ORIGINAL ARTICLE

Germination Index of Bean (*Phaseulus vulgaris* L.) Variety Bat 304 for Seed

Índice germinativo del frijol (*Phaseulus vulgaris* L.) variedad bat 304 para semilla

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ABSTRACT: The germination tests to evaluate the quality of the seed, were carried out in laboratory of Quality of the Agrarian University of Havana, under controlled conditions, of humidity and light. Values were obtained they evidence the growth of the black bean (Phaseolus vulgaris L var. BAT 304) per day, where it is shown that in the second day, of the 100 seeds that underwent the germination experiment, 8 of them were the most vigorous that measured between the values of 20 and 24,9 mm. In the third day the most vigorous they were 8 seedlings of values between 25 and 29,9 mm. In the fourth day they were 6 seedlings the most vigorous with values smaller than 30 mm. For what the fourth day was of 94%, you can demonstrate you that the seeds selected for the germination test in the laboratory are of high quality, being considered that this lot is of high quality, since it reaches superior levels to 90 germination%. The germination test in the field was carried out in a property in the immediacy of the popular advice of you Covered, the sampling was carried out to the fourth day, where 100 seeds that underwent the germination experiment, alone 3 of them the most vigorous that measured between the values of 20 and 24,9 mm. In the ninth day the most vigorous were they were 10 seedlings of values between 25 and 29,9 mm. In the tenth fourth day they were 9 seedlings the most vigorous with values smaller than 30 mm.

***Keywords*:** Control, Humidity, Light Growth, Vigorous.

RESUMEN: Las pruebas de germinación para evaluar la calidad de la semilla, se realizaron en laboratorio de Calidad de la Universidad Agraria de La Habana, bajo condiciones controladas, de humedad y luz. Se obtuvieron valores que evidencian el crecimiento del frijol negro *(Phaseolus vulgaris L var. BAT 304*) por día, donde se muestra que en el segundo día, de las 100 semillas que se sometieron al experimento de germinación, 8 de ellas fueron las más vigorosas, que midieron entre los valores de 20 y 24,9 mm. En el tercer día las más vigorosas fueron 8 plántulas de valores entre 25 y 29,9 mm. En el cuarto día fueron 6 plántulas las más vigorosas con valores menores de 30 mm. Por lo que el cuarto día fue de 94%, se puedes demostrar que las semillas seleccionadas para la prueba de germinación en el laboratorio son de alta calidad, ya que alcanza niveles superiores al 90% de germinación. La prueba de germinación en el campo se realizó en una finca en la inmediación del Consejo Popular de Tapaste, el muestreo se realizó al cuarto día, donde 100 semillas que se sometieron al experimento de germinación, solo 3 de ellas fueron las más vigorosas, que midieron entre los valores de 20 y 24,9 mm. En el noveno día las más vigorosas fueron 10 plántulas de valores entre 25 y 29,9 mm. En el decimo cuarto día fueron 9 plántulas las más vigorosas con valores menores de 30 mm.

***Palabras clave*:** control, humedad, luz, crecimiento, vigoroso.

INTRODUCTION

The seed is the effective vehicle through which plant breeding achievements are transferred from the research field to the farmer's field. Varieties become important agricultural inputs when the corresponding seed is genetically genuine, physiologically viable and mechanically pure (Ortiz-Aragón & Larios-González, 2020).

Modern agriculture demands high quality seed, this being the main input that must be met, among these are: genetic, physiological, physical and sanitary quality (Rojas *et al.*, 2010). All of this refers to intrinsic mechanisms of the fruit that determine its ability to emerge and the development of those structures essential to produce a normal seedling under favorable conditions.

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The result of the germination test is expressed as a percentage per number of normal and abnormal seedlings (Estrada-Zúniga, 2013; Flores de la Cruz *et al.*, 2018; Acuña *et al.*, 2019).

Seeds that germinate quickly and uniformly, generating healthy plants and reaching levels greater than 90% of total germination, can be considered high quality seeds, both for domestic consumption and for marketing according to Garay-Ayala *et al.* (2008); Romero-Pintor *et al.* (2020); Santana-Baños *et al.* (2021).

