THE EFFECT OF DIFFERENT TYPES OF CHEMICAL FERTILIZERS ON THE GERMINATION OF SEEDS IN HERB MIXTURES FOR RENATURATION AND ANTI-EROSION PROTECTION

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Abstract

Seeds from 4 grass species (Bromus inermis, Festuca pratensis, Lolium perenne, Phleum pratense), 3 perennial legumes species (Lotus corniculatus, Onobrychis viciifolia, Trifolium repens) and a cereal (Hordeum distichon) were mixed with 10 different chemical fertilizers and germination was determined after 90, 180 and 270 days. The chemical fertilizers had different influence upon the seed germination. The most aggressive were the ammonium sulphate and concentrate superphosphate and the harmless were the potassium salt and urea. The fertilizers effect is determinate by their acidity and other factors which will be studied on. Among the species there are great germination differences due to the morphological and physiological characteristics. The most consistent are barley and perennial ryegrass and the most affected by the contact with the fertilizer are the sainfoin and the timothy. Generally, the grasses are more resistant than the legumes. The result proves the possibilities of the achievement of complex mixtures, seeds-chemical fertilizer, with a known viability, for the antierozionale protection – dry variant or hydro sowings – and other utilization.

Keywords: *Compatibility of grass seeds - chemical fertilizers, contact time, germination effect.*

INTRODUCTION

The reseeding or overseeding of grasslands degraded by erosion (Motoc and colab.1975, Dumitrescu and colab.1979) and other lands devoid of vegetation (Marusca,1995,2007, Marusca and colab.2000 5, 6) constitutes a major problem with particular implications for preserving the ecological and economic balance, with the integrity of the natural and anthropogenic landscape. The improvement of current methods of grassing is possible by using complex mixtures between perennial grasses and chemical fertilizers through which, in a single administration, both the seeds and the nutrients necessary for the rapid establishment and consolidation of the grass carpet are provided in the harshest environmental and applicability conditions (Marușca., 1991, 1995, 2007, Marușca and colab. 1990, 2009, 2020, 2021). Preliminary research on the possibilities of creating seed mixtures with ammonium nitrate or complexes (15-15-15) has highlighted the need to store them in dry, tightly closed conditions to prolong germination and their shelf life ((Marușca. and colab., 1990). In this paper, studies are continued on the formation of complex seed-fertilizer mixtures, with deadlines for preserving the germination of perennial grasses and legumes in direct contact with the main types of chemical fertilizers in order to broaden the area of applicability of anti-erosion protection grasses of degraded meadows or other surfaces devoid of grassy vegetation such as tailings dumps, flotation, ores, slag and ash, etc. in different pedoclimatic conditions in our country. Following these preliminary studies on the compatibility between mineral fertilizers and seeds in complex mixtures for sowing, anti-erosion vegetation after land improvement works (slopes, canals, etc.) (Maruşca, 1995), industrial dumps such as slag and ash deposits from thermal power plants (Maruşca et al., 2000, 2009, 2021), mining tailings dumps (Maruşca and colab. 2020) and ski slopes (Maruşca, 2007) were successfully renatured.

MATERIAL AND METHOD

The seeds of 4 perennial grasses (*Bromus inermis, Festuca pratensis, Lolium perenne, Phleum pratense*), 3 perennial legumes (*Lotus corniculatus, Onobrychis viciifolia, Trifolium repens*) and winter barley (*Hordeum distichon*) were studied and were maintained in these conditions with 10 types of chemical fertilizers for a duration of 3, 6 and 9 months of direct contact, after which analyses were performed on the energy and germination capacity of the seeds according to the usual methods (Marușca, 1990, 1988).

