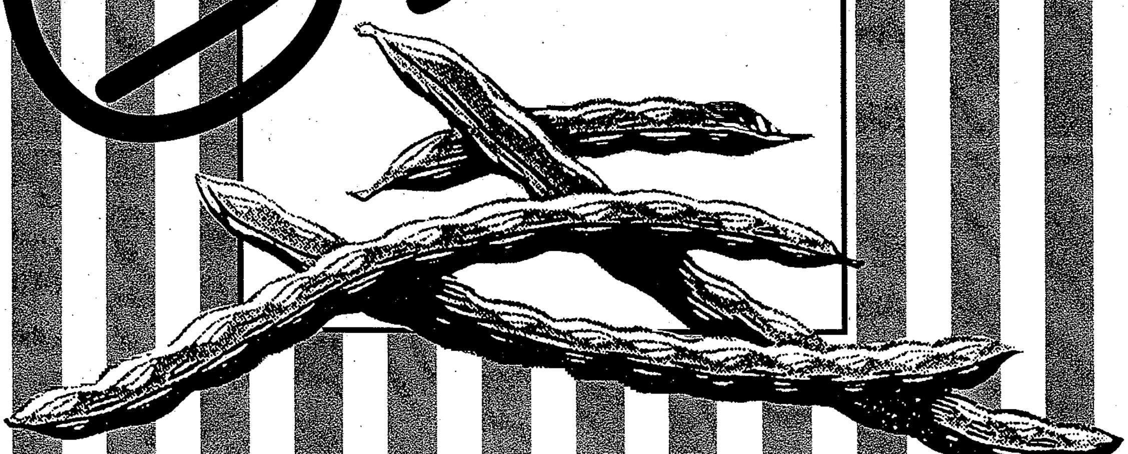
Bulletin 1036 • October 1995

Seed Maturation & Establishment of Hardseededness in Pinkeye Purple Hull SOUTHERN Peas



MAFES
MSU
MISSISSIPPI AGRICULTURAL & FORESTRY EXPERIMENT STATION Verner G. Hurt, Director Mississippi State, MS 39762
Donald W. Zacharias, President Mississippi State University R. Rodney Foil, Vice President

Seed Maturation and Establishment of Hardseededness in Pinkeye Purple Hull Southernpea in Mississippi

E.R. Cabrera
Associate Professor, Seed Technology
Department of Plant and Soil Sciences

C.C. Baskin
Professor Emeritus, Seed Technology
Department of Plant and Soil Sciences

L.E. Nsapato
Former Graduate Student, Seed Technology
Department of Plant and Soil Sciences

Published by the Office of Agricultural Communications, Division of Agriculture, Forestry, and Veterinary Medicine, Mississippi State University. Edited by Keith H. Remy, Senior Publications Editor. Cover designed by Betty Mac Wilson, Graphic Artist.

Seed Maturation and Establishment of Hardseededness in Pinkeye Purple Hull Southernpea in Mississippi

Introduction

Seed maturation may be regarded as a positive process during seed development encompassing additive changes in seed characteristics, which include increase in seed size, dry weight, viability, and vigor (Rajanna and Andrews, 1970). Physiological maturity is defined as the time when seeds attain maximum dry weight, maximum germination, and maximum vigor (Andrews, 1966; Delouche, 1958; Mejia, 1985; Rajanna and Andrews, 1970). Seed quality is at its peak at the time physiological maturity is reached; therefore, being able to identify this stage of development can aid a seed grower in optimizing subsequent operations such as harvesting and drying to maximize the germination and vigor of seed produced.

Seed development in southernpea [*Vigna unguiculata* (L.) Walp.] occurs more rapidly than in some other species. Oropeza (1976), working with two cultivars of southernpea, found maximum dry weight was attained 17 to 19 days after anthesis. Banyankiye (1993) found physiological maturity of sorghum seed was reached in 27 to 30 days under rainfed conditions in Mississippi. Caceres (1977) identified physiological maturity of Lee 68 soybean seed 68 days after anthesis. Physiological maturity of okra was reported to occur between 36 and 38 days after flowering by Ratresni (1991).

Hardseededness is a condition where seeds do not imbibe water because of an impermeable seedcoat. It occurs in several different species (Harrington, 1916). The actual mechanism involved is a controversial issue. In soybean [*Glycine max* (L.) Merril], hardseededness does not develop until seeds dry down to 15% or less moisture in the field (Duangpatra, 1976; Maxey, 1981).

