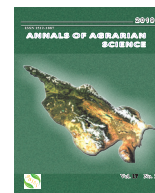




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Growing technology for soybeans with nanoherbicides

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ABSTRACT

Modern herbicide market in agriculture is about 2 billion tons and about 73 billion dollars industry with sophisticated multi-impact problems with food safety and human health, with increasing of weed resistance with every passing year at the topmost. Nanoherbicides under development in the current decade of our century could be a new strategy to address all the issues caused by the conventional non-nanoherbicides. From the beginning of 21 century group of Georgian scientists with farmers associations have begun development nanoherbicides (experimental name “Nanocooper 076”, which is under registration) in soybean experimental pilot plots and farmer’s fields, which will allow farmers to clear their soybean plantings from weeds without using toxic chemicals, like Glyphosate. As the potential use of nanostructured nanomaterials enables the use of nanoherbicides effectively and rules out the emergence of various weed-resistant population at an early stage of growing agricultural crops (first weeks after sowing), these very desirable nano technological methods and practices in general agriculture are reviewed by this article.

Keywords: Soya seed pilling, Nanocooper 076, Soil contamination, Friendly nanotechnologies, Nanoherbicides, Agriculture.

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Introduction

Recently definition of nanoherbicides in modern scientific dictionaries means like this – Nano herbicides also commonly known as weed killers, with chemical substances with various ingredients with nano metal composites, used to control unwanted plants, mainly weeds. Our nanoherbicide (Nanocooper 076) were synthesized and evaluated for herbicidal activity and cytotoxicity for the using in soybeans. The optimum formulation of nanoparticles was obtained using the cooper nano-technological composite. The basic properties - means particle size, stability time, morphology, and interaction between heavy metals (above 5 g/sm³) and herbicide were characterized using a particle size analyzer in

close labs. The nanoparticles were found to be in size range approximately 10-30 nm with low zeta potential value [1].

The genetically acquired capacity of the weed population to survive herbicide exposure under normal usage conditions could be stated as herbicide resistance. In a population of weeds exposed to herbicide, only a few individuals develop resistance, while the rest dies due to the herbicide action. This set resistant weed that survives eventually becomes a population of weeds with acquired resistance to a particular herbicide. The uncontrolled and repeated application of same herbicide will also select resistance plants. In some cases, multiple resistances can also appear due to sequential selection. Over the globe, nearly 250 herbicide-resistant weedy bio-

types have been identified in over 50 countries. This number constantly grows on an annual basis giving rise to new resistant weeds. Likely, some management practices also give a rise to the development of herbicide-resistant weeds [2,3].

The modern nanoherbicides has the potential to increase productivity- yield of field crops and guaranty food safety, while resolving the drawbacks of conventional pesticides and agrochemicals, which have negative environmental impacts [4,5].

Nanotechnology with his nanoherbicides offers exciting ways for averting the herbicide overuse and also a safe and effectual delivery. The usage of nanostructured systems in agriculture has increased tremendously in the current era for the controlled release of agrochemicals as well for plant nutrients (Fig. 1).

The nanostructured herbicide could substantially reduce the herbicide consumption rate 2-3 times and promise increased field crops productivity. This technology of exploiting nanomaterials guarantees to improve the current agricultural practices via the enrichment of field management methods. Nanoherbicides are one of the new-fangled strategies for combating the problems of conventional herbicides. These are being developed for addressing the issues in annual weed management and also for fatiguing the weed seed collection. The nanostructured formulation performs action through controlled release mechanism. The nanoherbicides comprise a wide range of entities such as polymeric and metallic nanoparticles. Nanoherbicides require a glance in order to place nanotechnology at the premier level [6].