MATERIALS AND METHODS

The black bean (Phaseolus vulgaris L.) grains, variety BAT 304, used in this study were obtained from the "El Guayabal" University Farm, belonging to the Agrarian University of Havana (UNAH), which is located at 23 °00'12.5" North latitude, and 82°09'57.9" West longitude in the municipality of San José de Las Lajas, Mayabeque province, Cuba. The existing soil is classified as Typical Red Ferralitic according to Hernández et al. (2015) in its entirety. It has a flat relief, height above sea level of 120 m and annual sunshine of 1825kWh/m2. The meteorological variables recorded during the period 2015-2022 at the Tapaste Meteorological Station showed that the maximum temperatures reached in the region exceeded 26 ºC between the months of June to September and the coldest temperatures fell on average to 20.76 ºC in January. . Precipitation showed increases starting in May, and indicated the highest average values in June and August with 255.50 and 245.16 mm, respectively. The relative humidity varied between 72.8% (minimum, in March) and 84.6% (maximum, in December), while the wind speed expressed its maximum limit of 5.46 km/h during the month of February. (Figure 1).

The germination potential was carried out in the Quality laboratory at the "Agrarian University of Havana" for this, 100 black bean seeds (Phaseolus Vulgaris L.) variety BAT 304 were selected, taken at random, and placed on a cardboard base with substrate (in this case cotton) moistened with water. (Figure 2)

The experiment was carried out under controlled conditions of temperature and humidity, protected from the sun, rain and strong winds, and periodic irrigation of the seeds was carried out according to the need. Among the seedlings that emerged, the normal ones are differentiated from the abnormal ones to know the germination percentage. This procedure is repeated from the 2nd to the fourth day after setting up the experiment.

The germination process can be divided into several events:

(1) Imbibition: The physical process of water absorption.

(2) Activation: The start-up of the synthesis and degradation machinery.

(3) Cell division and elongation.

(4) Rupture of the seed coat by the embryo.

(5) Establishment of the seedling as an autonomous entity.

It is necessary to carry out a final germination count at 7, 8 or 10 days, depending on the species, to determine the percentage, counting normal (PN), abnormal (PA) seedlings and ungerminated seeds (SSG) (Figure 3).

Those that met the following requirements were considered normal seedlings:

- Well developed root system, primary root and seminal roots.
- Hypocotyl with good development without tissue damage.
- Plumule with good growth, with well-developed leaves.
- One cotyledon in monocotyledons and two cotyledons in dicotyledons.

Seedlings with the following defects are classified as abnormal:

- Damaged primary root, without development and/or emergence, with little vigor without passing through the seed coat, with negative geotropism, without secondary roots.
- Bud (hypocotyl, epicotyl, mesocotyl) without development, widened, twisted or without emergence.
- Cotyledons and leaves deformed, necrotic or damaged by infections.

Ungerminated seeds: they did not germinate at the end of the test period. The classification is as follows:

- Hard: seeds that remain hard at the end of the analysis period, because they did not absorb water. Seed hardness is a form of dormancy. It is common in many species of Fabaceae, but can also occur in other families.
- Fresh: seeds (other than hard seeds) that have failed to germinate under the conditions of the germination test due to dormancy, but remain clean and firm and can develop into a normal seedling. They can absorb water under the conditions established in the ISTA standards, but the germination process is obstructed.
- Dead: seeds that are not hard or fresh and have not produced any part of a seedling at the end of the testing period. Dead seeds absorb water, are usually soft or discolored, and often have molds. They give no signs of seedling formation.

FIGURE 1. Guayabal Estate.

FIGURE 2. Germination in the Laboratory of black beans Var. BAT304

FIGURE 3. Anormal seedlings.

To analyze the growth of the seedlings on each day mentioned above, their elongation is obtained using those less than 5 mm as a classification scale; between 5 and 9.9 mm; between 10 and 14.9 mm; between 15 and 19.9; between 20 and 24.9 mm; and between 25 and 29.9 mm, measurements are made using a conventional, flexible 1-150 mm measuring tape, three times on each seedling to obtain the average seed stem length.

