Changes in physiological quality of encrusted sunflower (*Helianthus annuus* L.) seeds during storage.

Cyntia Szemruch[1] and **Liliana Ferrari**[2] [1]Cátedra de Oleaginosas. [2]Laboratorio de Semillas. UNLZ. Ruta 4. Km. 2. Llavallol (1832). Bs. As. **cyntiasz@yahoo.com.ar**

ABSTRACT

- **Background to the research and aims:** Seed encrusting increases weight and reduces variability in seed size through gradual accumulation of layers of adhesive and inert material. This technology ensures great accuracy in sowing of small caliber sunflower seeds and does not have adverse effects on physiological quality of seeds immediately after the treatment is made. However, this response could be modified along postharvest. Reductions in radicle and seedling emergence in encrusted seeds of different species have been detected during storage. So, the aim of this research was to evaluate the effect of encrusting over the percentage and rate of radicle and seedling emergence of sunflower seeds during their storage.
- **Overview of the methodology used:** The treatments applied were: encrusting with talc (T), encrusting with carbonate (C), encrusting with talc + insecticide + fungicide (TIF), insecticide + fungicide (IF). Seeds without any product were considered as control. Insecticide and fungicide were respectively tiametoxan and metalaxyl. Seeds were stored in laboratory conditions for 10 months in paper bags at 60 %RH and 25°C. The trials were performed as described by ISTA (2010) for sunflower. Measures were made at the initial moment of seed encrusting and 3, 5, 8 and 10 months later. Variables considered were: *Time required for the emergence of 50% of radicles* (G50 - h*), Final percentage of seeds with emerged radicle* (% RE), *Speed of seedling emergence index (SSEI),* germination percentage (GP) and seedlings dry weight (SDW-mg/seedling).
- **Key results:** After 10 months of storage, encrusted seeds showed a significant increase in G50, while %RE decreased only in C and TIF treatments. All treatments expressed and increase in SSEI up to the 5th month of evaluation, decreasing towards the end of the trial. In C treatment, GP was stable during all months of storage, however in control and the rest of treatments this stability was observed only until the 8th month with significant reduction after that time. SDW were significantly greater in all treatments of encrusted seeds, however IF treatment showed significantly lower values of this variable and GP during the whole period of storage.
- **Discussion and conclusion**: The reduction in radicle emergence rates over time agreed with that found in seeds of different species. Divergences in GP performance of encrusted sunflower seeds in relation to other species are probably due to morphological and biochemical differences among them. Seed encrusting did not exert adverse effects further deterioration caused by aging itself as it was exposed by the similar maintenance of GP till the 8th month in encrusted and control seeds. Therefore as a primary conclusion it can be said that, for the sunflower hybrid studied, the encrusting process applied after harvest did not affect negatively seed physiological quality along the storage period of 8 months.
- **The nature of the contribution to current knowledge achieved by the research on which the abstract is based:** These findings draws out some critical morphophysiological traits performance that support the analysis of encrusting effect during storage period, allowing to recommend appropriate time to apply this technology.

Keywords: encrusting, seed, storage, sunflower.

INTRODUCTION

The encrusting involves gradual accumulation of layers of adhesive and inert material on the seed together with the application of insecticides, fungicides, nutrients and growth regulators. ISTA (2010) makes a distinction between pelleted and encrusted seeds. While both suffer a change in size and weight, encrusted seeds have the same shape that the original seeds, while the pelleted seeds become completely spherical. Sunflower seeds have wide variability in size and shape (Lopes Cavalcante and Brito de Oliveira, 2008). This fact difficults precision planting, with greater impact in small seeds. This technology ensures great accuracy in sowing of small caliber sunflower seeds (Allen *et al*., 1983) and does not have adverse effects on physiological quality of seeds immediately after the treatment is made (Szemruch *et al.*, 2010). However, this response could be modified along postharvest. Reductions in radicle emergence rate in pepper (*Capsicum annum* L.) and lettuce (*Lactuca sativa* L.) encrusted seeds have been detected during storage (Kim *et al.*, 2000; Pereira *et al.*, 2005). Furtado de Mendonça *et al*. (2007) in sweet corn (*Zea mays* L.), detected significant reductions in seedling emergence speed and germination percentage of encrusted seeds during storage. Moreover, Gouda *et al.* (2008) in onion (*Allium cepa* L.) found that pelleted seeds have significantly higher germination percentages and seedling vigour indices in relation to non pelleted seeds during 10 months of storage. However, in carrot significant differences are not detected in the emergence rate of seedlings between encrusted and non-encrusted seeds during storage (Medeiros *et al*., 2006). So, the aim of this research was to evaluate the effect of encrusting over the percentage and rate of radical and seedling emergence of sunflower seeds during their storage.

