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Influence of seed planting depth on germination and physiological development of seedlings of maize (*Zea mays L.*)

Influencia de la profundidad de siembra de semillas en la germinación y desarrollo fisiológico de plántulas de maíz (*Zea mays L.*)

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Abstract

The objective of this work was to describe the response of maize to different thicknesses of seed coat. The trial was carried out in the exteriors of the soil laboratory of the Universidad Técnica de Babahoyo, located in Babahoyo, Ecuador. The experiment was about different thicknesses of maize seed coat and its influence on the germinative process and development of the first stages of the seedlings. When less depth was used in the cover, there was a higher percentage of germination and a better development of the maize seedlings was achieved, except for the height of the plant where the opposite occurred.

Keywords: Depth of sowing, germinative, growth.

Resumen

El objetivo de este trabajo fue describir la respuesta del maíz a diferentes espesores de tape de semilla. El ensayo se desarrolló en los exteriores de los laboratorios de la Universidad Técnica de Babahoyo, ubicada Babahoyo, Ecuador. El experimento se trató de diferentes espesores de tape de las semillas de maíz y su influencia en el proceso germinativo y desarrollo de las primeras fases de las plántulas. Cuando se empleó menor profundidad en el tape, hubo un mayor porcentaje de germinación y se logró un mejor desarrollo de las plántulas de maíz, exceptuado la altura de la planta donde ocurrió lo contrario.

Palabras clave: Profundidad de siembra, germinativo, crecimiento.

I. Introducción

Maize is one of the most important staple foods and has been used in different ways by humans. His contributions to human and animal food make him very important today in some parts of the world. Maize (*Zea mays L.*) is also highly used as food for livestock or animals from which other foods such as milk are obtained. In this way, whether for human or animal consumption, the production of maize is very important for many countries and regions that generate it for domestic consumption or that export it to those regions where maize cannot grow [1, 2].

A prime factor in modern agriculture is the use of a quality seed, which must be able to emerge quickly and uniformly, under different environmental conditions. Genetic quality, physiology, physics and health [3]. Physical quality involves characteristics such as moisture content, weight by volume and purity[4].

With the lower thickness of cover, Umeoka *et al.* (2016)[5]; Mehra *et al.* (2017)[6]; Koocheki *et al.* (2016)[7] and Singh *et al.* (2017)[8] indicate that they obtained significant results in evaluated parameters when the seeds were in the depths closest to the surface of the soil. The objective of this work was to describe the response of maize to different thicknesses of seed cover.

II. Materials and Methods

The present test was carried out in the exteriors of the laboratories of the Universidad Técnica de Babahoyo, located at km 7.5 via Babahoyo - Montalvo in Ecuador.

It consisted in the study of different thicknesses of cover of the seeds of maize and its influence in the germinative process and development of the first stages of the seedlings. The hybrid DK-7088 30F35 distributed by ECUAQUIMICA was used (The mention of the commercial origin of the genetic material, is solely for identification purposes, there being no promotional commitment in relation to it by the direction of the journal).

The treatments were constituted by the thickness of cover 3, 6, 9, 12, 15 and 18 cm.

For the experiment, wooden boxes of 1.20 x 0.60 m were built for each replica, the substrate that was used was prepared with a 2: 1: 1 ratio of soil (clay loam) from the area, washed river sand, and rice chaff respectively. Each drawer had three rows and three columns according to the methodology of Alemán *et al.* (2008)[9]

The evaluations are carried out from the third day of sowing with a frequency daily, until the 30 days that the germination process must end, according to Vázquez and Torres (2006)[10]. The parameters that were evaluated were: daily and accumulated germination; and physiological state of the plants when they had their first functional leaf (state V1) and at the end of the experiment (plant height, foliar emission and dry weight of roots).