The germination percentage is expressed as follows:

$$Germination\ \ (\%) = \frac{Number\ \ of\ \ normal\ \ seeds}{Number\ \ of\ \ seeds\ \ set\ \ to\ \ germinate} \times 100$$

Those that germinate quickly and uniformly, generating healthy seedlings and reaching levels greater than 90% of total germination, can be considered high quality seeds, according to Garay-Ayala *et al.* (2008); Rojas *et al.* (2010); Ramírez y Suris, (2015); Romero-Pintor *et al.* (2020).

To determine germination in the field, the experiment was carried out on a farm of the Tapaste Popular Council located in the municipality of San José de las Lajas. The crop to be investigated was the black bean (Phaseolus vulgaris L.) variety BAT 304; in non-optimal sowing period. The preparation of the experimental area was done using animal traction. On a sialitic brown soil, the furrow was drawn with 4 furrows of 25 seeds. (Figure 4).

The distance between furrows was 50 cm with a depth of no more than 2 cm. They are watered daily with 20 to 25 ml of drinking water for each plant and on the fourth day the germination process should begin. Two experimental samplings were carried out to collect the information, the first four days after sowing, the second at 9 and fourteen days according to the Technical Manual "Seeds in Emergency" of the (FAO (2011) and Minagri-Cuba (2000).

RESULTS AND DISCUSSION

Germinative index of black bean (Phaseolus vulgaris L., var. BAT 304) in the laboratory.

Table 1 and Figure 5 show the values corresponding to the growth of the seedlings per day for those that underwent the germination test in the laboratory. These values show the growth of the bean per day, which shows that on the second day, of the 100 seeds that underwent the germination experiment, 8 of them were the most vigorous, which measured between the values of 20 and 24.9 mm. On the third day, the most vigorous were 8 seedlings with values between 25 and 29.9 mm. On the fourth day, 6 seedlings were the most vigorous with values less than 30 mm.

In (Figures 6 A, B and C) the germination index is evident in percentage per day, in Figure 6 A only 1% of the plants showed a change in color, 45% of the beans were born and 54% represent the born beans , there was no sample of shelled beans.

In Figure 6 B, 3% changed color and were beans without shells, 14% represent those that were not born and 80% of them were born with good vitality.

In Figure 6 C, 2% of the beans change color, 3% are unshelled, 6% are unborn, and 89% of the beans are born. All this shows that the biological natures of seeds are good for giving rise to healthy and vigorous plants.

The result of the germination index of the seeds is shown in (Figure 7) the values obtained per day demonstrate that the seeds selected for the germination test in the laboratory, the fourth day was 94%, it can be demonstrated that the selected seed for the germination test in the laboratory it is of high quality since it reaches levels greater than 90% according

TABLE 1. Growth of seedlings for days in the laboratory

STEM ELONGATION			
	2nd day	**3rd day**	**4th day**
< 5 mm	18	14	8
5 -9,9 mm	21	14	10
10 - 14,9 mm	16	13	16
15 - 19,9 mm	10	8	19
20 - 24,9 mm	8	7	20
25 -29,9 mm		8	15
> 30 mm			6

FIGURE 4. Germination in the field of bean var. BAT304.

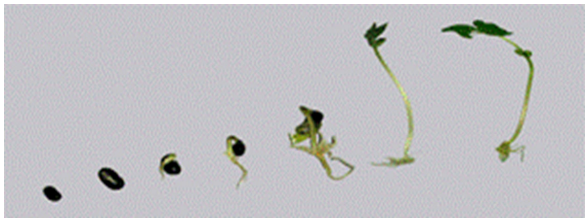
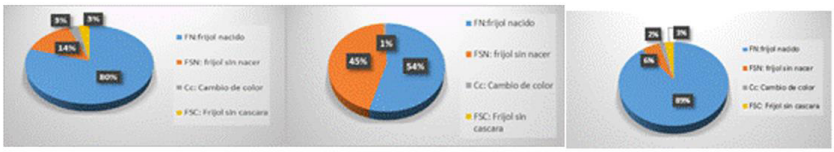


FIGURE 5. Germination of black bean seedling (Phaseolus vulgaris L var. BAT 304).



A **B** **C**

FIGURES 6 A, B and C. Germination percentage per day.

