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Legumes Seed Pilling Advance Technology and Protection of Topsoil from Contamination

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ABSTRACT. The traditional fertilizing system and plant protection by pesticides in crop rotation lead to contamination of topsoil. Unfortunately, in this case plants use only about 30-45% of mineral fertilizers. Its ballast, as well as that of pesticides accumulates in topsoil. To reduce contamination, the best way is advanced patented technology, which has been studied for the past 12 years. It was found that the proposed and used seed pilling technology is required to increase expenditure (53%) on cultivation and soil contamination. The rules of applying the technology have been ascertained and the contamination level determined for approximately 100 years of growing in crop rotation. *© 2010 Bull. Georg. Natl. Acad. Sci.*

Key words*: seed pilling, inoculation, contamination of topsoil, ballast of chemicals, Rizobium bacteria strains, chickpea pellet.*

Introduction. One of the most important roles in the Food Security Program of Georgia is attributed to the provision of the population with proteins of plant origin. For Georgia food safety and food standards are critical global issues against the background of soil contamination. Different diseases as diseases due to contaminated food and forages are widespread problems in Georgia and all over the world, and it is also an important cause of reduced economic productivity. Enhancement of Biological Nitrogen fixation by legumes is one of the biggest global issues of modern agriculture [1,2].

Georgia's experience proves that legume crops, like chickpea, faba beans, lentils, and in recent time – haricot and soybeans have plaid an important role throughout the country's 30 centuries history (to a lesser extent in the 19th and 20th centuries). The cited crops were not only a source of food and forage, but also a powerful lever in the restructuring of arable lands of Georgia and heightening the fertility of soils. Our forefathers knew well the high nutritive value of these crops and their positive effect on men and animals, which were used as green mass and straw, including medicinal characteristics[3].

Objectives and Methods. The original method of inoculation of grain legumes seed, using German made trans-modernized seed cleaning equipment "Petkus" K-541, elaborated and patented by our group of scientists in four countries, enables to get high yield of grain with minimal expenditures on the growing with increased biological nitrogen fixation [4].

Using new technologies in farmer's field provides high profit as well as protected environment for future generations.

Over many centuries these grain legumes, used in crop rotation together with the winter wheat and winter barley in West Georgia, became well accustomed to weather changes, biotic and abiotic stresses like precipitation, frost and other unfavorable climatic conditions, different varieties of diseases and against

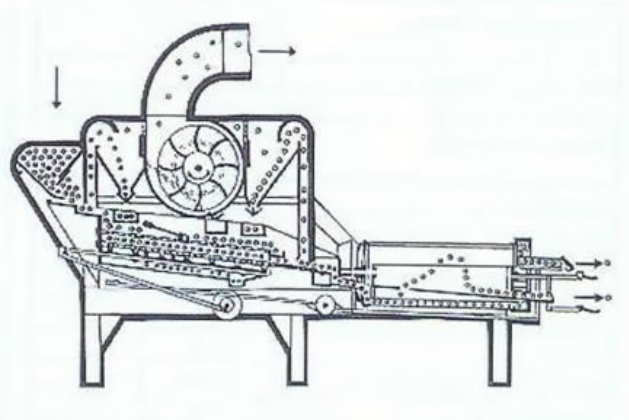

Fig. Scheme of cleaning equipment PETKUS K-541, used for the pilling of legume seeds

all odds, which gave almost stable yields. Georgians understood well the great significance of preservation of soil fertility and duly estimated the effect of biological nitrogen fixed by legume plants, on the output of grains to be sown on the same land plot in the following year using only efficient biological nitrogen and organic fertilizers [5].

The heightening of efficiency of these crops is based on the original method of inoculation of legume crop seed with modern strains of *Rizobium* bacteria, selected for each variety of legumes. This method enables us to get maximum harvest of grain, as well as straw, at the least expenditures. At the application of this method the seed prior to its sowing, does not require chemical treatment by fungicides, germination rate increases, high expenditures on mineral fertilizers, for *Rizobium* bacteria strains, inoculums, energy carriers for agro-machinery decrease, etc [6].