For this, the amount of germinated seeds was evaluated daily and for the physiological state the height of the plant, the growth of the root and the number of leaves they had at the end of the germination process were evaluated. For this analysis, ten plants per treatment. In addition, the dry matter of 10 seeds for each crop was determined which were taken at random and were representative of those used in the experiments. When the seedlings had the first functional leaf visible and before they carried out photosynthesis, they proceeded to determine their fresh and dry weight. For this, 10 plants were taken for each treatment of each replica.

The variables related to the development of the plants were processed with analysis of variance, the comparison of means with Duncan's multiple range test at 95% confidence.

The dry matter expenditure was modeled with respect to the different sowing depths by using linear regression, where the independent variable was the sowing depth. The statistical processing was done with Infostat package.

III. Results

In Table 1 it is observed that in treatments 1 and 2 more than 50% of the maize seeds had already germinated after five days, withoutt statistical difference between them but with the rest of the treatments that exceeded 46% of germination. When the cover of the seeds was 12, 15 and 18 cm of soil, germination was very low in the first ten days, especially in the last two, where not exceeded 56%, unlike the first three treatments, which reached 100% germination, in those seeds that had 3 cm of soil cover. After 15 days, treatments 1 and 2 show 100% and 95% of their germinated seeds without statistical difference between them and the other treatments whose germination percentages are in the order of 65 to 90%; for this moment, there was an accumulation of germination of 100% in the first 2 treatments and not in the last four treatments. In this way, it was maintained until 30 days, showing no statistical differences between treatments 1 and 2 but with the other treatments. The lowest percentages of germination were obtained in those treatments where the seeds had a thickness of 15 cm and 18 cm with values from 80 to 91%.

Table I: Proportions that show the germination of the seeds according to cover thickness and days after planting the maize crop

Treatments		Interval of days from sowing						
		3	**5**	**10**	**15**	**20**	**25**	**30**
Nº 1	3 cm	0,515 a	0,825 a	0,999 a	0,999 a	0,999 a	0,999 a	0,999 a
Nº 2	6 cm	0,518 a	0,856 a	0,963 a	0,999 a	0,999 a	0,999 a	0,999 a
Nº 3	9 cm	0,451 b	0,557 b	0,834 b	0,901 b	0,909 b	0,919 b	0,919 b
Nº 4	12 cm	0,404 c	0,543 b	0,650 c	0,867 c	0,886 c	0,902 b	0,902 b
Nº 5	15 cm	0,407 c	0,514 b	0,553 d	0,801 d	0,820 c	0,823 c	0,823 c
Nº 6	18 cm	0,302 d	0,506 b	0,530 d	0,651 e	0,803 e	0,802 c	0,802 c

(a, b, c, d) Proportions with non-common letters statistically at 95% confidence

Figure 1 shows that treatment 6 was where the highest average stem length was reached with 26.4 cm, which was statistically the same as treatment 5 and higher than the rest. The lowest values were in the first two treatments, which do not differ statistically between them; treatments 1 and 2 did not exceed 22cm in length. In the length of the stem in state V1 treatments 4, 5 and 6 were statistically equal and superior to the rest, with an average of 8.7 cm reached by treatment 6. The treatments of 3 and 6 cm of cover did not exceed 5 cm of length.

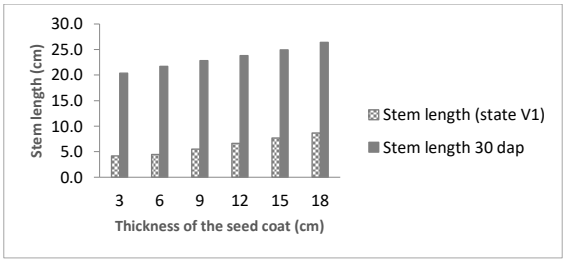

Fig. 1: Effect of cover thickness of the seeds on the length of the maize stem

The length of the roots was greater in the treatment 1 than in the rest of the treatments as observed in Figure 2. In state V1 this treatment reached a value of 12.3 cm showing statistical difference with the other treatments. It is observed that as the thickness of the seed coat increases, the root length values are smaller, with a value in the last

treatment of 5.1 cm. Between treatments 4 and 5 there were no statistical differences, but they were different from the rest of the treatments.

