IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 12, Issue 5 Ser. I (May 2019), PP 32-37
www.iosrjournals.org

GerminationOf Vegetable And Grasslandspecies With Micronizedchabazitic-Zeolites And Endophytic Fungi

Domenico Prisa
CREA Research Centre for Vegetable and Ornamental Crops, Council for Agricultural Research and Economics, Via dei Fiori 8, 51012 Pescia, PT, Italy
Corresponding Author: Domenico Prisa

Abstract: *Zeolites are crystalline, hydrated aluminosilicates of alkali and earth metals that possess infinite, three-dimensional crystal structures. They are further characterized by an ability to lose and gain water reversibly and to exchange some of their constituent elements without major change of structure. Zeolites were discovered in 1756 by Freiherr Axel Fredrick Cronstedt, a Swedish mineralogist, who named them from the Greek words meaning "boiling stones, "in allusion to their peculiar frothing characteristics when heated before the mineralogist's blowpipe. Natural zeolites have found applications as fillers in the paper industry, as lightweight aggregate in construction, in pozzolanic cements and concrete, as ion-exchangers in the purification of water and municipal sewage effluent, and in the removal of nitrogen compounds from the blood of kidney patients. In this test carried out at the experimental greenhouses of CREA-OF (Pescia- PT), was evaluated the possibility of using the micronized zeolites mixed to the substrate, for to increase the germination of horticultural and grass crops.*

Key-words: *alternative substrates, plant quality, inorganic additives, seeds, water use*

Date of Submission: 20-04-2019 Date of acceptance: 04-05-2019

I. Introduction

The zeolites are utilized in agriculture, because they have several interesting characteristics, in particular: i)cation exchange capacity (CSC): within its structure, zeolite has mobile cations that can be removed and replaced with others or exchanged. In addition, there is a selectivity scale which indicates the tendency of the exchanger to give cations to the aqueous phase, replacing them with those to which it is more akin. The preferred cations are those of small charge and large radius such as potassium (K^+), ammonium (NH_4^+), cesium (Cs_2^+), etc.. ii)high absorption capacity and hydrophilicity (reversible dehydration): the water in the channels and cavities of the zeolite can be removed by heating, leaving the channels free and ready to absorb, by simple cooling, the atmospheric humidity. This process can be repeated indefinitely. Commercial use of natural zeolites is still in its infancy, but more than 300,000 tons of zeolite-rich tuff is extracted annually in the United States, Japan, Bulgaria, Hungary, Italy, Yugoslavia, Korea, Mexico, Germany, and the Soviet Union(Galli and Passaglia, 2011) Natural zeolites have found applications as fillers in the paper industry, as light aggregates in construction, cement and concrete, as ion exchangers in water purification and municipal effluent purification, as traps for radioactive species in wastewater from nuclear plants, in oxygen production, as catalysts for oil fields, as acid-resistant absorbents and in the drying and purification of natural gas (Mumpton, 1978; Gottardi and Galli, 1985). Based on their high ion exchange capacity and water retention, natural zeolites have been widely used in Japan as soil improvers for sandy soils, and several quantities have been exported to Taiwan for this purpose (Hsu et al, 1967). The pronounced selectivity of zeolite for large cations, such as ammonium and potassium, has also been exploited in the preparation of chemical fertilizers that improve the capacity of retention of nutrients in soils promoting a slower release of these elements for absorption by plants, in rice fields, where losses by runoff of 50% of nitrogen supplied are frequent. Zeolites have been used in this experiment because they have several interesting characteristics for use in agriculture, in particular in horticulture, the use of zeolites in table tomatoes (Passaglia et al., 1997), celery (Bazzocchi et al., 1996), courgettes and melons (Passaglia et al., 2005b), vegetables and fruit (Passaglia e Poppi, 2005a) has led to an increase in the total production of finished product per hectare of land. In floriculture, the use of zeolites has determined, an increase in height, in the total number of inflorescences, of buds, of flowers, of the size of the bulbs and a greater precocity of flowering in geranium (Passaglia et al., 1998; Passaglia et al., 2005a,b), Lilium, Gerbera, Chrysanthemum, *Liatrisspicata*, Tulipano, *Cupressussempervirens*, Olivo, Camellia and Leucospermum (Prisa and Burchi, 2015). In this test, the germination capacity of both vegetable and grass species was assessed on a control substrate composed of: peat+vermiculite or peat+perlite; or on substrate treated with Trichoderma (commercial product Remedier®) or peat+chabazite.