MATERIALS AND METHODS

Treatments were obtained by placing seed-samples of 200 g. of PAN 7031 hybrid in an experimental machine (Cimbria Heyde type), sequentially adding the encrusting materials. Calcium carbonate and talc were used as inert agents in a dose of 500g / kg of seeds. Equate ® adhesive was placed diluted in water to 8% in proportion of 200 ml / kg of seeds. The active ingredients tiametoxan 35% (6 ml / kg. of seeds) and metalaxyl 35% (3 ml / kg. of seeds) were used respectively for insecticide and fungicide treatment. Once treated, seeds maintained their original shape. As discussed above, the term encrusting is proved to be the most appropriate to describe the treatment applied to sunflower seeds in the present paper. After 24-hour-drying in laboratory environment, seeds were stored in kraft-paper bags under 60% of humidity and 25 °C of temperature during 10 months. The treatments applied were, encrusted with talc (T), encrusted with carbonate (C), encrusted with talc + insecticide + fungicide (TIF), insecticide + fungicide (IF) and control.

Radicle emergence was examined at the initial moment of seed encrusting and 10 months later. Three replications of fifty seeds of each treatment were placed in 9 cm-diameter-Petri dishes over two pieces of Whatman-type filter paper moistened with 2.5 ml of distilled water. Afterwards, the boxes were wrapped with plastic wrap and placed in a chamber at continuous 25 °C, as established by ISTA (2010) standards with 12 h of alternating light/dark. The counting of emerged radicles was conducted at 24, 26, 28, 30, 32, 34, 37, 40, 43, 45, 47 and 49 hours after planting. According to Hernandez and Paoloni (1990) all those seeds that presented a radicle size greater than 2 mm long were considered as emerged. The study of radicle emergence was performed by means of the determination of the following variables: *Time required for the emergence of 50% of radicles (G50):* calculated according to Ranal and García de Santana formula (2006), expressed in hours for a 50% of maximum emergence; *Final percentage of seeds with emerged radicle (% RE):* resulting from the relationship between the total amount of seeds planted relative to those which indeed showed root emergence.

Seedling emergence was evaluated at the initial moment of seed encrusting and 3, 5, 8 and 10 months later, using eight replications of fifty seeds placed "between paper" (ISTA, 2010). A pre-cooling treatment (48 hours at 5° C on saturated substrate) was applied previously in order to eliminate the characteristic dormancy of sunflower. Germination took place in a chamber at continuous 25°C and 12 hours alternating light/dark, according to ISTA (2010). Seedling emergence was examined by the following variables: *Speed of seedling emergence index (SSEI):* normal seedling (NS) emergence speed was calculated applying an adaptation of Maguire index (1962), in which time interval for emergence was expressed in days (NS.d -1); *Germination percentage (GP*): discriminating number of normal, abnormal seedlings, dead and fresh seeds to the 10th day since sowing, as established in ISTA (2010); *Seedlings dry weight (SDW*): removing all normal seedlings from the germination test at the tenth day from sowing, according to Murcia *et al.* (2006), results were expressed in grams per seedling.

A Complete Randomized Block Design was used in radicle and seedling emergence tests. Analysis of variance (ANOVA) was performed to detect differences between treatments ($p < 0.05$). Comparison of means was carried out by means of the DGC test, Statistical Programme INFOSTAT (Di Rienzo *et al.*, 2008).