After 30 days, a marked statistical difference was observed between the first treatments and the last treatments where treatment 6 is 27.1 cm less than treatment 1. At this stage, there were no statistical differences between the last three treatments since all were about 22.5 cm in length of the root but with the rest. This is explained because the seedlings that emerge closest to the surface do not have to devote as much of their reserve to lengthen the stem to reach it as it happens in those that are more covered with soil.

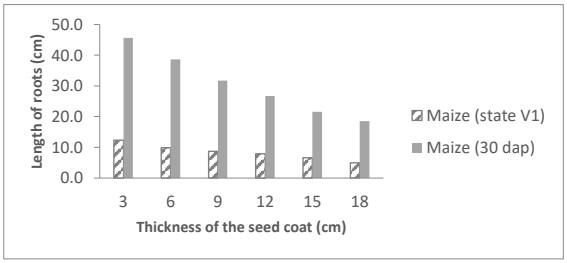

Fig. 2: Effect of cover thickness of the seeds on the length of maize roots

Figure 3 shows that the cultivation of maize developed a greater number of leaves in those plants whose thickness of cover was 3 cm. Treatment 1 differs statistically with the rest of the treatments, achieving a number of 10 leaves 30 days after planting. Between the treatments of 9 and 12 cm there are no statistical differences achieving a number of 8 leaves, but with the rest of the treatments. The minimum value was in the last two treatments with a number of 6 leaves, differing statistically with the rest of the thicknesses of cover.

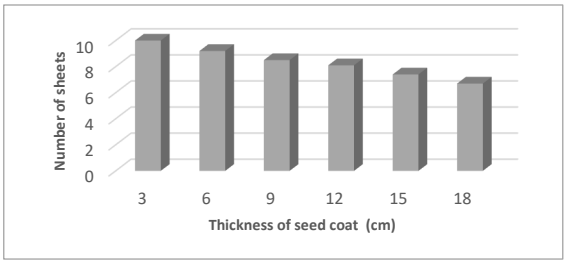

Fig. 3: Effect of cover thickness of the seeds on the length of maize roots

In Figure 4 it is shown that in the seeds that were with greater thicknesses of cover there was a greater energy expenditure, measured in this case by the difference between the dry weight of the seeds and that of the seedlings in state V1, with a high correlation of 98%. At 3 cm thick, the difference between the dry weight of the seeds and the dry weight of the seedlings was only 11.9 g. With 9 cm of thickness, 13.4 g are lost in the germination process and this is the general trend for the rest of the treatments, reaching values of 17.4 g in the treatment of 18 cm of soil cover highest value.

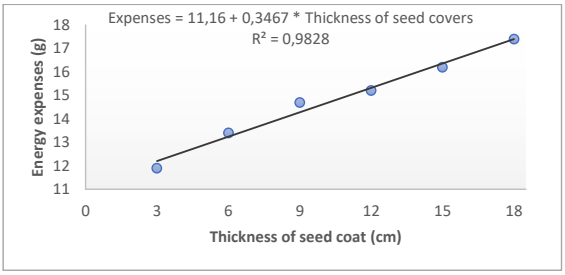

Fig. 4: Dry Material Expense (g) of the plants according to thicknesses of maize seed coat

IV. Conclusions

Seeds covered with soil thickness no greater than 6 cm present a better germination process, the radicles reach a greater length and more leaves are formed.

In maize there is a marked differentiation in the germinative process and physiological development of the first phases of the plants according to the thickness of the seeds.

To the extent that the thickness of the seed coat in maize is increased, a greater energy expenditure is produced which makes the plants weaker and with fewer reserves when initiating their photosynthetic activity.

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