II. Materials and methods

Greenhouse experiment and growing conditions

The test was carried out in 2017 at the CREA-OF experimental greenhouses in Pescia (PT) on unheated benches. With programmed irrigation system, and watering intervals of 1 minute twice a day (spraying on cultivation bench). The micronized chabazitic-zeolites used was supplied by Bal-co s.p.a. of Sassuolo (MO). A fully randomized experimental scheme with 50 pots (diameter 10) was used for each thesis. In each pot, 25 seeds were sown, which were then repicked at the right time. The various vegetable and grassland species were evaluated during their optimal seasonal cultivation period, with 5 species cultivated and then tested per week from March 2017.

The experimental theses have been:

- Peat and vermiculite (control) **(TV)**: (100g peat and 25g vermiculite dusted on the surface);
- Peat and perlite**(TP)**: (100g peat and 25g perlite dusted on the surface);
- Peat andTrichoderma**(TR):**(100g peat and 10g remedier®(based on the *T.asperellum* and *T. gamsii* strains)dusted on the surface, dose evaluated according to the volume of peat);
- Peat and chabazite**(TC):**(100g peat and 25g micronized chabazite dusted on the surface).

The analysis of zeolites used in the tests had a zeolithic content determined by X-rays using the Rietveld-Nir methodology described in (Gualtieri, 2000; Gualtieri and Passaglia, 2006): 67 ± 3% of which 64% given by chabazite and 3% by phillipsite. The cation exchange capacity (CSC) determined by exchange with 1 N solution of NH4 according to the methodology described in Gualtieri et al. (1999): 210 ± 10 meq/100g, of which 131 are due to Ca, 68 to K, 7 to Na and 4 to Mg.

Chemical composition (in % with standard deviation in brackets) determined by Fluorescence X and loss by calcination: SiO2 54.7 (2.0), A12O3 14.5 (2.0), TiO2 0.3 (0.1), Fe2O3 3.3 (0.5), P2O5 0.3 (0.05), MnO 0.2 (0.05), MgO 1.8 (0.4), CaO 5.5 (0.6), Na2O 0.5 (0.1), K2O 7.5 (0.6), H2O* 11.4 (2.0). Structural H2O lost above 120°C Heavy elements (ppm): Quantity released by elution according to IRSA-CNR procedure (1985): Pb 8; As 2; Cd < 1; Zn 12; Cu tr. Water retention (grain size 0.7 - 1.5 mm): 41% (w/w) Apparent density (grain size 0.7 - 1.5 mm): 0.74

For each vegetable and grass species, the germination percentage and the average germination time were evaluated. The species tested were: pumpkin, aubergine, tomato, basil, celery, tobacco, lettuce, pepper, melon, mangold, courgette, turnip, cucumber as far as vegetables are concerned (Fig.1). As far as grass species are concerned, the following have been evaluated: *zoysia japonica*, *festucarubra*, *poapratensis*, *loliumperennne*, *festucaarundinacea*, *trifoliumrepens*, *cynodondactylon* (Fig.2).

Statistics

The experimentwascarried out in a randomized complete block design. Collected data wereanalysed by one-way ANOVA, using GLM univariate procedure, to assesssignificant ($P \leq 0.05$, 0.01 and 0.001) differencesamongtreatments. Meanvalueswerethenseparated by LSD multiple-range test ($P = 0.05$). Statistics and graphicsweresupported by the programsCostat (version 6.451) and Excel (Office 2010).

