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FOLIAR FEEDING AND POLLINATION OF BUCKWEAT AS A FACTOR OF HIGH YIELD AND SEEDS QUALITY ON THE BLACK EARTH OF ALTAI

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The crops of buckwheat in the Altai region exceed 420 hectares (the largest in Russia), but the grain yield is low - 0.8 t/ha. Among many causes are isolated biological characteristics connected with feeding regime and the crop pollination, which directly affect the amount of the fruiting and the resulting crop productivity. The best results in growing buckwheat on black earth steppe in Altai are achieved at pollination and re-pollination – 1.47 t/ha, foliar feeding during early budding increased the yield to 1.84 t/ha. The artificial pollination while spring drought is more effective at sowing from the 25th to 30th of May using a cheesecloth leveler – 2.06 t/ha. The weight of 1000 seeds increases by 0.9 g, germinative energy 92%; germination power 95%.

Keywords: *Altai, buckwheat, foliar feeding, pollination, re-pollination, seed sowing quality.*

Introduction

Buckwheat *(Fagopyrum esculentum Moench)* grown widely in the Altai region is the most common and popular in the grain market of cereal crops [1]. The history of buckwheat cultivation in the Altai region started from the beginning of the seventeenth century when the first land pioneers and the Cossacks, then settlers from the land-poor provinces of the European part of Russia imported various field crops, including buckwheat seeds into the territory of Siberia [2]. Buckwheat crops in 2011 occupied over 420 hectares in the region, taking almost half of the sown area of buckwheat in the country [3, 4]. Despite the long historical period of growing buckwheat in Altai, its major national economic importance, its biological potential of about 3.0 t/ha, the average yield is rarely more than 0.8 t/ha [5].

The relevance of research

Among many reasons for buckwheat low yield, as very important can be defined biological ones. They are connected with a low field germination of seeds, weak viability of seedlings, and suppression by sprouting weeds as well as unfavorable meteorological factors. All these factors are weakening the plant development, worsening pollination of flowers, reducing the number of

seed-buds and productivity of the crop. Of paramount importance for the high buckwheat yield is the quality of seeds, ensuring good germination, high weed resistance and safety of plants [6]. One approach to solving the problem of field germination of buckwheat seeds is to improve foliar feeding and its technology.

Subjects and methods

The experimental data presented in the article are based on the field research, in which the author was directly involved [6]. The field research was conducted in 2010-2012 in the Tselinny district, typical for natural indicators for the forest-steppe of the Altai region. More than half of all buckwheat crops are cultivated in the forest-steppe zone of the Altai.

The object of the research is buckwheat crop of the variety Dikul. The area of the experimental plot is 18 sq. m; the repeatability of the experiment is fourfold. The experiment 1 included options:

Factor A – without feeding (control), foliar buckwheat feeding in the early budding stage, the same and feeding in early bloom.

Factor B – without feeding (control), mixed pollination by honeybees and wild insects, re-pollination.

During control stage we used a cheesecloth isolator of special design, limiting bees visiting buckwheat flowers.

We used for feeding the "Master" – a microcrystalline completely soluble fertilizer NPK: royal jelly solution of 2.5 kg per 10 liters of water, working solution – 300 liters per ha. The main feeding solution $N_{30}P_{30}K_{30}$ was disseminated locally by a seeding machine EWS-3.6. The sowing time was from the 5^{th} to the 10^{th} June, the seeding rate – 3.5 million seeds per 1 ha; the seeding method – wide sowing (0.45 m).

Artificial re-pollination of buckwheat was studied in the experiment 2, with two times of sowing *(Factor A):* from the 25^{th} to the 30^{th} of May and from the 5^{th} to the 10^{th} of June with $N_{30}P_{30}K_{30}$. We used levelers *(Factor B)* made from cheesecloth, linen and rope. The control option was taken without artificial pollination.

Re-pollination was conducted four times during the mass buckwheat flowering in the morning. The surveys and observations were carried out by the methods common in agriculture. The tested soil area was leached black earth; the humus concentration was 5.9%.

Results and discussion

The problem of the field germination power and seedling viability of the crops in Siberia is very important. According to F.E. Reimers and I.E. Illy [2], the temperature as well as the soil moisture is a good basic background on which the degree of influence of other factors on germination depends.

In general, the growing seasons of 2010 and 2012 were characterized as medium moist, 2011 as moderately dry. It should be noted that in the period of mass buckwheat flowering (July-August) in 2010 there was 76 mm of rainfall, in 2011 – 74 mm, in 2012 – 95 mm. Due to heavy rains in the second half of the summer the pollination in 2012 was poor, which affected the grain harvest. The best conditions for insect pollination activities developed in 2011, especially in the second half of flowering [6].