Hardseededness is heritable, and different cultivars within a species have different genetic potential to produce hard seed (Bennett, 1959; Maxey, 1981). The percentage of hard seed increases in soybeans as seed moisture content decreases below 14% (Baciu-Miclaus, 1970; Duangpatra, 1976; Hayes and Garber, 1927).

Although hardseededness is genetic, expression is subject to several environmental factors. Andrews (1956) found more hard seed in *Medicago trebuloids* when nutrition and moisture were adequate than when nutrition was low and plants were water stressed. El Bagoury and Niyazi (1973) reported that high levels of calcium, nitrogen, and potassium increased the amount of hard seed in *Trifolium alexandrium* (L.). Harrington (1916) reported that high temperature combined with low humidity favored the expression of hardseededness. The most important factor appears to be seed moisture content (Baciu-Miclaus, 1970; Duangpatra, 1976; Lebedeff, 1947; and Maxey, 1981).

This study was conducted to determine developmental parameters of Pinkeye Purple Hull southernpea seed and when, relative to seed maturity, hardseededness expresses itself.

Materials and Methods

Seed Material

Three lots of southernpea cultivar Pinkeye Purple Hull seeds were planted on the Plant Science Research Center of the Mississippi Agricultural and Forestry Experiment Station in Starkville, Mississippi. The Pinkeye Purple Hull cultivar was selected for this study because varying levels of hardseededness had been observed in numerous seed lots. Since there was a degree of hardseededness in the lots planted, all seeds were scarified by nicking the seed coat with a razor blade on the chalazal end prior to planting. This ensured a similar rate of water absorption and resulted in a uniform emergence.

During land preparation, nitrogen, phosphate, and potash were applied according to soil test recommendations. Seeds were hand planted in rows 1 meter apart with two seeds per hill 1 meter apart in the row. Two rows were planted for each lot, giving a total of 50 hills per lot.

Flower Identification

Tagging of flowers for identification was done daily on all flowers that bloomed from July 11 through July 20. Flowers were tagged when they had fully emerged from the calyx, but before they had begun to wither. Tagged flowers to be used for sampling were grouped into three tagging periods. A tagging period consisted of flowers tagged on 3 successive days. Table 1 shows dates of tagging, the tagging periods, age of seeds at sampling, and dates samples were taken.

Sampling

To establish parameters associated with seed development (seed moisture, dry matter accumulation, pod and seed size, and germination), samples were collected at 3-day intervals from 9 to 24 days after flowering (DAF). To further assess seed deterioration, seed samples were taken every 4 days from 24 to 36 DAF and every 5 days from 55 to 65 DAF. On these samples, seed moisture content, percentage germination, and incidence of hard seeds were evaluated.

Table 1. **Dates of tagging, tagging periods, seed age, and dates samples were taken.**

Tagging periods and tagging dates	Number of days from flowering and harvest dates											
	9	12	15	18	21	24	28	32	36	55	60	65
1st tagging period												
7/11/88	7/20		7/26			8/4						
7/12/88		7/24			8/2							
7/13/88				7/31								
2nd tagging period												
7/14/88		7/26		8/1	8/4		8/11					
7/15/88	7/24					8/8		8/16	8/20			
7/16/88			7/31									
3rd tagging period												
7/18/88	7/27			8/5			8/15			9/11		9/21
7/19/88		7/31	8/3			8/12		8/20	8/24			
7/20/88					8/10						9/18	

At each sampling period, 10 pods were harvested per lot. One to two pods were sampled from each tagged flower stalk to minimize variation within the age period since emergence of flowers from the same stalk differed by as much as 5 days. Harvested pods were placed in plastic bags to prevent moisture loss while transporting them to the laboratory for testing.

Weight and Length Measurements

Length, width, and thickness of pods were determined upon harvesting. Pods were then shelled, 30 seeds were randomly selected, and their length, width, and thickness measured.

Dry Matter and Moisture Determination

A random sample of 30 seeds was taken for moisture tests. Fresh seeds were weighed, dried in an oven at 105 °C for 24 hours, then weighed again and percent moisture calculated on a wet weight basis. These samples were also used to determine dry matter per seed.

