

**ASH AND SLAG HANDLING****3.5. Applications of ash and slag from power coals****3.5.4. Use of ash and slag for improving the properties of soil****3.5.4.3. Perspectives of ash-and-slag materials usage in agriculture**

*L.V. Berezin, M.A Lee, Omsk State Agrarian University named after P.A. Stolypin, Omsk, Russia*

*V.R. Shevtsov, OJSC "Territorial Generation Company #11", Novosibirsk, Russia*

**ABSTRACT**

Results of laboratory and field texts on ash-and-slag materials usage as an obligatory element during complex melioration of low fertility soils are presented in this article. Pilot studies showed that input of up to 1 tonn per ha Omsk TPPs' ash-and-slag materials to the soil increases effectiveness of agronomic experiments aimed at improving soil water and physical properties.

A field experiment on ash-and-slag materials input into the soil for summer barley was held in 2011 on the basis of the data acquired and with the help of working model of combined tool. The experiment showed yield increase by 1...2 centner per ha.

**INTRODUCTION**

TPPs' ash-and-slag usage as a component for raising soil fertility has great influence during economical and ecological analysis of increasing of natural resources usage effectiveness.

Considering the importance of this direction OJSC "TGC-11" entered into an agreement with scientists of OSAU named after P.A. Stolypin on studies and ash-and-slag usage in agriculture technology development on the basis of data acquired.

On the basis of the results of the study suggested volumes were calculated and taken into account in Perspective plan of large-capacity usage of ash-and-slag materials from TPPs of OJSC "TGC-11". According to calculations volumes of ash-and-slag usage in agriculture are on the fourth position, it is the most important direction concerning rehabilitation of positive balance of the environment.

Omsk region is one of the leaders in cereals production in Western Siberia nevertheless less than 20% of soils are fertile. Great territories are exhausted and are in need of fertility rehabilitation.

Up to the present moment coal ash hasn't been used in agriculture as it doesn't have nutrition elements for the plants and high alkalinity of this materials at ash ponds doesn't allow its usage for soil chemical melioration. The aim of the studies is the development of the technology of ash-and-slag usage as an effective element in the process of complex soil melioration.

**RESEARCH**

With the aim of determination toxicity of ash-and-slag materials for the seeds sprouting and with accor-

dance to OJSC "TGC-11" task laboratory studies were held.

Ash-and-slag materials were put into fertile meadow-chnozemic soil (ash-and-slag materials were put on 0...20 cm and 20...30 cm down the surface) as well as into low fertility alkaline soil which is the most spread soil in the Western Siberia (ash-and-slag materials were put into this type of soil on 20...30 cm as this type is characterized as the least fertile). Dried ash was taken from ash pond of TPP-4. Seeds of winter rye with high germination (97 %) were used for the study.

Study consisted of the following stages:

- 1) Control;
- 2) 1 mg of ash per 100 g of soil;
- 3) 30 mg of ash per 100 g of soil;
- 4) 120 mg of ash per 100 g of soil;
- 5) 400 mg of ash per 100 g of soil.

The study was based on norm that have already been calculated during fertilizers and ameliorants application 0,1..0,3...12...40 ton per ha. Water extract from clean soil was taken for a control.

Study showed that input of ash to meadow-chnozemic soil to subsoil as well as to topsoil in dosage more than 30 mg per 100 g of soil lead seeds germination decreasing by 15...30 %. When ash-and-slag materials were put into alkaline soil it lead to seeds germination decreasing by 30...50 % in comparison with the control. Hence usage of ash-and-slag materials in dosage that are equal to the dosage of mineral fertilizers (up to 300 kg/ha) of meadow-chnozemic soils didn't lead to seeds germination decrease but same quantity of ash-and-slag materials put into alkaline soil *stimulated seeds germination by 15...20 % in comparison with the control.*

On the basis of acquired data a field experiment aimed at studying maximum dosage of ash-and-slag materials input of meadow chnozemic soil by bottomless vessels was held on experimental field of FSBEI HPO OmSAU named after P.A. Stolypin.