Garay-Ayala *et al.* (2008); Peña-Calzada *et al.* (2017); Kangue y Boicet-Fabre (2020).

Germinative index of black bean (Phaseolus vulgaris L., var. BAT 304) in the field

Table 2 shows the values per day of the growth of the bean seedlings, the sampling was carried out on the fourth day, where 100 seeds that were subjected to the germination experiment, only 3 of them were the most vigorous, which measured between the values of 20 and 24.9 mm. On the ninth day, the most vigorous were 10 seedlings with values between 25 and 29.9 mm. On the fourteenth day, 9 seedlings were the most vigorous with values less than 30 mm.

The result of the germination index of the seeds is shown in (figure 8) the values obtained per day demonstrate that the seeds selected for the germination test in the field, the fourteenth day was 95%, it can be demonstrated that the seeds selected are of high quality. According Garay-Ayala *et al.* (2008); González-Torres *et al.* (2008), due to its rapid and uniform form of germination, it reaches levels greater than 90%.

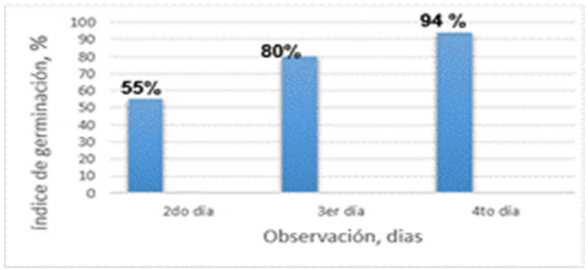


FIGURE 7. Germinative index per day in the laboratory.

TABLE 2. Growth of seedlings per day in the field

STEM ELONGATION			
	4th day	**9th day**	**14 day**
< 5 mm	16	15	11
5 -9,9 mm	18	14	12
10 - 14,9 mm	14	13	10
15 - 19,9 mm	12	10	14
20 - 24,9 mm	3	23	25
25 -29,9 mm		10	13
> 30 mm			9

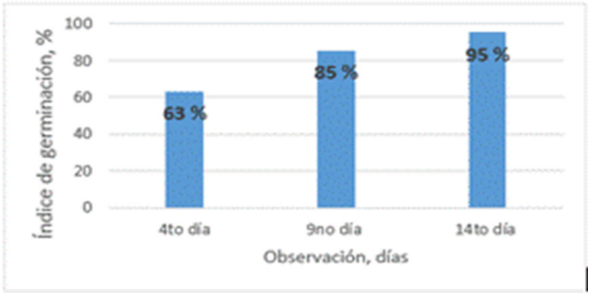


FIGURE 8. Germinative index per day in the field.

CONCLUSIONS

El índice de germinación, en el laboratorio fue de 94% y en el campo de 95% por lo que el frijol negro (Phaseolus vulgaris L var. BAT 304), son alta calidad y posee además las características adecuadas para su utilización como semilla, para ser mecanizada su siembra y cosecha.

REFERENCES

ACUÑA, R.; NAGUELQUIN, F.; GARCÍA, F.; TORRES, J.: "Aplicación de Campos magnéticos (CM) y su relación con la recuperación de la viabilidad y vigor en semillas envejecidas de Lactuca sativa L.", *Agro sur*, 47(1): 9-21, 2019, ISSN: 0719-4196.

ESTRADA-ZÚNIGA, R.: "Cultivo de quinua (Chenopodium quinoa willd) en la Región Cusco", 2013, ISSN: Publisher: INIA. Estación Experimental Agraria Andenes-Cusco.

FAO: *Manual Técnico "Semillas en Emergencia*, Inst. FAO "Food and Agriculture Organization of the United Nations, Roma. Italia, 2011.

FLORES DE LA CRUZ, M.J.; GARCÍA ESTEVA, A.; GARCÍA NAVA, J.R.; KOHASHI SHIBATA, J.; YBARRA MONCADA, M.C.: "Diferencias fenológicas, morfológicas y de componentes del rendimiento entre una forma silvestre y domesticada de frijol común", *Revista mexicana de ciencias agrícolas*, 9(1): 137-149, 2018, ISSN: 2007-0934, Publisher: Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias.