Germination Tests and Determination of Hardseededness

A random sample of 40 seeds was air-dried at room temperature then stored at room temperature for approximately 30 days before germination tests were conducted. Replications of 20 seeds each were planted in moist, rolled germination towels then placed in a germinator at an alternating 20-30 °C temperature. Germination counts were made at 5 and 8 days after planting. Hard seeds were counted 24 hours after planting and again at the termination of the test.

Results and Discussion

Seed Moisture Content

Plants began flowering 38 days after seedling emergence. Seed moisture content at 9 DAF was approximately 84% and declined rapidly during seed development to 12.7% 24 DAF (Figure 1). Prior to physiological maturity, seed moisture loss took place at a nearly linear rate. At physiological maturity, which was attained about 18 DAF, seed moisture content was approximately 54%. Oropeza (1976) found seed moisture content to be approximately 50% when seed reached maximum dry weight 17 to 19 DAF.

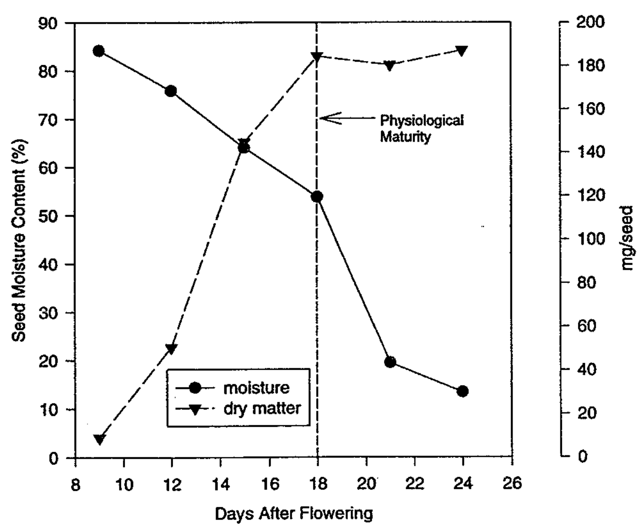


Figure 1. Dry matter accumulation and moisture content of developing Pinkeye Purple Hull southernpea seed.

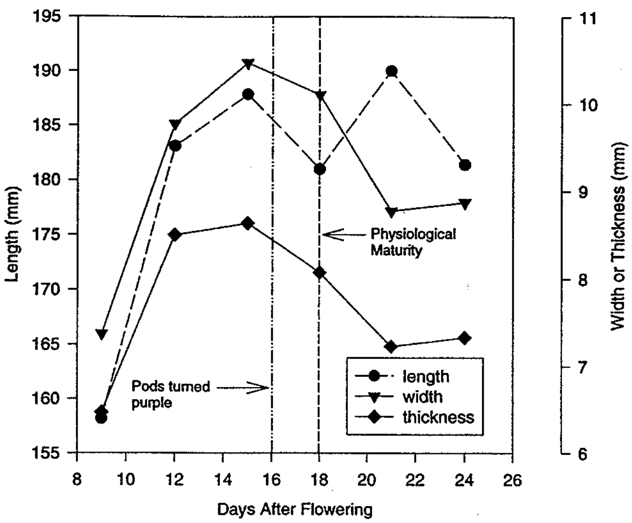


Figure 2. Pod dimensions of developing Pinkeye Purple Hull southernpea.

Pod and Seed Size

Length, width, and thickness of pods and seeds followed a similar trend in development. Figures 2 and 3 illustrate the changes in length, width, and thickness of the developing pods and seeds, respectively. Pod and seed size increased rapidly from the ninth day after flowering, reaching a maximum at approximately 15 DAF. Following 15 DAF, both pod and seed size declined, particularly following the 18th DAF, reflecting the rapid loss of moisture that occurs after physiological maturity is reached. Closely coinciding with the maximum pod and seed size was the change in pod coloration from green to purple, which was distinctly observed at 16 DAF.

Dry Matter Accumulation

Physiological maturity is the point at which seeds attain maximum dry weight (Andrews, 1966; Delouche, 1958; Mejia, 1985; Rajanna and Andrews, 1970). In this study, maximum seed dry weight was attained at approximately 18 DAF (Figure 1). Similarly to other species, maximum dry matter accumulation in southernpeas occurs a few days after maximum seed size is reached.

In the case of the Pinkeye cultivar, maximum dry matter accumulation was reached 3 days after maximum seed size was attained, at which point the seed moisture content was about 54%. The change of pod color from green to purple occurred 2 days before physiological maturity was reached. This is a most practical attribute to observe in the field to determine when physiological maturity in this variety of southernpeas is attained.