Dry ash was put in a depth of 20...25 cm. Seeding rate of summer barley is 5 mill germinated seeds per ha. Seeding method - narrow-row, distance between the rows 7.5 cm. Depth of seeing - 4 cm. Period of seeding - third decade of may. Square of fields is 1 m<sup>2</sup>, position of the variants is systematic, triple replication. Winning was made during earing-flowering period taking into account elevated mass of the summer barley.

### Study scheme.

- 1) Control;
- 2) 0.3 ton per ha of ash;
- 3) 1 ton per ha of ash;
- 4) 3 ton per ha of ash;
- 5) 10 ton per ha of ash.

Results presented at Figure 1.

Analysis of the data proved that *ash-and-slag materials in dosage from 300 up to 1000 kg per ha of soil didn't have toxic effect on barley plants but stimulated increase in elevated mass of the plants.* Hence ash-and-slag materials can be used (in optimum dosage) in increasing soil fertility.

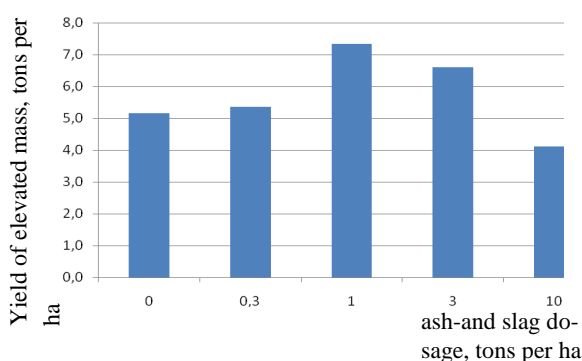


Fig. 1. Ash-and-slag dosage influence on summer barley elevated mass formation.

Ash-and-slag materials can be widely used in agriculture if their input is connected with some type of soil preparation for a particular zone.

Non-dumping and plain-cut preparation of the top level of soil at the depth of 16...20 cm are two most spread technologies among modern technologies of soil preparation in the Western Siberia.

But usage of these powerful tractors affects soil dramatically, soil firms much under the pressure of these machines.

Field studies shown that ash-and-slag mixtures input is more effective at deep bursting of the soil. Thus in order to organize mechanical ash-and-slag input into the soil two problems have to be solved which are special agricultural tool creation and optimal technology of ash-and-slag granulation.

Process of ash-and-slag materials granulation is similar to the method of unburnt coal gravel making with addition of gypsum and its derivatives as binding elements. The process allows to get ash-and-slag material which can be put mechanically into the soil and be used as an effective element for soil fertility increasing. 300...500 kg per ha is a recommended dosage of granulated product at this stage.

In order to put ash into the ground in working conditions FSBEI HPO OmSAU named after P.A. Stolypin created a working model of mounted implement for tractor "Belarus" on the basis of serial deep tiller PH-4 for tractors K-701 type. Working model has two operating tools (at PH-4 there are 10) and equipped with bunker for ash-

and-slag materials, seeding device allowing to regulate dosage of ash-and-slag materials input (fig. 2).

Suggested combined equipment for deep soil cultivation provides deep input of granulated ash-and-slag material into the cracks made by operating tools



Fig. 2. Experimental model of the tool in operation.

by 35...40 cm down.

### FIELD EXPERIMENT

Field experiment of complex melioration was held on a massive of alkaline soil on the basis of peasant farm enterprise "Kristina" of Maryanovsky region in Omsk region. Before the seeding soil was cultivated by experimentally modified deep tiller mounted at tractor "Belarus". Deep tilling by this aggregate was done together with input of created ash-and-slag material named Granzol. Granzol is granulated product made from ash-and-slag materials with usage of binding dried gypsum - alabaster (mark A) and dried additives (mark AC).