RESULTS AND DISCUSSION

When radicle emergence was examined after ten months of storage, encrusted seeds showed a significant increase in G50 (i.e. decrease in radicle emergence speed), while %RE decreased only in carbonate and talc + insecticide + fungicide treatments (Table 1). Such behavior was coincident to Kim *et al.* (2000) and Pereira *et al.* (2005) findings. The higher speed of radicle emergence of the encrusted seeds with respect to control at the initial moment, was not repeated at 10 months of storage. However, the encrusted seeds exceeded non encrusted ones concerning %RE at both moments.

Table 1. *Time required for the emergence of 50% of radicles* (G50 - h) and *Final percentage of seeds with emerged radicle* (RE - %) of sunflower encrusted and non encrusted seeds at the initial moment of seed encrusting (0) and 10 months later.

		Radicle Emergence			
		G50 (h)		**RE (%)**	
Month		**0**	**10**	**0**	**10**
Non encrusted seeds	Control	36,4 ± 1,2 B a	37,5 ± 1,9 A a	81 ± 2 C a	80 ± 7 B a
	Insecticide + Fungicide	37,8 ± 1,1 B a	39,5 ± 2,3 A a	78 ± 2 C a	77 ± 10 B a
Encrusted seeds	Carbonate	30,4 ± 0,5 A b	36,2 ± 1,6 A a	100 ± 0 A a	91 ± 2 A b
	Talc	32,6 ± 1,3 A b	35,1 ± 0,1 A a	94 ± 2 B a	89 ± 2 A a
	Talc + Insecticide + Fungicide	29,9 ± 0,9 A b	36,1 ± 0,6 A a	98 ± 4 A a	88 ± 4 A b
C.V. (%)		4,4	4,8	7,0	6,0

* Different small letters within each line and different capital letters within each column indicate significant differences ($p < 0.05$, test DGC).

When seedling emergence was evaluated, both the encrusted and non encrusted seeds expressed an increase in SSEI up to the 5th month of evaluation, decreasing towards the end of the trial (Figure 1). These results agree with published data obtained from Medeiros *et al.* (2006) in carrot, but were inconsistent with those obtained by Furtado de Mendonça *et al.* (2007).