When choosing the seeds, their adaptation to different climate and trophic conditions was taken into account, such as obsiga and sainfoin for warmer-drier areas, timothy and tifoli for wetter, cooler areas, as well as ryegrass with white clover with higher demands for soil fertility. The introduction of winter barley is motivated by its faster rooting, which serves to fix the superficial layer of soil until the emergence and consolidation of the protective grassy carpet (Maruşca, 1995). The main types of chemical fertilizers produced in our country were: simple nitrogenous (ammonium nitrate, nitrolime, ammonium sulfate, urea), phosphate (concentrated superphosphate), potash (potassium salt), binary complexes (27.0-13.5-0 and 22-22-0) and ternary complexes (22-11-11 and 16-16-16), which practically cover almost all the fertilization needs of soils from acidic to alkaline with different degrees of supply in nutrients. Also, the possibilities of renaturing industrial dumps were taken into account, which have a very wide range of substrates from very acidic ones (non-ferrous ore flotation sands, pyrite ashes, etc.) to basic or alkaline ones (slag and ashes from coal-fired power plants) and many other conditions and situations of surfaces stripped of vegetation, generating air, water, soil, landscape pollution, etc., which require urgent ecological restoration, according to European standards.

In forming the mixture samples for analysis, several principles were respected, namely:
- sample size calculated for an area of 10 m2;
- perennial grass seeds in double quantity compared to the norm per hectare in pure culture and for barley a norm of 50 kg/ha;
- chemical fertilizers calculated at the level of 100 kg/ha N for simple nitrogenous, binary and ternary ones, as well as 100 kg/ha P2O5 or K2O only for simple ones with these active principles.

The seed mixtures with perfectly dry fertilizers were kept in tightly closed plastic bags, so as to prevent air and humidity from entering, as the hygroscopicity of chemical fertilizers is known. The samples thus packaged were kept in a dry store from where, at the established deadlines, a set of bags were opened, the seeds from the chemical fertilizers were separated by various methods (sieving, selection, etc.), after which the usual germination analyses were carried out in the Seed Control Laboratory in Braşov. For the chemical fertilizers, their acidity value was established expressed as % HNO3, % H2SO4, % HCl and % P2O5, depending on the type of fertilizer, as well as the pH in aqueous extract (5 g/l liter) according to the current methods at OSPA Braşov .

RESULTS AND DISCUSSIONS

The influence of chemical fertilizer types over time on the germination of perennial grass and grassy cereal (barley) seeds is presented in Table 1.

Thus, the control variants, without chemical fertilizers, have an average germination of 86%, which is reduced by 1% after 270 days. In direct contact with urea and potassium salt, after 90 and 180 days the seeds maintain their germination intact like the control variant and with a slight average decrease of 1-3% after 270 days.

The most “aggressive” chemical fertilizers proved to be ammonium sulfate and concentrated superphosphate, which after 90 days reduce seed germination by 19-21%, at 180 days by 53-58% and after 270 days by 68-71% of the 86%, which represents the average initial germination.

Ammonium nitrate, C 16-16-16 complexes, C 22-22-0 and nitrolim after 270 days of direct and sealed contact with the seeds have a medium influence on germination (-16…-24%). At 180 days, these types of fertilizers reduce average germination by 9% (-7….-11%), and at 90 days by only 2% (-1…-3). Also, a big influence on germination (-27…-33%) after 270 days is had by C 27-13-0 fertilizers, followed by C 22-11-11, with an average effect (-10…-21%) after 180 days and a smaller one (-1…-7%) after 90 days of contact. With the exception of ammonium sulfate and concentrated superphosphate, which at 90 days of contact reduce the average germination of seeds by about 20%, the remaining types of chemical fertilizers affect germination less at this time (90 days) or after 180 days, some even after 270 days.

