Ecophysiology, Crop Metabolism, Technology, Production and Seed Physiology / Ecofisiología, Metabolismo de Cultivos, Tecnología. Producción y Fisiología de Semillas

doi: http:// dx.doi.org/10.15446/acag.v64n3.44511 e-ISSN 2323-0118

Variability of soybean plants originated from seeds with different physiological quality levels

Variabilidade de plantas de soja originadas de sementes de diferentes níveis de qualidade fisiológica

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Rec.: 10.09.2014 Acep.:18.11.2014

Abstract

The objective of this work was to evaluate the variability among plants within populations of soybean that had different vigor levels. Seed lots of CD 202 soybean cultivar with three levels of vigor (high, medium and low) were used. The plots consisted of 1 line of 7 m long spaced 0.45 m from other plots. The experimental design was a randomized block design with four replications. A total number of 50 seeds were arranged within the planting rows to obtain and adequate number of plants and the excess of plants were later thinned. The initial population after thinning was 32 plants/m^2. All plants in the 6 linear meters from each plot were collected and the following measurements were done: plant height, stem diameter, number of branches per plant and number of pods per plant. The plants were harvested individually and all above mentioned parameters were also evaluated. In addition, the coefficient of variation was calculated and used as an indicator of variation between plants in plant populations. It is concluded that low quality seeds cause a decrease in the survival of plants in the field and increase in the variability among plants in plant communities.

Key words: *Glycine max* (L.) Merrill, vigor, spatial distribution of plants.

Resumo

O objetivo foi avaliar a variabilidade entre plantas dentro de populações de soja estabelecidas em sementes com diferentes níveis de qualidade fisiológica (germinação de 96, 82 e 70%, respectivamente). Foram utilizados lotes de sementes de soja, cultivar CD 202, em três níveis de qualidade (alta, média e baixa). As parcelas foram constituídas por 1 linha de 7 m de comprimento espaçadas das demais parcelas 0.45 m. O delineamento experimental utilizado foi de blocos ao acaso, com quatro repetições. Dentro das linhas de semeadura foram dispostas cerca de 50 sementes visando obter uma emergência com excesso de plantas para posterior desbaste. A população inicial após o desbaste foi de 32 plantas/m^2. Para avaliação das variáveis respostas coletou–se todas as plantas distribuídas nos 6 m dentro de cada parcela, sendo feita as seguintes determinações: estatura de planta, diâmetro do caule, número de hastes por planta e número de vagens por planta. As plantas colhidas foram avaliadas individualmente nos parâmetros mencionados, e calculado o coeficiente de variação, que foi utilizado como um indicador da variabilidade entre plantas dentro das populações de plantas. Conclui–se que sementes de baixa qualidade fisiológica ocasionam diminuição na sobrevivência de plantas no campo e aumento da variabilidade entre plantas na comunidade vegetal.

Palavras chave: *Glycine max* (L.) Merrill, sementes de soja, vigor, germinação, distribuição espacial de plantas.

Introduction

The evaluation of the physiological quality of soybean seeds is one of the main aspects to be considered in an efficient production program, making it possible to estimate the vigor, field performance of plants and disposal of bad quality seed-lots, reducing risks and losses to an agriculture that is increasingly demanding the production of higher quality seeds. In the last five decades, soy production has had a growth rate higher than the population growth rate, occupying a key role in the interests of companies to search for improving and adjusting the plant populations per area focused on the adaptation of different cultivars that are currently in the seed market.

There are many causes reduction of crop yields through the use of low physiological quality seeds. In research conducted by Kolchinski *et al.* (2006) it was found that the low seed vigor has been associated with reductions in speed and percentage of emergency, emergency uniformity, reduction in the initial size of the plants, in the production of dry matter, leaf area and the crop growth rate. Furthermore, many species have the capability of adapting to the space available, by adjusting the individual production capacity in smaller populations (Marcos Filho, 2005). For Marcos Filho and Kikuti (2006) the use of seeds with high physiological quality is justified for all species because it helps to adjust the plant population that is affected by field conditions during the emergency, especially in less favorable conditions.