GARAY-AYALA, A.V.; SCHWENTESIUS-RINDERMANN, R.E.; ALMAGUER-VARGAS, G.: "La competitividad del frijol en México", *El cotidiano*, (147): 81-89, 2008, ISSN: 0186-1840, Publisher: Universidad Autónoma Metropolitana Unidad Azcapotzalco.

GONZÁLEZ-TORRES, G.; MENDOZA-HERNÁNDEZ, F.; COVARRUBIAS-PRIETO, J.; MORÁN-VÁZQUEZ, N.; ACOSTA-GALLEGOS, J.A.: "Rendimiento y calidad de semilla de frijol en dos épocas de siembra en la región del Bajío", *Agricultura técnica en México*, 34(4): 421-430, 2008, ISSN: 0568-2517, Publisher: Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias.

HERNÁNDEZ, J.A.; PÉREZ, J.; BOSCH, I.; CASTRO, S.: *Nueva versión de clasificación genética de los suelos de Cuba*, Ed. Ediciones INCA, Mayabeque, Cuba, Primera edición ed., San José de las Lajas, Mayabeque, Cuba, 93pp. p., 2015, ISBN: 978-959-7023-77-7.

KANGUE, A.F.; BOICET-FABRE, T.: "Evaluación de los parámetros fisiológicos y físicos de semillas de cuatro variedades locales de frijol común (phaseolus vulgaris l.)", *Ojeando la Agenda*, (64): 4, 2020, ISSN: 1989-6794, Publisher: Mª Begoña Peris Martínez.

MINAGRI-CUBA: *Guía Técnica para el cultivo del frijol en Cuba*, Instituto de Investigaciones Hortícolas Liliana Dimitrova, Quivican, Mayabeque, Cuba, 2000, Publisher: Instituto de Investigaciones Hortícolas Liliana Dimitrova.

ORTIZ-ARAGÓN, A.N.; LARIOS-GONZÁLEZ, R.: "Uso eficiente del agua en la producción de semillas de frijol común (Phaseolus vulgaris L.) con sistema de riego por aspersión", *La Calera*, 20(35): 81-87, 2020, ISSN: 1998-8850.

PEÑA-CALZADA, K.; RODRÍGUEZ, J.C.; OLIVERA, D.; LEÓN-ORELLANA, N.; LUGONES, Y.: "Efecto de un promotor del crecimiento en el comportamiento productivo del frijol (*Phaseolus vulgaris* L.)", *Avances en investigación agropecuaria*, 21(1): 35-46, 2017, ISSN: 0188-7890, Publisher: Universidad de Colima.

RAMÍREZ, S.; SURIS, M.: "Ciclo de vida de Acanthoscelides obtectus (Say.) sobre frijol negro (*Phaseolus vulgaris* L.) en condiciones de laboratorio", *Revista de Protección Vegetal*, 30(2): 158-160, 2015, ISSN: 1010-2752, Publisher: 1986 Centro Nacional de Sanidad Agropecuaria.

ROJAS, W.; SOTO, J.L.; PINTO, M.; JÄGER, M.; PADULOSI, S.: *Granos andinos: avances, logros y experiencias desarrolladas en quinua, cañahua y amaranto en Bolivia*, 2010, ISBN: 92-9043-858-4.

ROMERO-PINTOR, E.P.; PELAYO-ROBELTO, W.V.; OTALORA-CRISTANCHO, A.; ORTIZ-VILLOTA, M.T.: "Evaluación de la calidad de semillas de fríjol común (*Phaseolus vulgaris* L.) variedad Palicero en el banco de semillas de la Universidad Libre", *Avances Investigación en Ingeniería*, 17(1), 2020, ISSN: 2619-6581.

SANTANA-BAÑOS, Y.; CARRODEGUAS-DÍAZ, S.; AGUIAR-GONZÁLEZ, I.; BARROSO-ARAGÓN, A.; BUSTO-CONCEPCIÓN, A.; LÓPEZ-ALFONSO, R.: "Grain production and incidence of galling nematodes in common bean", *Revista mexicana de ciencias agrícolas*, 12(2): 183-192, 2021, ISSN: 2007-0934, Publisher: Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias.

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