Table 1

The influence of different types of chemical fertilizers over time on the germination (G) of perennial grass and grassy cereal seeds

Types of Chemical Fertilizers No Fertilizers (Mt)	Seed germination after contact with chemical fertilizers (days)									G loss limit below 20% (days)
	90			180			270			
	G%	Diff.	%	G%	Dif.	%	G%	Dif.	%	
Ammonium Nitrate	86	0	100,0	86	0	100,0	85	-1	98,5	-
Nitrolime	85	-1	98,5	79	-7	91,3	69	-16	80,6	270
Ammonium Sulphate	83	-3	96,1	75	-11	87,5	61	-24	70,6	180
Urea	67	-19	77,9	28	-58	32,6	14	-71	16,5	0
Concentrated Superphosphate	86	0	100,1	86	0	100,3	82	-3	96,3	270
Potassium Salt	65	-21	75,6	33	-53	38,4	17	-68	20,0	0
Types of Chemical	86	0	100,4	86	0	100,4	84	-1	98,4	270
C (complexes) 27-13-0	85	-1	98,3	76	-10	87,9	52	-33	60,7	180
C 22-22-0	85	-14	98,5	79	-7	91,9	63	-22	74,0	180
C 22-11-11	79	-7	91,4	65	-21	76,0	58	-27	68,1	90
C 16-16-16	84	-2	98,0	77	-9	90,0	68	-17	80,3	270

In order to elucidate one of the main causes of the influence of different types of chemical fertilizers, chemical analyses were performed on their acidity, given the known harmful effect of this factor on seed germination (table 2).

Table 2

Acidity valuesof chemical fertilizer types in aqueous extract, 5 g/1 liter

Types of chemical fertilizer	**Acidity expression**	**Acidity value**	**pH aqueous extract**
Ammonium nitrate	% HNO_3	3,62	5,10
Nitrolime	% HNO_3	2,95	7,15
Ammonium sulfate	% H_2SO_4	39,39	1,60
Urea	% HNO_3	0,13	5,45
Concentrated superphosphate	% P_2O_5	36,28	3,30
Potassium salt	% HCl	0,30	4,05
C 27-13-0	% P_2O_5	10,11	5,15
C 22-22-0	% P_2O_5	8,79	5,40
C 22-11-11	% P_2O_5	10,70	5,20
C 16-16-16	% P_2O_5	10,99	5,45

Thus, the acidity value is extremely high in concentrated superphosphate (56.28% P2O5) and ammonium sulfate (39.39% H2SO4) with a pH in H2O of 3.3 and 1.6 respectively, which explains the very strong influence (class I) on the decrease in seed germination. average acidity value of 3-4% (class III) and those with a value below 1% (class IV), which are almost harmless or have a very low effect on seed germination. In order are fertilizers with an acidity value of around 10% with different ways of expression that have a fairly large influence (class II), which includes complex chemical fertilizers, followed by fertilizers with an This class of values of the influence of chemical fertilizers on seed germination was inspired by and is similar to the acute toxicity classes of pesticides, unanimously accepted internationally. Regarding the average germination of various species of perennial grasses and barley to chemical fertilizers in class II - IV of "aggressiveness", a differentiated degree of compatibility is observed depending on the morphology and physiology of the seeds (table 3). Thus, after 90 days of contact with chemical fertilizers, non-arrested fescue and perennial ryegrass even have a 1% increase in germination, a phenomenon explainable by the presence of fertilizer particles on the seeds, which can stimulate germination energy, or by normal deviations from the average of germination determinations (4). A more pronounced decrease in germination is seen in seeds in pods of sainfoin and the more naked seeds of timothy, being quite difficult to explain on morphological criteria the causes of sensitivities to contact with chemical fertilizers. The results obtained allow the formulation of complex mixtures of seeds with chemical fertilizers for different pedoclimatic conditions and known shelf life (use) (table 4).

Table 3

Germination of some perennial grass and grassy cereal seeds after different periods of contact with chemical fertilizers (without ammonium sulfate and concentrated superphosphate) from sealed dry mixtures