III. Results

The test showed significant results with regard to germination and average germination time in the substrate in which micronized chabazitic-zeolites were present for all test species, both horticultural and lawn type (Fig. 3-6). In (Fig.1) on pumpkin there is a significant increase in seed germination on chabazite compared to control (81% compared to 68%) and a reduction in TMG (average time of germination) is passed from 6 days in the thesis with chabazite to 10 of peat + vermiculite and peat + perlite. Also on aubergine(Fig.1) the thesis with micronized chabazite, has increased the germination of the seeds going from 81% of germinated seeds where this silicate alumina was present, to 72% of the control peat+vermiculite. The TMG went from the 8 days of the peat+chabazite thesis to the 13 days of peat+vermiculite. In table 3 on tomato the thesis with micronized chabazite has guaranteed 94% of germinated seeds against 76% of the control peat + vermiculite. Also in this case, there was a significant reduction in the average germination time from 11 days of the thesis peat+chabazite micronized to 16 days of the two controls peat+vermiculiteand peat+perlite. Also in the other vegetable species (basil, celery, tobacco, lettuce, pepper, melon, chard, courgette, turnip, cucumber) (Fig.1), in the thesis with micronized chabazite was found a germination around 88-96% against 78-90% of the two controls peat + vermiculite and peat + pearlite. For TMG, in general, the range is from 5-10 days for vegetables treated with micronized chabazite to 9-15 days for seeds germinated in peat+vermiculite and peat+perlite. The same trend was also found in the turf species (*zoysia japonica*, *festucarubra*, etc.). In fact, in the theses with micronized chabazite, germination was found in the different species from 86 to 99% of germinated seeds, compared to 60-86% of the controls peat+vermiculite and peat+perlite (Fig.2). In general, the same trend was also observed for the average germination time, from 13-16 days in the theses treated with chabazite, compared to 15-22 days in the peat+vermiculite and peat+perlite controls (Fig.2).

IV. Discussion

The results obtained are probably due to the constant humidity provided by the zeolite powder which allows a homogeneous germination of the seeds. The seedlings grow faster and have a more pronounced root development. This was also noted in other tests, where zeolite was mixed with the rooting substrate. The roots in the tests appeared less developed in length, but more developed in volume. The vegetable and grass species tested in the substrate in which trichoderma (remedier® based on the *T.asperellum* and *T.gamsii* strains) was inoculated also had a significant increase in germination compared to the two controls consisting of a peat+perlite substrate or peat+vermiculite. Probably the beneficial micro-fungus allows a better control of the possible pathogens present in peat, allowing a greater number of seeds to germinate (tanning effect). In addition, in the theses with chabazite and remedier, the germinated seedlings have shown a with a more intense green, compared to the two controls in vermiculite and perlite. This aspect is probably due to the transfer in the substrate of microelements naturally present in zeolites (K, N etc.) and to a greater solubilization of the substances present in peat by trichoderma.(Prisa et al., 2013).

The use of chabazite, as demonstrated by this test, can ensure better germination of seeds of different vegetable and turf species. The zeolites and, more particularly, the chabazite, in fact, once introduced in the germination substrata, can increase the water retention and guarantee the maintenance of an optimal humidity in the substratum, with a significant improvement of the germination of the seeds and a speeding up of the growth of the plants (Passaglia and Sheppard, 2001). Zeolites, also as demonstrated in previous tests (Prisa and Burchi, 2015) ensure a reduction in irrigation and fertilization, representing unlike aggregates on the market, something functional that in addition to encouraging the aeration of the substrate, allows colonization in both substrate and field of microbial flora useful, which promotes the solubilization of minerals trapped in the zeolite and makes them available through a symbiotic relationship with the roots of the plants. The effect normally seen when this mechanism occurs is an increase in seed germination, plant growth and productivity and greater resistance to water, nutrient and temperature stresses.

Determining the chemical-physical characteristics is in fact of particular importance in order not to run into problems during the cycle of cultivation in pots or in the open field. A new decree of March 3, 2015, proposed by prof. Passaglia (Passaglia, 2008; Passaglia and Prisa, 2018), indicates the non-commerciality of zeolites that do not contain within their structure a content greater than 50% of that particular mineral. This is to limit the marketing of products that are not of quality and to ensure that people who use this type of mineral can not then encounter problems of phytotoxicity on plants in cultivation.