Seed Germination

Percentage seed germination at different harvest intervals is presented in Figure 4. In the early stages of development, no germination was registered; however, 15 DAF, 23% of the seeds germinated. Maximum germination was attained at physiological maturity, 18 DAF, when nearly 96% of the seeds germinated. From 18 to 36 DAF, germination decreased

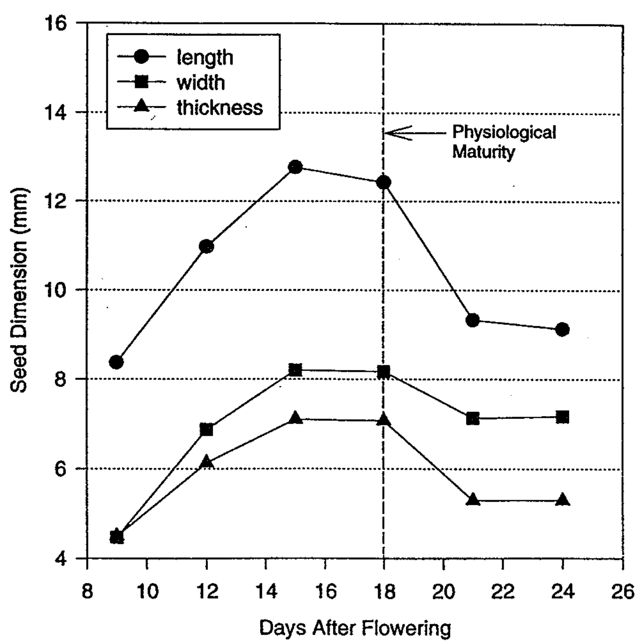


Figure 3. Length, width, and thickness of developing Pinkeye Purple Hull southernpea seed.

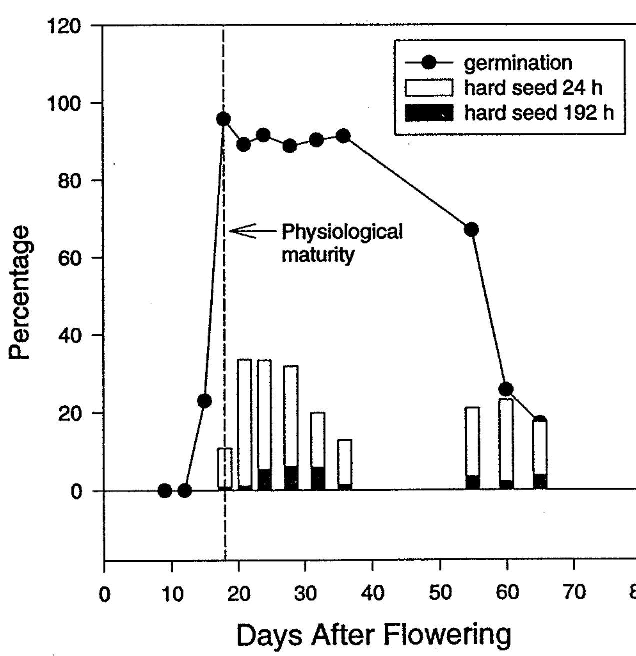


Figure 4. Germination and expression of hardseededness in developing and maturing Pinkeye Purple Hull southern pea.

somewhat. Following 36 DAF, germination decreased drastically as a consequence of field deterioration, reaching a minimum of 17% 65 DAF.

Expression of Hardseededness

Expression of hardseededness is presented in Figure 4. No hard seeds were detected until seeds reached physiological maturity at 18 DAF, at which time seed moisture content was 54%. This is in agreement with Dexter's (1955) observations in alfalfa, however, Duangpatra (1976) and Maxey (1981) found no hard seeds in soybeans at physiological maturity. Hardseededness did not occur until seed moisture decreased to 15% in the field. At 21 and 28 DAF seed moisture content decreased to 20% and 13%, respectively. Hardseededness peaked at those sampling times based on the 24-hour imbibition observation.

Hardseededness at 24 hours of imbibition was considerable higher than hardseededness at 192 hours of imbibition and fluctuated among harvest times at both the 24-hour and 192-hour imbibition times.