Several studies have demonstrated that disuniformity among plants causes competitive differences between plants within plant communities; so that more developed plants have an advantage in the intraspecific competition. Seed vigor modifies vegetative growth and is frequently associated with yield in crops that are harvested in the vegetative stage or during early reproductive development. Several surveys show influence of seed vigor in grain yield in crops. In corn, up to 8% reduction in productivity can occur with the use of low vigor seeds (Grabbe, 1966). Kolchinski (2003) observed 28% reduction in grain yield due to the variation of seed vigor in soybean populations. Schuch and Finatto (2006) in an experiment of behavior of isolated plants of soybean, observed reduction in yield related to the variation of seed vigor. In irrigated rice, plants from populations coming from high vigor seeds had 20% more yield than populations of plants coming from low vigor seeds (Melo *et al.*, 2006). Poor quality of seed lots in addition to reducing, delaying and making less uniform the field emergence, could be associated with changes in plant competition within the plant community, causing that earlier emerged seedlings have an advantage over those of later emergence.

Plant competition has been studied for many years. However, there are few studies that look at the effects due to different vigor qualities between the seeds within a lot on the uniformity in emergency, the initial size of seedlings, the growth rate of the crop, the subsequent intraspecific competition, seed yield of individual plants within communities, and the general behavior of communities (Kolchinski *et al.*, 2005). Although it is known the effect of plant competition within populations, there are not measurements of the effects of seed vigor in plant competition in a rice community (Melo, 2005). In this context, the work aimed to evaluate the variability among plants within soybean populations established with soybean seeds with different levels of physiological quality.

Materials and methods

The experiment was conducted in the experimental area of the Department of Plant Protection of the Faculty of Agronomy Eliseu Maciel of the Universidade Federal de Pelotas (FAEM/UFPel), located in the municipality of Capão do Leão/RS, 31° 52’ S and 52° 21’ W at 10 MASL.

The soil is classified as Planossolo (hydromorphic) corresponding to the mapping unit of Pelotas. Soil samples were collected and sent to the Laboratory of Soil Analysis of the FAEM/UFPel for chemical analysis and later the fertilization was done according to the CFQS RS/SC (Commission on Soil Fertility and Chemistry – RS/SC, 2004). The sowing was done with the system of direct sowing with no tillage, using the CD 202 cultivar. The seeds were inoculated with *Brandyhizobium japonicum* at a rate of 150 ml of inoculum for 50 kg of seeds. Removal of weeds was done by applying the herbicide Roundup® at a rate of 3 l/ha. Pest, disease and weed control was done with products recommended for the soybean crop.

The treatments consisted of three levels of physiological quality of seeds, which were top, medium and low vigor seeds, and two lots of seeds were used for each level of quality, for a total of six lots. The batches of high, medium and low physiological quality seeds had germination of 96, 82 and 70%, respectively. The levels of vigor were determined by the accelerated aging test and showed 96 and 95% for batches of high quality, 67 and 64% for batches of medium quality and of 58 and 55% for batches of low quality. Lots of high and medium physiological quality were obtained usually with soybean seed producers. To characterize the low quality batches was required the accelerated aging test, it means, from seeds of the two batches of high quality were subjected to specific periods of time and temperature before the accelerated aging test exposing the seeds to high temperature and relative humidity with combinations of 45 °C for 48 h and 41°C for 72 h, getting two batches of low vigor.

The plots were composed of lines of 7 m in length and space between them of 0.45 m. The sowing was done by making ridges manually and distributing 60 seeds/m in each line, this in order to get a higher amount of emerged seedlings to guarantee a standard number of plants. 10 days after emergence (DAE) thinning was performed to get a population of 32 plants/m^2. To avoid the tendency to thin with the possibility of selecting the most vigorous plants in the treatments, a labelled ruler was used marking the distance between plants in order to keep the closest plant to the labelled point.

The experiment was done in completely randomized blocks with four replicates. To evaluate the variables all the plants in the useful area of 6 m per plot were harvested. The harvested plants were analyzed individually for the parameters: plant height, stem diameter, number of branches/plant, number of pods/plant, grain yield/plant and grain yield/ha. Plant height was done using a millimeter ruler, stem diameter was measured with a caliper ruler.

The threshing of the pods was performed manually to determine grain yield/plant. Grain yield per area was determined in a similar manner to grain yield per plant, converting it to grain yield per hectare. Samples were taken to determine grain moisture and to correlate it to yield at 13%, both for grains/plant and grains/ha. With the data taken individually per plant the average values between plants and coefficients of variation for each parameter were calculated for each plot. The coefficient of variation values were used to validate the uniformity between plants within the each treatment. A higher coefficient of variation indicates disuniformity among plants within each population. The experimental data, including the coefficients of variation for each experimental unit were subjected to analysis of variance, and the effects of the treatment were evaluated by the 'F' test. For mean comparison the Duncan test at 5% probability was used.