V. Conclusion

These trials showed several benefits that can be obtained through the use of chabazitic-zeolites: improvement of quality in vegetable and grassland species, increase in seed germination and reduction in TMG, better water use, alternative inorganic additive that can improve the capacity of germination substrates. Further experiments are currently underway to evaluate the growth of plants of Mizuna (*Brassica juncea japonica*) with zeolites and a dried chabazite taken directly from the quarry without processing.

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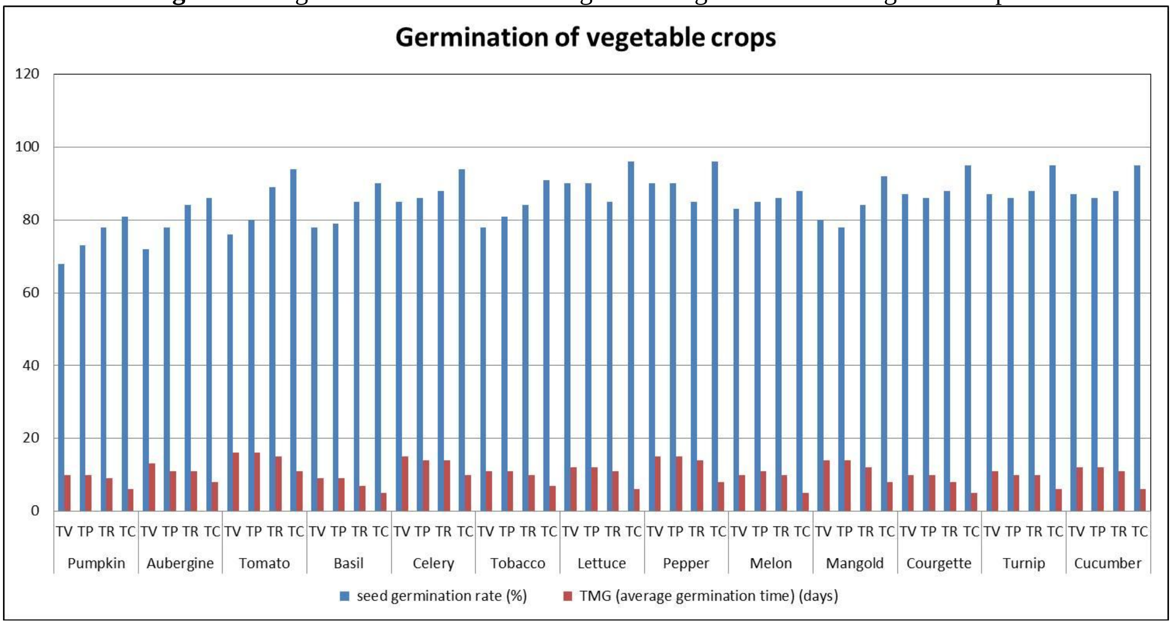
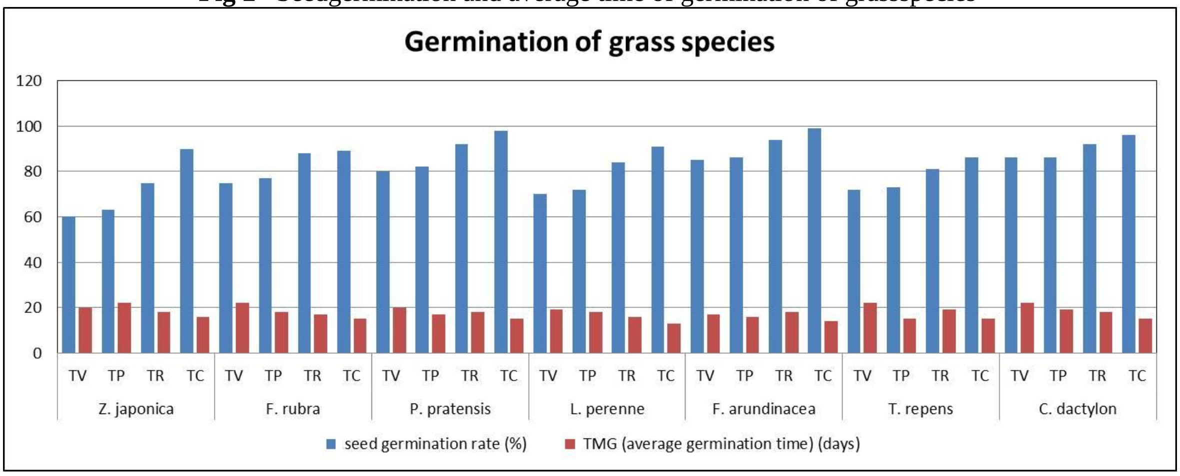
Figures

