SEED MOISTURE RANGE IN A SOYBEAN PLANT [1]

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RESUMO - É comum observa-se em plantas de soja que as sementes alcançam a maturação em diferentes períodos. Assim, o objetivo do presente estudo foi determinar a magnitude da distribuição da umidade das sementes, em diferentes estádios de maturação, em uma planta de soja. O estudo de campo foi conduzido no estado de Mato Grosso e estabelecido com sementes básicas da cultivar de soja MTBR-45. Na floração, 100 plantas no mesmo estádio, foram marcadas e a colheita iniciada quando as sementes ainda estavam com alto grau de umidade. Em oito colheitas, durante 16 dias, colhiam-se todas as vagens oriundas de duas plantas. Essas sementes, de cada vagem, foram debulhadas mecanicamente e sua umidade determinada. Os resultados revelaram que há uma grande amplitude na distribuição da umidade das sementes em uma planta de soja em que na maturidade fisiológica, pode alcançar mais de 30 pontos percentuais e, mesmo com uma umidade média inferior a 12%, há mais de 20% das sementes com umidade superior a 13%, por outro lado nesse período existem sementes que estão aguardando a colheita por mais de uma semana. Com base nos resultados, pode-se concluir e/ou recomendar que: 1 A grande amplitude do grau de umidade das sementes de soja recém colhidas, na maturação de campo, propicia a presença de sementes suscetíveis a danificação mecânica e com umidade não segura para armazenamento; 2- É recomendável colher as sementes com grau de umidade entre 15-18%, para minimizar os efeitos da deterioração de campo e as perdas com sementes muito úmidas; 3- É recomendável a utilização de secagem, mesmo em lotes de sementes colhidos em que a média da umidade esteja adequada para armazenamento .

Termos para indexação: *Glycine max*, distribuição umidade, semente soja.

DISTRIBUIÇÃO DA UMIDADE DA SEMENTE EM UMA PLANTA DE SOJA

ABSTRACT - It is common to see in any soybean plant that seeds reach maturity at different times. Thus the objective of the present study was to determine the magnitude of the seed moisture range at different stages of maturation in a soybean plant. The field study was conducted in a tropical region in the state of Mato Grosso – Brazil, established with foundation seeds of the MTBR-45 cultivar, and at flowering, 100 plants were marked at the same maturity stage. Harvesting began when seeds still were at high moisture content (MC). At each of eight harvesting times, during 16 days, all pods from two plants were harvested and the seeds from each pod were hand threshed individually and determined the moisture content . The results revealed that there is a great distribution of seed MC in a soybean plant, where at physiological maturity, the magnitude can reach more than 30 percentage points. Also, even with an average MC below 12%, there were more than 20 % of the seeds with MC above 13% and some seeds at this point had been waiting to be harvested for more than a week. The following conclusions and/or recommendations can be taken: 1- The great seed MC range in a soybean seed lot harvested at field maturity leads to the presence of seeds susceptible to mechanical damage and with MC unsafe for adequate storage; 2 – It is recommended that harvesting be accomplished when the seeds are in the 15-18% MC range, in order to minimize field deterioration and the percentage of seeds with high MC; 3– Drying is recommended, even when soybean seeds are in their average MC safe for storage.

Index terms: *Glycine max*, soybean seed, field deterioration.

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INTRODUCTION

Brazil produces around 950,000 tons of soybean seeds/year with average 78% commercial seed usage. Among the country´s states, Mato Grosso stands out with a usage of 95% and production of 166,000 ton/year (Abrasem 2003).

It is considered that soybean seeds deteriorate fast after reaching physiological maturity (Marcos Filho & McDonald, 1998).Thus production of high quality seeds in regions like Mato Grosso with high relative humidity and temperature during maturation and harvesting time has been a great challenge.

Temperature and soil moisture content during the period of seed filling have great influence on seed physical and physiological quality (Bewley & Black. 1994) . Moisture stress decreases seed size and too much rainfall and high temperature cause tissue exposition in such a way that the seed coat often ruptures (França Neto *et al*., 1993). Seeds with ruptured coat inside the vain (mainly those with larger size) are frequent in soybean fields from tropical regions, where there is a combination of higher humidity and temperature. Keingley & Mullen (1985) verified that the increase in temperature during seed filling had great negative effect on germination and vigor, especially if it occurred during the first 10 days of seed filling.