Results and discussion

In Table 1 is observed the effect of physiological quality of soybean seeds on the initial and final stand and survival of plants. Although there was an excess in seedlings at initial establishment for later thinning in all the levels of physiological seed quality, it was observed a reduction in standing plants at harvest. However, this reduction in standing plants was only observed in batches of low physiological quality seeds. Probably there was a development of less vigorous plants that did not have the conditions to survive within the plant community along the crop development, confirming then the results of Vanzolini and Carvalho (2002) that demonstrate the effect of vigor at the initial stages of development. Therefore, through the crop development there is mortality of some plants in populations coming from low physiological quality seeds, reducing the plants in 17% when compared to batches of high physiological quality.

Table 1. Effect of the physiological quality level of soybean seed batches at the initial (10 DAE) and final establishment and survival of plants in the field.

Physiological quality	Initial number (plants/m)	Final number (harveting) (plants/m)	Survival (%)
A (High)	14.5	14.5	100
B (High)	14.5	14.5	100
C (Medium)	14.5	14.2	97
D (Medium)	14.5	14.3	98
E (Low)	14.5	12.0	83
F (Low)	14.5	12.0	83

DAE = days after emergence.

The average values for the coefficient of variation (CV) indicate the uniformity grade among the plants in the population (Table 2) and shows the difference between the batches of high, medium and low physiological quality. In this sense, the seeds from the high physiological quality batches showed plants with high uniformity within the plant population and low disuniformity between plants. The variability in the development of plants within the plant community was discussed by Kolchinski (2003), being

Table 2. Effect of the physiological quality level of soybean seed batches for the coefficient of variation (CV) of plant height (PH), stem diameter (SD), number of branches per plant (NBP), number of pods per plant (NPP) and grain weight per plant (GWP).

Physiological quality	Agronomical characters				
	PH (%)	SD (%)	NBP (%)	NPP (%)	GWP (%)
High	10.75 b*	15.75 b	42.62 b	38.87 b	38.12 b
Medium	12.50 a	17.00 ab	54.62 a	42.25 ab	47.25 a
Low	13.25 a	19.12 a	52.50 a	44.75 a	49.12 a
Medium	12.16	17.29	49.91	41.95	44.83
CV (%)	13.1	12.7	11.6	8.4	9.8

*Averages followed by different letters in the column are statistically different according to Duncan´s test at 5% probability.

Table 3. Effect of the quality level of soybean seed batches on several parameters such as plant height (PH), stem diameter (SD), number of branches per plant (NBP), number of pods per plant (NPP) and grain weight per plant (GWP).

Physiological quality	Agronomical characters			
	PH (%)	SD (%)	NBP (%)	NPP
High	114.61 a*	6.40 a	2.71 a	50.89 a
Medium	117.80 a	6.62 a	2.68 a	52.54 a
Low	112.28 a	6.70 a	2.86 a	55.57 a
Medium	114.9	6.57	2.75	53.0
CV (%)	5.5	5.0	10.3	8.6

*Averages followed by different letters in the column are statistically different according to Duncan´s test at 5% probability.

this variability initiated from emergence, stage in which the batches of low physiological quality have a higher disuniformity. According to this, it can be said that the disuniformity of plants at emergence and the difference in initial plant height compromised the plant development of the emerged plants and these cannot follow the growth rate of the plants emerged initially, consequently they are less competitive for space, light, water and nutrients, keeping the disuniformity until the end of the crop cycle.

The higher variability of plants was within the population of batches of low physiological quality (Table 2). The increase in disuniformity between plants within the population in function to the reduction of seed quality may be due to the disuniformity at seedling emergence or differences in the initial height of the seedlings, which remains until the end of the cycle. But also the plant variability within the plant community reduces the interception of photosynthetically active radiation, reducing the concentration of assimilates in the grain filling (Ottman and Welch, 1989).

Although there was a higher variability between plants as the physiological quality of the seed batches was reduced, there was no effect of the seed quality on the plant height, stem diameter, number of branches per plant and number of seeds per plant (Table 3). These results do not agree with the ones of Kolchinski *et al.* (2005), and Cervieri Filho (2005) who cited that plants originated from low quality seeds had an inferior performance in different agronomical characters when evaluating individual plants.

Conclusions

Seeds of low physiological quality caused a reduction in the plant survival in the field and increase in the variability within plants in the plant community.

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