31, n. 6, p. 1616-1623, nov./dez., 2007.

RIBEIRO, A. C.; GUIMARÃES, P. T. G.; VICENTE, V. H. A. **Recomendações para o uso de corretivos e fertilizantes em Minas Gerais**: 5a aproximação, Lavras, UFLA, 1999. p. 359.

SEDIYAMA, C. S.; VIEIRA, C.; SEDIYAMA, T.; CARDOSO, A. A.; ESTEVÃO, H. H. Influência do retardamento da colheita sobre a deiscência das vagens e sobre a qualidade e poder germinativo das sementes de soja. **Experientiae**, Viçosa, v. 14, n. 5, p. 117-141, set. 1972.

SEDIYAMA, T.; SILVA, F.; BORÉM, A. **Soja**: do plantio à colheita. Viçosa : UFV, 2015.

SEDIYAMA, T.; TEIXEIRA, R. C. T.; BARROS, H. B. Cultivares. In: SEDIYAMA, T. (Ed.). **Tecnologias de produção e usos da soja**. Londrina, PR: Mecenas, 2009. p. 77-91.

SOUZA, C. W. A.; VEIGA, A. A.; VEIGA, P. A.; SILVA, P. A. P. L.; BERNARDES, T. A. S.; LOURENÇO, R. C. Avaliação de aspectos produtivos de diferentes cultivares de soja para região de Machado-MG. In: JORNADA CIENTÍFICA E TECNOLÓGICA DO IFSULDEMINAS. 7., 2015. Poços de Caldas. **Resumo**. Poços de Caldas, 2015.

UNITED STATES DEPARTMENT OF AGRICULTURE, FOREIGN AGRICULTURAL SERVICE (USDA), **Table 07**: Soybeans: World Supply and Distribution. 2016. Disponível em: http://apps.fas.usda.gov/psdonline/psdReport.aspx?hidReportRetrievalName=Table+07%3a+Soybeans%3a+World+-Supply+and+Distribution&hidReportRetrievalID=706&hidReportRetrievalTemplateID=8. Acesso em: 10 set. 2016.

VANZOLINI, S.; CARVALHO, N. M. Efeito do vigor de sementes de soja sobre seu desempenho em campo. **Revista Brasileira de Sementes**, v. 24, n. 1, p. 33-41, 2002.

VERNETTI JUNIOR, F. J.; FRAGA, M. S.; NUNES, T. L. Avaliação de cultivares de soja do grupo de maturidade seis tolerantes ao Glifosato da rede soja sul de pesquisa na Embrapa clima temperado. In: REUNIÃO DE PESQUISA DE SOJA DA REGIAO SUL, 38., 2010, Cruz Alta, RS. **Resumo.** Cruz Alta: Fundação Centro de Experimentação e Pesquisa, 2010. p. 41-44.

Received: January 16, 2018
Accepted: March 5, 2018