The state of Mato Grosso is presently the first soybean producer in the country and still has some millions hectares to be included under cultivation. It has very good climatic conditions for grain production, allowing the state to present remarkable yields, above 3t/ha. This condition plus research and heavy investments by the seed producers have made the region a place where soybean seed is big business using high technology. Even so, some difficulties remain, such as a high level of field losses and high seed loss during the processes of post-harvesting. The main reason for these losses is moisture damage (Aprosmat 2000).

Seed moisture damage occurs because there is a long period of seed storage in the field due to a great inequality of maturation in the plant population (Hamer, 1999), as well as inside an individual plant, which results in two consequences in seed production: seeds from plants that mature first are exposed to adverse conditions in the field, waiting for the maturation process of those seeds from plants that mature later, and green seeds will be found in the seed lot.

The objective of the present study was to investigate seed moisture distribution that occurs in a soybean plant to improve efficiency in the production of high quality seeds.

MATERIAL AND METHODS

The field experiment was conducted at the seed company “Sementes Arco Iris” in Alto Garças, state of Mato Grosso, during growing seasons, 2000/01 and 2001/02 respectively. The region has a tropical climate with high temperatures ranging from 20 to 35°C and high relative humidity (60 to 95%), latitude 16°56’18”.

It was used the soybean cultivar MTBR-45 and in order to evaluate seed moisture range inside a single plant, 100 plants, in four field plots 10km apart, were labeled at same maturation stage. This was necessary due to rain, which occurs in this growing period, every two to three days, ranging normally from 20 to 60mm. Even though there were four fields, harvesting was done in just one at each time, where it had not rained during the last 24 hours. Harvesting began when some pods on the plant were yellow, and thereafter, every two to three days, all the pods from two plants (ranging from 98 to 115) were harvested at 4:00 pm. Eight harvests were made during 16 days. Seeds from each pod were manually shelled and their moisture content (MC) was determined. The oven method with 105 ± 1°C for 24 hours was used to determine MC, according the Brazilian Rules for Testing Seeds (1992).

The seed MC from the two plants as well as from the two crop years, were kept separated, but as the results from each one were quite similar, the data was pooled.

The statistical analysis used frequency distribution, determined for 100 observation points related to the pods harvested at each time.

RESULTS AND DISCUSSION

Maturation inequality in a soybean seed field is not only due to plant population variability, as verified by Hamer (1999), but also to the fact that there is a large range of seed MC from an individual soybean plant.

Analyzing the trend of soybean seed MC in the maturation process, it can be observed that at first harvesting the average MC was 59.8%, but with 27 percentage points (pp) difference between the seeds with highest MC and those with the lowest MC coming from the same plant (Table 1). At this harvesting, observing the data through standard deviation, it showed that 95% of the seeds had 50,4 to 69,2% MC, which means that practically none of the seed population reached the point of physiological maturity, as determined by Andrews (1966).

The data of the second harvest, made two days after the first one, showed, as expected, that the average seed MC decreased to 53.3% with seeds ranging from 33,3 to 67.5% MC. Analysing the coefficient of symmetry of – 0.90, it revealed that a group of seeds presented high MC and a small portion was close to 33.3% MC, allowing the mean to be positioned closer to the wetter seeds (67%). In relation to data concentration around the mean, it showed, through kurtose coefficient of 1.29, that seed MC is low concentrated, which can also be visualized through the values amplitude of 31.2 pp (Table 1, Figure 1).

TABLE 1. Statistical data of seed moisture range in a soybean plant harvested at different maturation stages.

Harvesting Times	Harvesting Days	Values Minimum-Maximum	Average	Standard Deviation	Kurtose Coefficient	Coefficient of Asymmetry
1	0	45.2 - 72.2	59.80	4.70	1.24	-1.16
2	2	33.3 - 67.5	53.30	4.81	1.29	-0.90
3	4	23.2 - 58.4	44.20	6.19	1.34	-0.40
4	7	13.0 - 37.6	25.10	4.51	-3.34	1.38
5	10	12.5 - 29.5	19.20	2.87	-0.45	0.62
6	12	11.8 - 21.0	15.20	1.88	-0.46	0.65
7	14	11.0 - 18.3	12.70	1.82	-0.46	0.67
8	16	10.6 - 16.2	11.80	1.90	-0.35	0.64