Next technological operations were done mechanically in accordance with zone recommendations. Norm of seeding - 5 mill germinated seeds per ha. Seeding method - row seeding. Seeding depth - 4 cm.

Soil surface is a complex of meadow-chernozemic alkaline soil of the third category with crusted alkaline soil spots.

#### Study scheme:

1. Control #1
2. Granzol A (ash+alabaster) 500 kg/ha
3. Granzol A (ash+alabaster) 1000 kg/ha
4. Granzol AC (ash+alabaster+drying agent) 500 kg/ha
5. Granzol AC (ash+alabaster+drying agent) 1000 kg/ha

Position of the variants is systematic, triple replication. Each replication had a control on each side.

Yield determination according to soil types revealed that low fertility alkaline soil showed the best result in a variant when 1 ton of granzol per ha was used. Increase in yield of winter barley seeds comprised 1...2 centner per ha (fig. 3).



Fig. 3. Summer barley grown up with ash-and-slag mixtures.

Positive effect as a result of the field study obviously was achieved by soil water and physical properties improvement. Thus bad water conductivity and expansibility of alkaline soil aggregates improves with granulated ash-and-slag materials input. Granzol usage had a positive impact on water resoluble ooze and soil structure.

Soil density change is a result of granzol usage that became evident during the first year after input. Thus experimental field was totally cultivated including control variants without ash-and-slag materials soil firmness dramatically decreased only after granzol usage. Soil firmness decreased better on meadow-chernozemic alkaline soil (fig.4).

Ash-and-slag materials don't contain nutrients for plants but they improve water and physical properties

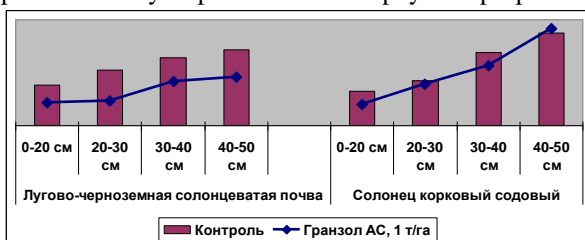


Fig. 4. Firmness of alkaline soil changes after deep cultivation with granzol AC input.

Лугово-черноземная солонцеватая почва - grassland black earth alkali soil; солонец корковый содовый – crusted alkali sodium soil; контроль – control; гранзол – granzol; т/га – t/ha; см –cm.

of soil which creates better conditions for development of plants root system and soil microbiology.

Study results allow to expect that dosage of ash-and-slag materials input can be increased during process of crusted alkaline soils properties improvement ash-and-slag materials can be also put on a soil surface in granules. To check this hypothesis, to know the period of positive effect, as well as to develop recommendations of ash-and-slag materials usage for increasing soils fertility in agriculture studying shall proceed in laboratory and working conditions.

## REFERENCES

1. **Materials** III International Scientific and Practical Workshop "Ashes from TPPs: removal, transport, processing, landfilling": – Moscow, April 22-23, 2010 – M.: Publishing house of MPEI. – 140 pages with graphic.
2. **PGD 34.02.202-95** "Recommendations on worked-out TPPs' ash ponds recultivation". SPO ORRES, 1995. 25 pages.
3. **Materials** of scientific and practical Conference "Innovation system of lowering resource capacity of coal OJCS TGK-11 TPPs production", Omsk, February 2011. Scientific and technological magazine "Westnik AELPS", volume 17, number 2 .
4. **Perspective Plan** of large-tonnage usage of ash-and-slag of OJCS "TGC-11" TPPs.

**L.V. Berezin, M.A Lee, V.R. Shevtsov.** Perspectives of ash-and-slag materials usage in agriculture // Proceedings of the IV scientific and practical workshop “Ashes from TPPs: removal, transport, processing, landfilling”, Moscow, April 19–20, 2012 — M.: MPEI-Publishers, 2012. P. 197 – 199.