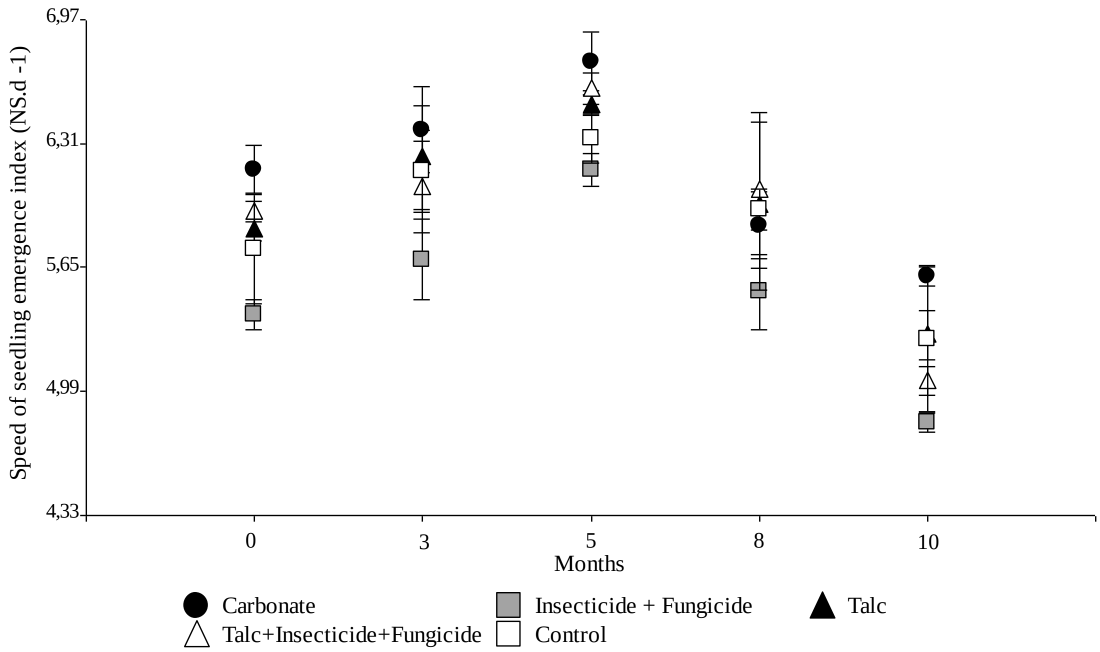

Figure 1. *Speed of seedling emergence index* (SSEI) of sunflower encrusted and non encrusted seeds during storage.

For carbonate treatment, GP was stable during all storage period. However, for the control and the rest of treatments this stability was observed only until to the 8th month with significant reduction for the last two months (Figure 2). That response did not agree with by Furtado de Mendonça *et al.* (2007) in corn and Gouda *et al.* (2008) in onion. Divergences in GP performance of encrusted sunflower seeds in relation to other species are probably due to morphological and biochemical differences among them.

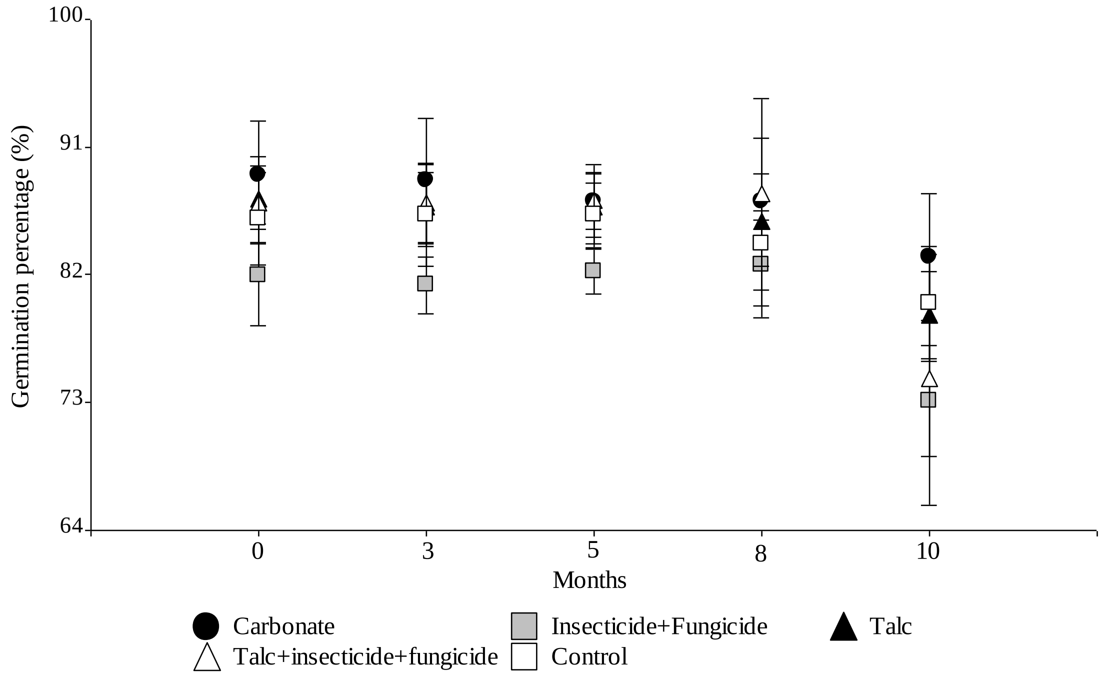

Figure 2. *Germination percentage* (GP - %) of sunflower encrusted and non encrusted seeds during the storage period.