Summary and Conclusions

Developing seeds of Pinkeye Purple Hull southernpea first germinated at 15 DAF. Seed reached physiological maturity at 18 DAF at which time maximum dry weight and maximum germination were attained. Purple coloration of the pods was detected 2 days before physiological maturity was reached. Hardseededness was not observed until seeds had reached physiological maturity. At this time, seed moisture content was approximately 54%. A similar pattern of hard seed development was observed by Dexter (1955) in alfalfa. However, Duangpatra (1976) and Maxey (1981) found no hardseededness in soybeans until seed moisture content reached 15% in the field.

As seed decreased in moisture content, hardseededness tended to increase until seed moisture content reached 12 to 14% at 28 DAF, after which time hardseededness fluctuated and tended to decrease slightly. Hardseededness in moist germination towels decreased considerably from 24 hours of imbibition to 192 hours of imbibition (1 to 8 days). This is important for this cultivar because it dispels the fears that hardseededness may contribute significantly to the establishment of uneven or delayed stands, (Potts, 1985).

Acknowledgment

Funding to support this research was provided by the Mississippi Agricultural and Forestry Experiment Station.

Literature Cited

Andrews, W.D. 1956. Interaction of the moisture and nutritional regimes on hard seed production in berril medic. Proc. Aust. Plant Nutrition Conf. 1956. pp. 76-90.

Andrews, C.H. 1966. Some aspects of pod and seed development in Lee soybeans. Ph.D. Dissertation. Dept. of Agron. Miss. State Univ., Miss. State, MS.

Baciu-Miclaus, D. 1970. Contribution to the study of hard seed and coat strcuture properties of soybean. Proc. Int. Seed Test. Assoc. 35:599-617.

Banyankiye, P. 1993. Some aspects of seed development, maturation and field deterioration in sorghum. M.S. Thesis. Dept. of Agron. Miss. State Univ.,Miss. State, MS.

Bennett, H.W. 1959. The effectiveness of selection for the hard seed character in crimson clover. Agron. J. 51: 15-16.

Caceres, J. 1977. Pod and seed development in Lee 68 soybean [*Glycine max* (L.)Merrill]. M.S. Thesis. Dept. of Agron. Miss. State Univ., Miss. State, MS.

Delouche, J.C. 1958. Germination of Kentucky bluegrass harvested at different stages of maturity. Proc. Assoc. Off. Seed Anal. 48:81-84.

Dexter, S.T. 1955. Alfalfa seedling emergence from seed lots varying in origin and hard seed content. Agron. J. 47:357-361.

Duangpatra, J. 1976. Some characteristics of impermeable seedcoat in soybean [*Glycine max* (L.) Merr.]. Ph.D. Dissertation. Dept. of Agron. Miss. State Univ., Miss. State, MS.

El Bagoury, O.H., and M.A. Niyazi. 1973. Effect of different fertilizers on the germination and hard seed percentage of Egyptian clover seeds (*Trifolium alexandrium* L.) Seed Sci. and Technol. 1:773-779.

Harrington, J.F. 1916. Agricultural value of impermeable seeds. J. Agr. Res. 6:761-796.

Hayes, H.K., and R.J. Garber. 1927. Breeding Crop Plants. pp. 130-141. 2nd ed. McGraw-Hill Book Co. New York, NY.

Lebedeff, G.A. 1947. Studies on the inheritance of hard seed in beans. J. Agr. Res. 74:205-215.

Maxey, A.M. 1981. Influence of the hard seed character on some responses of soybeans. [*Glycine max* (L.) Merr.] M.S. Thesis. Dept. of Agron. Miss. State Univ., Miss. State, MS.

Mejia, R.P. 1985. Seed quality of ten soybean entries as affected by weather and fungal seed infection. M.S. Thesis. Dept. of Agron. Miss. State Univ., Miss. State, MS.

Oropeza, F. 1976. Seed maturation in cowpea [*Vigna unguiculata* (L.) Walp]. M.S. Thesis. Dept. of Agron. Miss. State Univ., Miss. State, MS.

Potts, H.C. 1985. Seed coat permeability and deterioration studies. 15th Soybean Research Conf. Am. Seed Trade Assoc., Washington, DC.

Rajanna, B., and C.H. Andrews. 1970. Trends in seed maturation of rice (*Oryza sativa* L.). Proc. Assoc. Off. Seed Analysts 60:188-196.

Restreni. 1991. Seed development, maturation, and hardseededness in okra [*Abelmoschus esculentus* (L.) Moench] M.S. Thesis. Dept. of Agron. Miss. State Univ., Miss. State, MS.

64765/0.9M