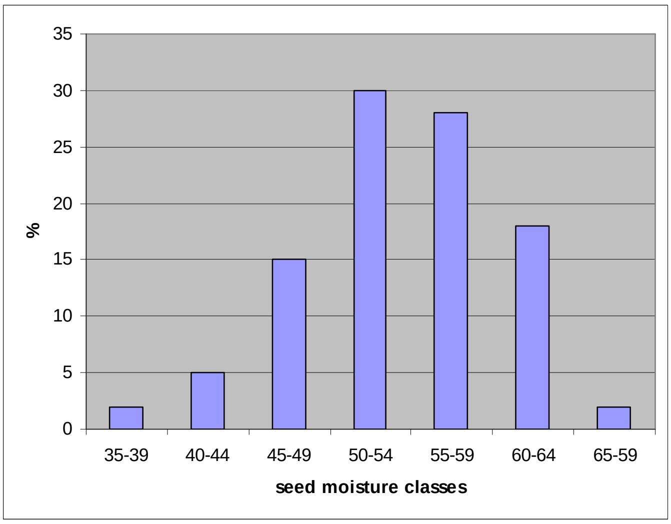

FIGURE 1. Seed moisture range in a soybean plant harvested at a average of 53.3% MC.

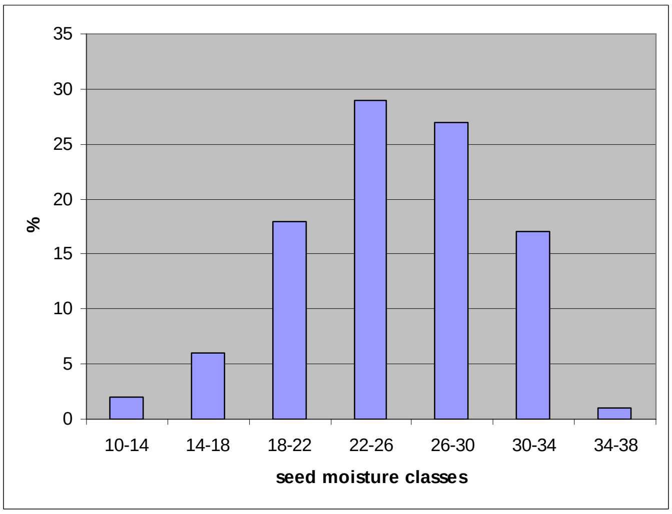

FIGURE 2. Seed moisture range in a soybean plant harvested at an average of 25.10% MC.

Up to the third harvesting, four days after the first one, most of the seeds had reached physiological maturity, but still more than 10% of the seeds presented above 50% MC (Table 1). On the other hand, harvesting seven days after the first one, all the seeds had reached the point of physiological maturity, and the seed MC began to concentrate around the mean, with a kurtose coefficient negative and tended to present some seeds with low MC, as shown by the symmetry coefficient of 1.38 (Table 1 and Figure 2). Also at this harvesting, for the first time it was detected seeds with 13% MC, a percentage indicating that the seeds were in hygroscopic equilibrium with the relative humidity of the air of 75% (Baudet, 2003) common in the region.

The sixth harvesting presented an average seed MC reduction greater than 40 pp in relation to the first one, 12 days earlier, decreasing from 59.8 to 15.2% (Table 1). This harvesting indicated that the seeds would be in condition to be mechanically harvested, according to Hamer & Peske (1997), where only 2.5% of the seeds would present MC superior to 19%, as determined by the standard deviation. At this maturation stage, the moisture range by seed population tended to present a normal distribution according to coefficient of kurtose and symmetry.

Fourteen days after the first harvesting, there was a range of MC among the seeds of 7.3 pp, where the concentration of the seed tended to be closer to the dryer side of the distribution (figure 3), as would be expected due to the equilibrium moisture content of the seeds where they dry to a certain point. On the other hand, the harvesting accomplished 16 days after the first one, even though with a average seed MC lower than 12%, still presented more than 20% of the seeds with MC superior to 13%, a level not safe for storage, specially in tropical regions (Baudet, 2003).

