Original Article

Yield and agronomic caracteristics of soybean breeding lines in Minas Gerais State, Brazil

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Abstract
This study evaluated yield performance of lines in the trial network of the Soybean Breeding Program of Universidade Federal de Uberlândia, in Uberaba-MG. The experiment was done at the Experimental Farm of Faculdades Associadas de Uberaba - FAZU, in the season 2007/2008, with plots consisting of four 5.0-m long rows spaced by 0.50 m. The agricultural characteristics evaluated were: plant height at flowering, plant height at maturation, insertion height of the first pod, number of days for flowering, number of days to maturity, yield and lodging, in late cycle soybean. The lines UFU-518 with 4300.3 kg ha^{-1} and UFU-513 with 3810.2 kg ha^{-1} were the most productive, with performance above the commercial controls.

Keywords: *Glycine max*, selection, yield, breeding lines.

Características agronômicas e produtividade de linhagens de soja em Minas Gerais

Resumo
O objetivo deste trabalho foi avaliar o desempenho produtivo de linhagens da rede de ensaios do programa de melhoramento de soja da Universidade Federal de Uberlândia em Uberaba-MG. O experimento foi realizado na Fazenda experimental da Faculdades Associadas de Uberaba - FAZU, na safra 2007/2008, as parcelas foram constituídas por 4 linhas espaçadas entre si de 0,50 m com 5,0 m de comprimento. As avaliações agronômicas foram: altura da planta na floração, altura da planta na maturação, altura de inserção da primeira vagem, dias para a floração, dias para a maturidade, produtividade e acamamento, em soja do ciclo tardio. As linhagens UFU-518 com 4300,3 Kg ha^{-1} e a UFU-513 com 3810,2 Kg ha^{-1} foram as mais produtivas, com desempenho superior às testemunhas.

Palavras-chave: *Glycine max*, seleção, produtividade, linhagens.

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Introduction

With the importance of soybean as socioeconomic factors, research has been directed to this culture in order to achieve higher yields associated with a reduction in yield costs. In this sense, coupled with knowledge of nutritional requirements and water and the use of cultivars with high yield, resistant to lodging, pests and diseases and adaptation to diverse environmental conditions, it is necessary to search for innovative technologies that assist in the expression of yield culture (Ferrari, 2008). Thus, the selection of genotypes in early or late cycles that may be highly productive in a given state and / or region is crucial for the yield of this important oilseed.

Soybeans have high genetic diversity and morphology due to the high number of cultivars available, result of the efforts of several breeding programs that seek even higher grain yield, resistance to pests, diseases and adapted to different environmental conditions (Sediyama, 2009).

Knowing the behavior of the cultivars, the agronomic characteristics and its interaction with the environment, related to photoperiod and climate, are of significant interest mainly to the producers. According Priolli et al. (2004), several breeding programs have contributed to the development of cultivars of high yields and adapted to different agro-climatic conditions of the country.

Once again Brazil appears in the world scenario as the second largest soybean producer. In the harvest 2008/2009 the expected planted area in Brazil is approximately 21.249 million hectares, with a total yield of 57.579 million metric tons. In the state of Minas Gerais, the planted area will be 878 thousand hectares, with total yield of 2.574 million tons (Conab, 2009).

In order to meet the national and international demands, Brazil advanced its agricultural frontiers, introducing soybean in all its states, especially those in the Midwest, which present the greatest national yield. Such expansion was possible only due to the development of a national soybean yield technology, especially that related to the creation of new genetic materials, with adaptability to different ecophysiologic conditions (Câmara et al., 1998)

According to EMBRAPA (2008), the improved cultivars carrying genes capable of expressing high yield, wide adaptation and good resistance / tolerance to biotic and abiotic events usually represent the most significant contribution to the efficiency of the productive sector. The development of soybean cultivars with adaptation to climatic conditions of the main regions of the country, especially in the savannah and the low latitudes is also providing the last three decades, the expansion of the agricultural frontier in Brazil.

During the development of a cultivar, it is essential that the line worked to be evaluated in different locations, aimed at testing their response to adverse agro-climatic conditions. Through tests: beginning, intermediate and final stages of improvement, it is possible to obtain important information on the release of a cultivar to a specific location. However, the disclosure of soybean cultivars recommended for cultivation in each state, is meant to inform both professionals and entrepreneurs in the productive sector advances that have occurred every year, technology variety of culture (EMBRAPA 2004).

The objective of this study was to evaluate the performance of the network of lines of test program soybean breeding at the Federal University of Uberlandia in Uberaba County, Minas Gerais State, Brazil.

Material and Methods

The trials were done in the season 2007/2008 in the county of Uberaba County, Minas Gerais State, Brazil, at the Experimental Farm of FAZU, located at 47°57'27''W, 19°44'13''S, at 780 m above sea level. The soil is a typical distroferric red latosol.