SDW were significantly greater in all treatments of encrusted seeds, however insecticide + fungicide treatment showed significantly lower values for this variable and GP during the whole storage period (Figures 2 and 3). These results were coincident with those obtained by Gouda *et al. (*2008).

The significant reduction in the speed and the percentage of normal seedlings that combined treatment insecticide + fungicide was maintained throughout the evaluation period. Such behavior would be due to phytotoxic effects resulting from the combination and doses of pesticides applied.

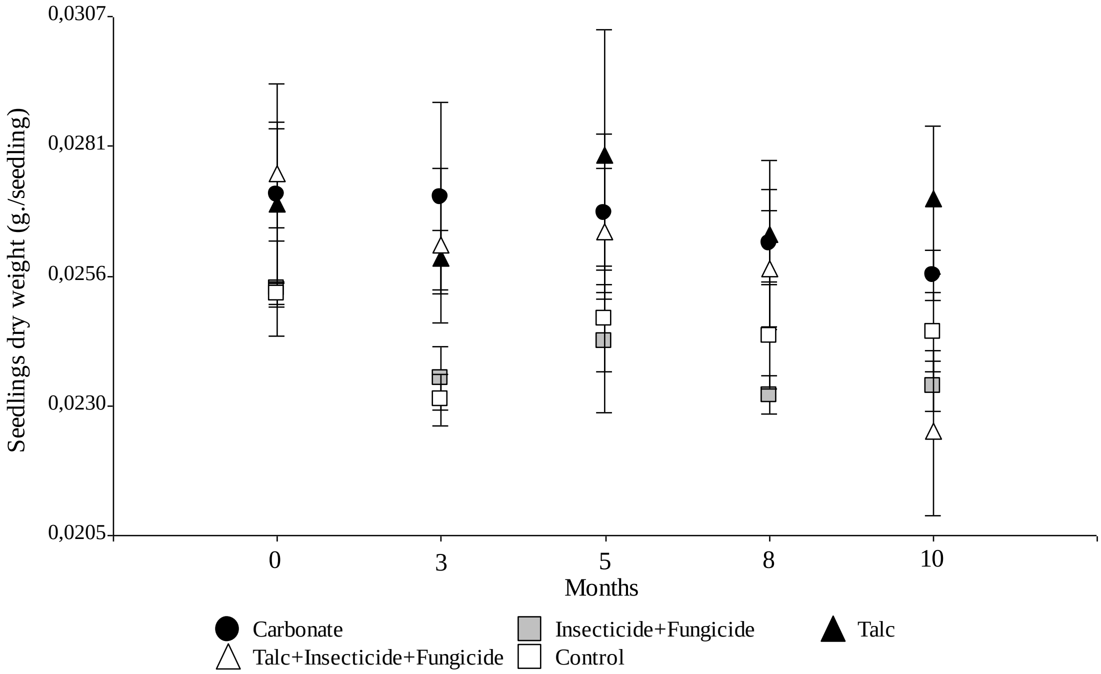

Figure 3. *Seedlings dry weight* (SDW – g/seedling) of sunflower encrusted and non encrusted seeds during the storage period.

CONCLUSIONS

The results of this study showed that the emergence of radicles of encrusted sunflower seeds exceeded control ones for ten months of storage. From a technological point of view, seed germination was not affected by the treatment of encrusting during storage because seed encrusting did not cause adverse physiological effects further deterioration caused by aging itself as it was exposed by the similar GP till the 8th month in encrusted and control seeds

Phytotoxic effects resulting from the combination of pesticides applied, should be examined in detail towards the adjustment of the dose products when developing encrusting technology. On the other hand, the interaction with the germination substrate used should be also examined. Thus it would be possible to detect whether the observed response is magnified by the use of paper substrate.

Therefore as a primary conclusion it can be said that, for the sunflower hybrid studied, the encrusting process applied after harvest did not affect negatively seed physiological quality along the storage period of 8 months. These findings draws out some critical morphophysiological traits performance that support the analysis of encrusting effect during storage period, allowing to recommend appropriate time to apply this technology.

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