Fig. 1 –Seedsgermination rate and average time of germination of vegetablecrops



Legend: TV: peat+vermiculite; TP: peat+perlite; TR: peat+trichoderma; TC: peat+chabazite

Fig 2 –Seedgermination and average time of germination of grassspecies



Legend: TV: peat+vermiculite; TP: peat+perlite; TR: peat+trichoderma; TC: peat+chabazite

Fig 3 -Effect of the substratepeat+chabazite (treated) compared to the (control) of peat+perlite on courgetteplants

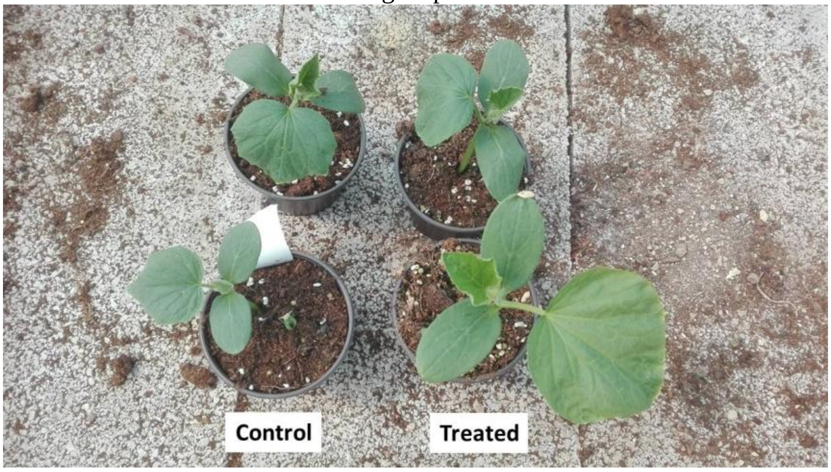
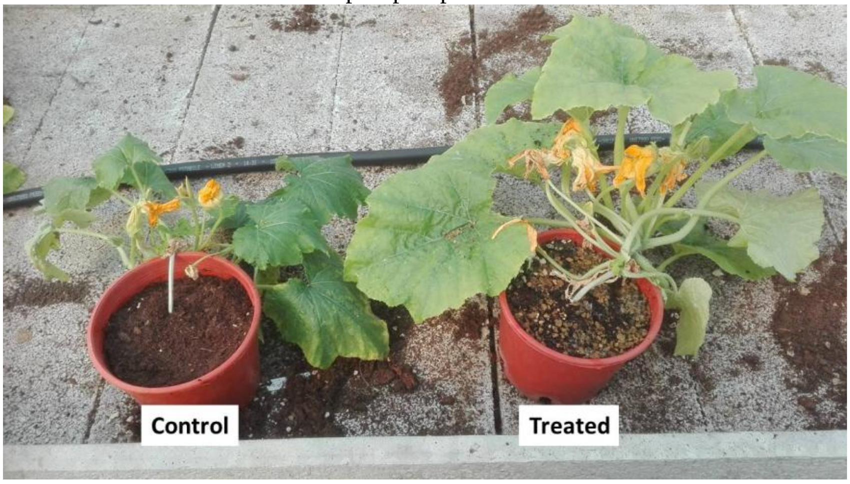


Fig4 -Effect of the substratepeat+chabazite (treated)comparedto the(control) of peat+vermiculite on tobaccoplants

Fig5 -Effect of the substratepeat+chabasite (treated) compared to the (control) of peat+vermiculite on tomato plants

Fig6 -Effect of the substratepeat+chabazite (treated) compared to the (control) of peat+vermiculite on pumpkinplants



Domenico Prisa."Germination Of Vegetable And Grasslandspecies With Micronizedchabazitic-Zeolites And Endophytic Fungi." IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) 12.5 (2019): PP- 32-37.