The experimental design was randomized blocks, with 3 repetitions and the treatments consisted of 24 genotypes (19 late cycle lines and 5 commercial controls). The experimental units consisted of four 5-m rows spaced by 0.45m. The two center rows of each experimental unit were used for data collection.

Sowing was done on 17 November 2007 and inoculation with *Rhizobium* was done in the furrow at sowing. Planting fertilization applied 400 kg ha^{-1} of the formulation 02-30-15 applied in the furrows.

Performance of the lines was evaluated through the following agricultural characteristics: Number of days to flowering, defined as the period between sowing and the date in which 50% of the flowers are open, in the stage R1 (early flowering) to R2 (full flowering); number of days to maturation, defined as the period between sowing and that in which approximately 95% of the pods are ripe (stage R_8), plant height (cm) at flowering, measured from the plant collar to the tip of the major stem, plant height (cm) at maturity, measured from the plant collar until the tip of the major stem, height (cm) of the first pod insertion, measured with a graduated ruler, from the soil to the insertion point of the 1st pod, plant lodging, evaluated at maturity: stage R_8, using a visual scale, varying from 1 to 5, where 1 corresponds to the plot with upright plants, and 5 to the plot with plant completely lodged; and grain yield from the 4m² area, with estimation to kg.ha^{-1}, adjusted to 13% moisture (Fehr, 1977).

The statistical analyse were realized in program SISVAR-UFLA, according Ferreira (2000).

Results and Discussion

According to analysis of variance results were significant by F test a 0.05 the significance. According to the data presented on Table 1, the commercial control Garantia had the greatest height when more than 50% of the flowers were opened, although not presenting significant differences in relation to the controls DM – 339 and UFU-518. In contrast, the line UFU-514 had the smallest height at flowering.

Table 1. Average results of plant height at flowering, and at maturation, height of first pod insertion, number of days to flowering, number of days to maturity, yield and lodging, obtained at the competition trial of late cycle lines, in the agricultural year 2007/08, Uberaba, Minas Gerais State, Brazil.

Breeding line	Height at Flowering (cm)	Height at Maturation (cm)	Height of 1st pod (cm)	Flowering Cycle (days)	Maturation Cycle (days)	Yield (kg.ha^{-1})	Lodging (rating)
UFU-501	104.8 e	114.4 d	9.8 a	100.0 a	170.0 a	3313.7 c	1.7 a
UFU-502	97.6 e	102.7 c	8.7 a	108.0 a	174.0 a	3564.9 c	2.0 a
UFU-503	105.1 e	116.3 d	16.3 c	100.0 a	168.3 a	2424.9 a	2.0 a
UFU-504	102.5 e	113.3 d	12.8 b	114.0 b	172.0 a	3245.2 c	3.0 a
UFU-505	100.1 e	114.2 d	13.5 b	100.0 a	172.0 a	2827.7 b	2.3 a
UFU-506	103.8 e	115.1 d	15.6 c	100.3 a	174.0 a	2826.8 b	2.0 a
UFU-507	82.9 d	99.0 c	12.7 b	120.7 b	172.0 a	2981.9 c	2.7 a
UFU-508	80.1 d	98.4 c	10.5 a	114.3 b	173.3 a	3184.4 c	2.7 a
UFU-509	85.1 d	105.3 c	15.2 c	121.0 b	172.0 a	2740.4 b	2.3 a
UFU-510	78.4 d	99.8 c	13.8 b	119.7 b	172.6 a	3131.3 c	2.0 a
UFU-511	101.3 e	110.9 d	17.9 d	100.0 a	174.0 a	3071.1 c	1.7 a
UFU-512	102.1 e	115.9 d	16.2 c	100.0 a	174.0 a	2093.2 a	1.7 a
UFU-513	82.5 d	104.5 c	13.9 b	119.3 b	174.0 a	3810.2 d	1.7 a
UFU-514	47.3 a	71.1 a	9.1 a	111.7 b	187.0 b	2464.2 a	3.0 a
UFU-515	56.3 b	68.1 a	10.7 a	111.0 b	175.0 a	2804.8 b	1.0 a
UFU-516	62.1 b	85.6 b	13.6 b	118.0 b	164.7 a	3437.4 c	2.0 a
UFU-517	64.6 b	95.0 c	13.0 b	115.7 b	187.0 b	2173.0 a	2.0 a
UFU-518	108.9 f	110.4 d	11.5 b	128.0 b	174.0 a	4300.3 d	1.7 a
UFU-519	71.0 c	82.9 b	13.0 b	116.0 b	171.0 a	3145.2 c	1.3 a
Garantia	116.7 f	121.4 d	14.5 c	118.7 b	172.0 a	2433.1 a	1.7 a
Chapadões	70.3 c	96.3 c	14.4 c	119.7 b	174.0 a	2225.5 a	2.0 a
Luziânia	73.4 c	108.4 d	12.5 b	122.7 b	168.3 a	3577.1 c	1.7 a
Msoy 8914	73.3 c	105.8 c	18.1 d	123.7 b	170.0 a	3377.2 c	1.7 a
DM – 339	112.4 f	121.5 d	18.2 d	104.0 a	174.0 a	2587.7 b	1.3 a
Average	86.8	103.2	13.6	112.8	173.3	2989.22	2.0
VC (%)	6.65	5.05	12.02	4.81	3.38	11.15	32.82
SMD	9.00	2.6	1.5	19.3	13.0	155.1	-----