The flaw of this method is that it consists of costly mineral nitrogen fertilizers owing to agro-technology. Its application results in the growth of self-cost of the obtained production, washing off almost half of these fertilizers and its evaporation, pollution of the environment, water reservoirs, and the development of the unfavorable process of eurofication (precipitation of organic mass at the bottom of lakes, rivers, basins, etc). The flaw of this agro-technical method means that the productivity is low, fertilizers and Rhizotorphin are consumed in great quantity, and only the third part of it is consumed by plants, the applied agro-technology is of low profitability, mineral nitrogen is washed off and it pollutes the environmental ecology [7].

Our technology was used in inoculation of legume plant seeds by the method of formation of pill or inoculation of seed. In the above-stated method of making pills of grain crop seeds by the use of mineral fertilizers, manure, the seed is covered with polymer protective film which consists of potassium, phosphorus fertilizers in the amount which are provided by agro-technical norms per plant, fixed for legumes.

The flaw of this agro-technical technology is that the productivity is low, mineral and organic fertilizers and Rhizotorphin (*Rizobium* bacteria contain bio-fertilizer on the peat base) are consumed in great quantity, and only the third part of it is consumed by plants, the applied agro-technology is of low profitability, mineral nitrogen is washed off and it pollutes the environment[8].

The offered innovation ensures the growth of crop of legume plants. For the inoculation of legumes seed by inoculation and obtaining pills, we are using the PETKUS Seed Cleaning and Processing Plant K- 541 (Fig.) with technical capacity data – 2.5 t/h for seed cleaning and 1.8 t/h for seed inoculation (pelleting) to pills after reconstruction (for a while, for inoculation).

The innovation consists in the following: seed of legume crops is moistened first by water, then by 30% solution of polyvinyl alcohol, seed is covered with micro and macro fertilizers. Micro fertilizers are: boric acid, ammonium molybdenate, zinc sulfate and additionally thermally modified cement, and only after this the seed is covered with Rhizotorphin *(*containing *Rizobium)* – activator of biological nitrogen fixation, selected specially and precisely for each crop and variety.

By our patented technologies (Georgia State Patent # 1180) seed pills are made as follows (Example) : 100 kg conditional seed of chickpea is covered with 12.9 liter water, it is kept in a closed vessel for one hour up to complete consumption of that water; then seed is taken from the vessel (seed surface must be dry), is put into rotating drum, 0.9411 of 30% polyvinyl alcohol water solution is added and mixed for 15 minutes, for equal wetting, boric acid – 0.0134 kg, zinc sulfate– 0.0087 kg, ammonium molybdenate – 0.024 kg, cement –4.3068 kg and Rhizotorphin –0.3529 kg is added and mixed for final fixation of component mixture to the seed, for which 10-15 minutes are sufficient. The obtained pill is dried through warm air flood (30-35^{o}C) up to drying the seed surface. Then the seed is rinsed in chloroform, 3% solution of polycarbonate and is dried anew in a flush of warm air (30-35^{o}C) for 10-15 minutes up to complete evaporation of the solvent and the appearance of a film on the seed pills.

Results and Analyses. Inoculation of legume crops seeds by the method of seed pilling of seed, ensures considerable economy of micro and macro mineral fertilizers as well as R*izobium* bacteria treatment material, protection of the environment from its pollution, ecologically pure and safe production of legumes and

Table 1

Economic Efficiency of Pilling Technology with Legume Seed

Version/ variety	Yield t/ha	Growth of yield comp. control	Price per ton grain, EURO	Total value of production harvested per ha, EURO		Expenditures made for growing	Net income, EURO	Fixed nitrogen, kg	Profit, %
				total	extra				
Chickpea, grown by standard agrotechnology (control)	1.75	_	400	700	_	274.5	425.4	23.7	155
Chickpea, grown by the method of seed pilling and relevant agrotechnology	2.45	0.72	400	988	288	183.4	804.5	51.6	439

later on the same land plots, high output of other crops, which are sown after those legumes, and favorably use biological nitrogen fixed by legume crops.

Intensive accumulation of biological nitrogen in soil results in heightening of its fertility and growth of output of legumes by 40% and that of legume grasses by 57%.

Table 1 presents the data on the economic efficiency of the above-described method, clearly proving its profitableness. Application of the technologies elaborated in grain legumes crop farm economies, irrespective of their small territories, proved that traditional technologies used in growing of these cultures can not compete, even slightly, with scientific achievements, especially if we consider the indices, such as net income and environmental protection value.