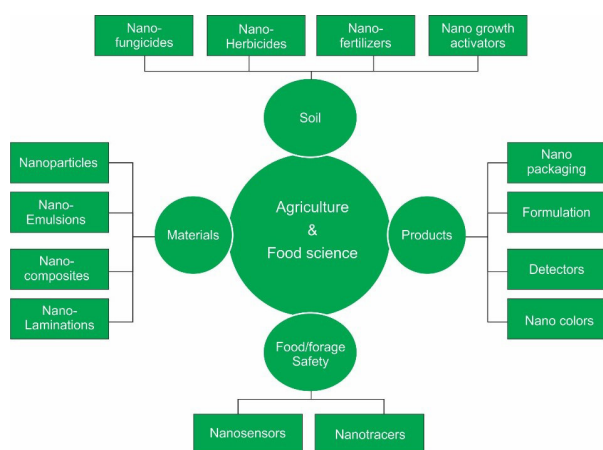


Fig. 1. Applications of nanoherbicide in agriculture & food/forage

Modern nanotechnology has potential for efficient delivery of chemical and biological pesticides using nano-sized preparations or nanomaterials (in our case Nanocooper 076) based agrochemical formulations. The active ingredient is adsorbed, attached, encapsulated or entrapped unto or into the direct nano-matrix. Controlled release of the active ingredient is achieved due to the slow release characteristics of the Nanocooper 076, bonding of the other ingredients to the material and the soil and climate as well as whole of environmental conditions for future generations [7].

Results and Discussion

Influence of Nanocooper 076 efficiencies on soybean yield and food safety positive parameters, as well as main use for soybeans - weed control with using seed pilling technology during last 12 years field and lab research results showed that application of herbicide-loaded Nanocooper 076 particles could be used to reduce the use of herbicides with improved efficacy and ecological environmental protection and food safety. During 2007 to 2018 in labs and farmer's fields with very close cooperation of researchers from Georgian Agricultural University in Tbilisi and the University of Maryland in USA, we are collaborating on a project to research and develop a nanotechnology-based herbicide that would prevent weeds from germinating and starting period of time during first 5 leaves faze growing of soybeans in West Georgia region in 14 hectares [8,9].

Preliminary lab analysis proves that the benefits of such technologies – seed pilling + Nanocooper 076, based on formulations of improvement of efficacy due to higher surface area, higher solubility of herbicide and seed pills with mineral fertilizers, higher mobility and lower toxicity due to elimination of organic and mineral solvents. Our nanopesticide involve either very small particles of pesticidal active ingredients of cooper or other small engineered structure with useful active pesticide properties. Our nanoherbicide show that it can increase the dispersion and wettability of agricultural formulations and unwanted pesticide movement, it's working very next day [10,11].

Nanocooper 076 exhibit useful properties such as stiffness, thermal stability, solubility, permeability, crystallite stability and biodegradability needed for formulating nanopesticide. It can also offer large

specific surface area and hence increased affinity to the target, it's very useful for the application by small size drones or airplane and need low expenses – in our pilot plots for 14 ha only \$784.

The use of nanopesticide copper 076 may offer new ways to control of these biological agents. nanopesticides or fungal bio control agents are promising as they act by contact and do not need ingestion, can be easily mass produced, and are

relatively specific. Microbial products such as enzymes, inhibitor, antibiotics and toxins are also promising as biopesticides against plant pests and pathogens. However, microbial products need stabilization and directed delivery mechanism towards identified targets, which need a very huge scientific research in collaboration with many biological and chemical specialists [12].

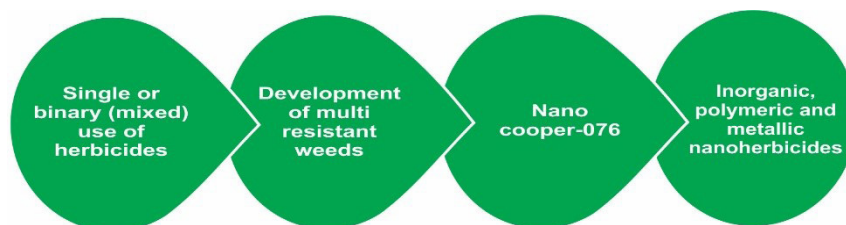


Fig. 2. Evolution of “Nano cooper 076”

Advancements in nanotechnology could be a boon for mitigating the unsolvable herbicide resistance prevailing for centuries (Fig. 2). The high penetration efficiency of nanoherbicides helps in eliminating the weeds before resistance could develop [13].

Nanocooper 076 was formulated by exploiting the nano technological potential for effectual delivery of chemical pesticides with the help of nano-sized preparations or nanomaterials-based herbicide formulations. Nanomaterials or nanostructures materials-based formulations could improve the efficacy of the herbicide in economically too, enhance the solubility and reduce the toxicity in comparison with well-known conventional herbicides on the basis of Glyphosate ($C_3H_8NO_5P$), which in the near future will be prohibited [14].