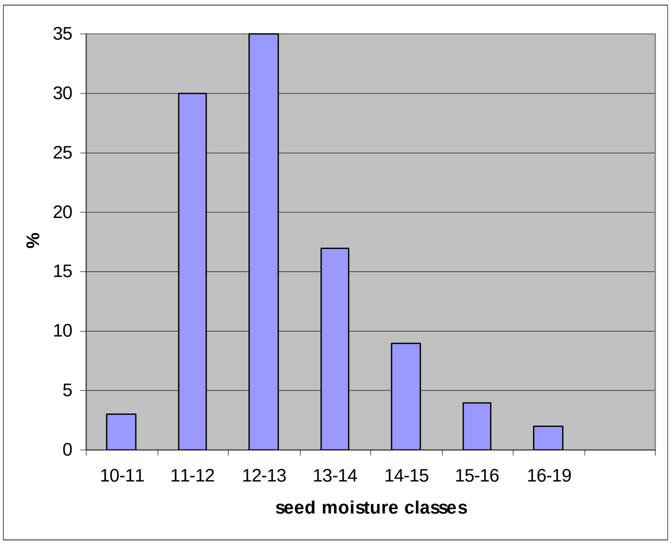

FIGURE 3. Seed moisture range in a soybean plant harvested at an average of 12.7% MC.

It is pointed out that even when the average seed MC was higher than 20%, not recommended for mechanical harvesting, according to Hamer & Peske (1997) and França Neto (1984), there were some seeds with 13% MC waiting to be harvested which tended to rapidly increase as harvesting was delayed.

The gain of MC of a soybean seed in the field waiting to be harvested can reach 5 pp in a single day, due to dew, which accelerates the deterioration process while the seed is not harvested, according to Ahrens & Peske (1994). Thus in the case of harvesting seeds with an average MC of 12%, many seeds will already have deteriorated by the process of gaining and loosing water in the field. Those seed producers who do not harvest their product with MC higher than 15%, undergo high risk to obtain seed with high physiological quality. It is evident, according to Table 1, that in order not to loose seeds by field deterioration, seeds with high MC should be harvested and dried as soon as possible for safe seed storage. Also, it is well documented that soybean seeds with MC higher than 20% are highly susceptible to mechanical damage, however, as these seeds are much larger than the others in the population, they can be easily separated during the pre-cleaning process before the seeds are dried (Peske *et al*., 1995).

Seed field deterioration due to moisture is the main cause of low physiological quality, and this occurs because during a relatively long period of time, the seeds remain mature in the field (Delouche, 1979) which is increased by the inconvenience of great inequality in the maturation stage of the plants inside a population (Hamer, 1999), and, according to this study, in a individual plant. This inequality causes two consequences to soybean seed production: seeds from plants that mature early are submitted to unfavorable field conditions and, green seeds are mixed in the seed lot.

The seed coat has an essential role in protecting the seed, as described by Delouche (1979), as well as controlling water imbibition and the entrance of microorganisms. Thus a mature soybean seed in the field, due to frequent drying and swelling, will eventually rupture the seed coat and become practically unprotected to the environmental adverse conditions. The soybean seeds that presented wrinkled coat, opposite (Peske &Pereira, 1982) the hilum, where hourglass cells are not present, were those that remained in the field longer than they should.

It must be emphasized that this study was undertaken in a region with high temperature, relative humidity and rainfall, requiring that the harvesting process be accomplished as quickly as possible, considering that in a two week period, the soybean seeds went from a pre-physiological maturation stage to one with an average seed MC lower than 12%. The rate of seed MC reduction to 12% is really fast up to 20% and there after it slowed down due to the increased number of seeds whose MC was in equilibrium with the relative humidity of the air. This can be misleading if it is not considered that, on a daily basis, the MC reflects the average, meaning that in a seed population with seed MC of 15%, some seeds will still be dry and some others no.

Another aspect that deserves consideration is that in the seed population just harvested with a seed MC of 12%, some seeds had already deteriorated to such a stage that they would probably not germinate and others would have MC well above 15%, which, if not dried, will also deteriorate quickly

CONCLUSIONS

This study allows the following conclusions and/or recommendations for production of high quality soybean seed in a tropical region:

1 – There is a high seed MC range in an individual soybean plant during the maturation process;

2 – The great seed MC range in a soybean seed lot just harvested leads to the presence of seeds susceptible to mechanical damage and with MC unsafe for adequate storage;

3 – It is recommended that harvesting should be accomplished when seed MC is around 15-18%, in order to minimize field deterioration;

4 – Drying is recommended, even when soybean seeds are at an average MC safe for storage.

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