Especially very well were matters in farm economies distributed in the arid zone of Eastern Georgia, in last 2007-2009 vegetation year (as winter crops) in Mtskheta and Dedoplitskaro districts, where we planted those crops using the technology of seed pellet by kind financial and scientific assistance of the USDA and College of Agriculture and Natural Resources at the University of Maryland (UMD).

In these regions, on the land plots of farmers' households, at about 3.8 metric t/ha chickpea, 2.7 t/ha lentils, and 4.2 t/ha faba bean was obtained on the small trials, while in Western Georgia, in the humid zone (Lanchkhuti and Samtredia districts) soybeans on pilot plots reached 2.5 ton per ha without nitrogen mineral fertilizers. The fact is to be emphasized that the advantage of the elaborated technologies was so apparent and reliable that they found great popularity among farmers and local governmental authorities during field days.

From the point of view of environmental protection, we carried out calculation of contamination of topsoil during 1 century, growing by traditional and new technologies (Table 2). Using pesticides (traditional) and new technologies have no alternative for contamination, as in the case of wheat, the difference is 363%, in the case of alfalfa 235%, and 297% less in the case of chickpea.

In the coming years we shall try to release our technology throughout the country in farmers' field and we have been trying to advertise this method in four regions of Georgia very successfully - in Lanchkhuti, Samtredia in Western Georgia and in Mtskheta and Dedoplitskaro districts in Eastern Georgia.

Joint scientific collective groups must be created in the nearest future, which will exchange the results of scientific-research achievements, will intensify the exchange training of farmers, take active part in advertising meetings of scientists and farmers, symposia and conferences in neighboring countries.

Heightening of efficiency of the results of research work is a demand of the day and it must be supported by creation of necessary conditions for strengthening the economies of private farms not only in Georgia, but also South Caucasus, EU countries, USA, etc. This will pave the way for successful implementation of the Food Security and Safety Programs of our country on the basis of this environmental protection technology.

Table 2

Contamination of Soils over 100 Years of Growing Different Crops

Crop Sequence (Rotation)	Contamination of topsoil remaining (Traditional / New Technologies*), kg/ha
Continuous Wheat	689.56/190.37*
Continuous Alfalfa (3 years)	239.92/102.85*
Continuous Chickpea	440.32/148.32*
*Wheat, Alfalfa (3 years stand), Chickpea (Grown by New Technologies of seed pilling) in 5 years fields rotation	

სოფლის მეურნეობა და გარემოს დაცვა

პარკოსნების თესლის ინოკულაციის მოწინავე ტექნოლოგია და ნიადაგის დაცვა დაბინძურებისაგან

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თესლბრუნვებში სასოფლო-სამეურნეო კულტურების მინერალური სასუქების ტრადიციული სისტემებით განოყიერებისა და პესტიციდებით სარეველებთან ბრძოლისა და ავადმყოფობისგან დაცვის დროს ადგილი აქვს ნიადაგის საზნავი ფენის დაბინძურებას ამ ქიმიკატების ნარჩენებისაგან. სამწუხაროდ, ასეთ შემთხვევებში მცენარეები გამოიყენებენ მინერალური სასუქების მხოლოდ 30-45%-ს, ხოლო მათი და პესტიციდების ბალასტი გროვდება ნიადაგში, ნაწილი კი გადადის მცენარეულ პროდუქციაში. ეკოლოგიური გარემოს დაბინძურების თავიდან აცილების საუკეთესო საშუალებად მიგვაჩნია ჩვენს მიერ ბოლო 12 წლის განმავლობაში შესწავლილი ინოკულაციის დაპატენტებული ტექნოლოგია. მისი გამოყენებით დადგენილია, რომ ასეთ პირობებში მნიშვნელოვნად მცირდება ნიადაგის დაბინძურება და მოყვანაზე გაწეული ხარჯები (53%). ამ ტექნოლოგიის გამოყენების საშუალებით ჩატარებულია გათვლები კულტურათა მოყვანის დროს თესლბრუნვებში ნიადაგის დაბინძურების შემცირების შესაძლებლობებზე საორიენტაციოდ ვირტუალური 100 წლის განმავლობაში.

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