Averages followed by the same letter do not significantly differ from each other by the Scott-Knott test, at 5% probability.

It is expected that, at flowering, the crop has already completely covered the soil surface, especially if the crop is fertilized and grown at spacing smaller than 0.50 m (Câmara et al., 1998). In a study performed by Pelúzio et al. (2008) with eight soybean cultivars it had an average of 91 cm plant height at flowering, higher than the average obtained in this experiment which was 86.8 cm.

Regarding plant height at maturation it varied from 68.1 to 121.5 cm. The controls DM – 339, Garantia and Luziânia were the tallest ones; however, no significant differences were observed among UFU-501, UFU-503, UFU-504, UFU-505, UFU-506, UFU-511, UFU-512 and UFU-518. In contrast, UFU-515 and UFU-514 were the shortest ones at maturation, presenting significant differences from the controls.

In soybean, the very high levels of productivity, with values greater than 3,300 kg/ha obtained in major producing regions of the Midwest of the country, as in Mato Grosso have ensured the competitiveness of Brazilian soybeans on the international market (Hamawaki et al., 2007).

For the character height of insertion of the first pod, as shown in Table 1, the lines UFU-502, UFU-514, UFU-1, UFU-508, UFU-515, and UFU-518 were below the 12 cm standard; however UFU-518 was not significantly different from the control Luziânia. Harvester high operational yield, associated with minimum harvest losses, demands that minimum height of soybean pod insertion should be at least 12 cm (Sediyama et al., 1985).

For lodging, no significant differences among the lines evaluated. Lodging rate varied

from 1 to 3 (Table 1), demonstrating that the plants had moderate inclination. The lodging rate is a character influenced by soil type and the conditions of plant development. In general, the soybean plants suffer greater lodging in fertile and heavy soils with abundant moisture, than on light and sandy soils. Another point to consider relates to the height of plant, usually taller plants may provide a higher rate of lodging given the fact that they have thinner stems, becoming more subject to wind action (Guimarães et al., 2008).

The lines presented a variation from 100 to 128 days to flowering. The lines UFU-505, UFU-511, UFU-512, UFU-503 and UFU-501 required fewer days for flowering, but they were not different from the control DM-339. The line UFU-518 required the greatest number of days for flowering, which was not significantly different from the controls Garantia, Chapadões, Luziânia and Msoy 8914.

Temperature is an important factor to be considered since it affects the phonological stages of soybean. The interaction of this factor with photoperiod was studied by Board & Settimi (1986), who demonstrated that high temperatures shorten the flowering period, and this effect is more evident in short days.

As for productivity, the mean score was 2989.22 kg ha-1 and 39.2% higher than the average obtained by Pelúzio et al. (2008), which was 2121 kg ha-1, and that income is related to numerous factors of environment and plant.

Torrie & Briggs (1995) reported that a sowing delay in relation to the most appropriate date for soybean reduces the number of days for flowering, to a variable value, according to the maturation cycle of the cultivar. This study showed that the lines had a long maturation cycle, varying from 164 to 187 days. The lines UFU-517 and UFU-514 were the only ones presenting differences from the controls, with a cycle of 187 days.

Yield is related to all agricultural characteristics, and reflects the good adaptation of the genotype to the location evaluated. The line UFU-518 had the greatest yield, with 4300.3 kg ha^{-1}, even with the first pod insertion height lower than 12 cm and it was not significantly different from the control Luziânia for this characteristic; it also had a lodging rate of 1.7, which is acceptable by normal standards, and it had a long maturation cycle, which was not different from the controls. The line UFU-513 had a yield of 3810.2 kg ha^{-1}, with the same lodging rate as UFU-518, its height at maturation was 104.5 cm, and it was not different from the controls Msoy 8914 and Chapadões, its first pod insertion height was 13.9cm, which was above the standards recommended for mechanical harvest, i.e. 12 cm height.

Conclusion

The lines UFU-518 and UFU-513 had better performance, yielding 4330.1 kg ha^{-1} and 3810.2 kg ha^{-1}, respectively, coupled to adequate agricultural characteristics for mechanical harvest, in the county of Uberaba, MG.

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