Weed control in soybeans with the use of nanoparticle-based herbicide Nanocooper 076 release systems could reduce the herbicide resistance potential, maintain the activity of the active ingredient and prolong their release over a longer period of time (2-3 years). The development of such specific herbicide molecule encapsulated with nanoparticle aims at specific receptors present at the root of the weed, especially in the spring before planting and during germination of soybeans. The developed Nanocooper 076 enters the root system of the weed and gets translocated to perform its action which in turn inhibits the glycolysis of the plant root system, while they are small and sick. The targeted action creates starvation of the plant and thus kills it. This Nanocooper 076 could also be used in rain-fed areas, where conventional herbicides get dissipated

through misty due to insufficient soil moisture (East Georgia). With the help of controlled release of Nanocooper 076 via encapsulation, approximately 90% weeds can be utterly destroyed with their formulated seeds.

Due to renewal of conventional herbicides with every passing year, the contaminant elements in soybeans increased by 0.3%. As a result, reducing the contamination of soils and correspondingly soybeans by represented technology estimated by 0.04 per year. In constructed crop rotation with 4 fields of legumes, calculated on a century, using nanoherbicides significantly decrease contamination of soil: in wheat by 88 %, in alfalfa 3 years fields by 74%, in soybeans by 94%. The notion of proposed technology has to introduce efficient of nanoherbicides in such rotations [15,16].

Additional successful new by point of view of food safety is that proposed new friendly technology used in our researches is the inoculation of soybean seed by the method of seed pilling [patent # 1180 GE], ensures considerable economy of micro and macro mineral fertilizers as well as *Rhizobium* bacteria treatment material. Technology protect the environment from its pollution, ecologically pure and safe production of legumes and 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. It's one of strong way for intensive accumulation of biological nitrogen in soil results in heightening of its fertility and growth of output of grain legumes by 4% and that of legume grasses by 17% (3 years stand). With

this technology is very effective using of nano-herbicide - Nanocooper 076, which practically do not contaminated soils by chemicals and adsorbed during calculate time of period (the century).

Table below presents the data on contamination, efficiency of the above-described technologies, clearly proving its profitability by point of the view of soil contamination. 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 cannot compete, even slightly, with scientific achievements, especially if we consider the indices, such as net income and environmental protection value with maximally of food safety.

Especially very well were matters in farm economies distributed in the arid zone of East Georgia, where we planted those crops using the technology of seed pilling with nanoherbicides.

Table. Contamination of soils conditionally for 100 years of different crops growing

Crop Sequence (Rotation)	Contamination of topsoil (0-30 cm) conditionally remaining (conventional herbicides / new technologies of seed pilling + Nanocooper 076 *), kg/ha
Continuous Wheat	689.56/84.31*
Continuous Alfalfa (3 years stand)	239.92/63.15*
Continuous Soybean	532.36/32.28*
*Wheat, Alfalfa (3 years stand), Soybean (All grown by new technologies of seed pilling and “Nanocooper 076”) during 5 years field rotation	

In these regions, on the pilot plots of farmers' households, at about 4.2 metric t/ha soybeans (with irrigation), 2.6 t/ha lentils, and 4.1 t/ha faba bean was obtained on the small trials, while in West Georgia, in the humid zone (with drainage) soybeans on pilot plots reached 3.8 tons grain per ha without additional mineral fertilizers. The fact is to be emphasized that the advantage of the elaborated technologies (seed pilling with Nanocooper 076) were so apparent and reliable that they found great popularity among farmers and local governmental authorities during field days [17].

Conclusion

Field and lab scientific-research work show that from the point of view of soil rehabilitation and environmental protection, we carried out calculation of contamination of topsoil during 1 century, growing by traditional and new technologies (table). Using Nanocooper 076 and new friendly technologies of growing with seed pills have no alternative for

contamination of environment, as in the case of wheat, the difference is 363%, in the case of Alfalfa 235%, and 297% less in the case of soybeans. 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. All of results is open for any scientists and commercial farmers. 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 in South Caucasus, EU countries, etc. This will be pane the way for successful implementation of the Food Security and Safety Programs of our country on the basis of this soil and environmental protection friendly technologies.

In Georgian agricultural practice for the destroying of typical for soybean weeds, for the growing of this cultural crop, farmers are using conventional

herbicide when sprayed has a chance of getting affected to the food crops too by this and there can be huge loss in the crop yield [18]. By using Nanocopper 076 which is cheap then very released and useful for soy herbicide Pivot on the base of Glyphosate by 32%, will try to mingle with the soil particle and try to destroy the entire weeds from their roots by not affecting soybean.

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