Species	Initial germination (G%)	Duration of contact with chemical fertilizers (days)									Limit of G losses below 20% (days)
		90			**180**			**270**			
		G%	**Diff.**	**%**	**G%**	**Diff.**	**%**	**G%**	**Diff.**	**%**	
Bromus inermis	92	93	+1	100,7	91	-1	98,8	89	-3	97,0	270
Festuca pratensis	95	95	0	100,4	92	-3	96,7	87	-8	91,8	270
Lolium perenne	94	95	+1	100,7	94	0	99,5	91	-3	96,7	270
Phleum pratense	94	88	-6	93,5	84	-10	89,2	59	-35	63,0	180
Lotus corniculatus	64	61	-3	95,3	52	-12	81,1	41	-20	63,5	180
Onobrychis viciifolia	77	72	-5	92,9	53	-24	68,7	32	-45	41,6	90
Trifolium repens	76	73	-3	95,9	66	-10	86,2	48	-28	63,5	180
Hordeum distichon	96	96	0	100,1	93	-3	97,3	92	-4	95,4	270
Average	86	84	-2	97,8	78	-8	90,8	67	-19	78,5	-

These preliminary studies allowed the classification of chemical fertilizer types according to their acidity values into 4 groups of incompatibility with seeds in complex mixtures.

Table 4

Possibilities for formulating complex seed mixtures with chemical fertilizers

Degree of incompatibility (acidity values)	Group I (over 20%)			Group II (11-20%)			Group III (1-10%)			Group IV (below 1%)		
Types of chemical fertilizers	▲ammonium sulfate ▲concentrated superphosphate			▲complex C 27-13-10 ▲C 22-11-11 ▲C 16-16-16			▲ammonium nitrate ▲nitrolime ▲C 22-22-0			▲potassium salt ▲urea		
Mixture validity *) duration days	90	180	270	90	180	270	90	180	270	90	180	270
Seeds *Bromus inermis*	0	0	0	+	+	0	+	+	+	+	+	+
Festuca pratensis	0	0	0	+	+	0	+	+	+	+	+	+
Lolium perenne	+	0	0	+	+	+	+	+	+	+	+	+
Phleum pratense	0	0	0	+	0	0	+	+	0	+	+	+
Lotus corniculatus	+	+	0	+	+	0	+	+	0	+	+	+
Onobrychis viciifolia	0	0	0	+	0	0	+	0	0	+	+	+
Trifolium repens	+	+	+	+	+	0	+	+	0	+	+	+
Hordeum distichon	+	0	0	+	+	+	+	+	+	+	+	+
% by total species	50	25	12	100	75	25	100	87	60	100	100	100

*) Calculate for a maximum 20% reduction in seed germination compared to the initial one.

After determining the acidity of a chemical fertilizer, it falls into the respective group where the duration of validity of a mixture with a seed species from the presented list is indicated. Complex seed-fertilizer mixtures can be used as such by spreading on the soil surface and manual incorporation, mechanized sowing and fertilization with seeders adapted for this purpose, hydroseeders for uneven, rugged terrain, specially formulated bioplates made of various materials containing seeds and chemical or organic fertilizers that partially replace more expensive concrete slabs, biorolls made of geotextiles, paper, peat, vegetable carpets, etc., as well as other systems and methods for grassing surfaces devoid of vegetation.

CONCLUSIONS

Complex mixtures made up of perennial grass seeds (grasses and legumes) and cereals (barley) together with different types of chemical fertilizers can be formulated and stored in sealed polyethylene bags, guaranteed for different shelf lives until grassing works for anti-erosion protection or ecological restoration of heavily anthropogenically degraded lands, such as industrial dumps. The biggest influence on seed germination is the acidity of chemical fertilizers, the most aggressive being superphosphate and ammonium sulfate, and among the most sensitive seeds it turned out to be, in order: sainfoin (*Onobrychis viciifolia*), timothy (*Phleum pratense*), white clover (*Trifolium repens*) and common vetch (*Lotus corniculatus*) and the most resistant are perennial ryegrass (*Lolium perenne*), brome (*Bromus inermis*), barley and orchard fescue *(Festuca pratensis*).

The advantages of formulating such complex mixtures are countless, starting with the uniformity of seed spreading through the simultaneous application of fertilizers that also act as diluents, the possibility of applying them in a dry state by manual, mechanical or aircraft means, having reduced volume and weight, as well as through hydroseeding and many other.

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