Considering the meteorological situation in 2012, it should be noted that for buckwheat this year was unusual compared with a number of many years before. The beginning of the growing season was characterized by severe drought. In the second half of June there were about 5 annual rates of rainfall (72.4 mm). During this period, the crops of buckwheat from the 5^{th} to the 10^{th} of June during sprouting and budding came under good hydration. In late June there was no rain again. There were showers only in the first decade of August (the end of flowering) at 3 annual rates (54.3 mm), then up to the harvesting there was no rain.

The range of temperatures at cardinal points and the extreme temperatures growing ability of buckwheat seeds of different varieties in Siberia is rather wide: the minimum temperature is +4+6°C, the maximum +34+36°C. In the first case, 50-92% of the seeds germinate, depending on the varietal characteristics, in the second case 34-94%. The temperatures within which maximum germination of buckwheat seeds of different varieties is remaining range from +6+10°C to +26+36°C [2].

The thermal and physical resources for buckwheat in 2012 were higher than the multiyear averages. From seeds to flowering periods the average daily air temperature was +20+21°C; during flowering +19+20°C; at the beginning of fruiting increased to 23.1°C.

Our research has shown that in the experiment 1 the grain yield was high and ranged from 1.39 t/ha (in 2010) to 2.16 t/ha (in 2011). In the cases of double feeding the increase was higher by 0.05 t/ha, but it did not pay back the cost of feeding [5, 6]. By the experimental variants the average yields for 2009-2012 changed significantly. The options without pollination had the following characteristics: no feeding (control) 0.29 t/ha; feeding at the beginning of budding 0.42 t/ha – increase 0.13 t/ha (45%), feeding in the early budding and flowering 0.46 t/ha – increase 0.17 t/ha (59%).

The variants with pollination: no feeding 1.43 t/ha – increase 1.14 t/ha (393%), feeding in the early budding 1.65 t/ha – increase 1.36 t/ha (469%); feeding in the early budding and flowering 1.71 t/ha – increase 1.42 t/ha (490%).

The variants with pollination and re-pollination: no feeding 1.47 t/ha – increase 1.18 t/ha (407%), feeding in the early budding 1.84 t/ha – increase 1.55 t/ha (534%); feeding in the early budding and flowering 1.89 t/ha – increase 1.60 t/ha (552%).

The least significant difference at 5% level by the years of the research changed as follows: the combined factors effect 0.08-0.12 t/ha; feeding 0.05-0.07 t/ha; pollination 0.05-0.07 t/ha.

Thus, in the forest-steppe areas buckwheat tolerates drought well in the first vegetation season. The most important factors are pollination and re-pollination, foliar feeding enhances the effect, which can be seen in the yield rates [6].

In the experiment 2, the first time of buckwheat sowing with re-pollination from the 25th to the 30th of May by all kinds of levelers was characterized by better productivity: at control 1.72 t/ha of grain; using the cheesecloth leveler 2.06 t/ha (control rates increase was 0.34 t/ha or 20%); using linen leveler showed lower results 1.93 t/ha (increase 0.21 t/ha or 12%); using rope leveler only 1,85 t/ha (increase 0.13 t/ha or 7%). In the first two cases, the yield increase is mathematically accurate.

The second time of buckwheat sowing from the 5th to the 10th of June showed the following results: control 1.46 t/ha, cheesecloth leveler 1.71 t/ha (control rates increase 0.25 t/ha or 17%); linen leveler 1.58 t/ha (increase 0.12 t/ha or 8%); rope leveler 1.53 t/ha (increase 0.07 t/ha or 5%). The increase is reliable only at the option of using the cheesecloth leveler.

It should be noted that the weight of 1000 seeds in the experiment came to an average of 28 g, its increase depending on the timing of planting and pollination reached 0.6-0.9 g [6].

The germinative energy as an indicator of the quality of the seeds about 3 times shorter than the time set by the observable laboratory germination [2]. The direct regularity is observed: the higher the germinative energy, the higher yield can be obtained. The temperature of the greatest germinative energy of buckwheat in Siberia in different varieties ranges from +18+28°C to +22+36°C. At a minimum temperature of +4+6°C the energy is 2-10%; with a maximum +34+36°C is 32-92%.

A monthly (within six months after the harvest) observation of germination power and quality of seeds at different times of sowing (from the 25th to the 30th of May and from the 5th to the 10th of June) on all variants of pollination led us to the conclusion that the studied parameters have changed little over time, although it is believed that freshly harvested seeds have reduced their crop quality, as there were processes of synthesis and accumulation of plastic materials. By the spring of 2013, we obtained the following data: from the 25th to the 30th of May the germinative energy was 92%; the germination power – 95%. The second sowing time (from the 5th to the 10th of June) showed worse results: 90 and 93 % respectively.

The first time of sowing formed a higher yield due to vigorous sprouts. Fruiting took place against relatively good weather conditions; the grain was more than satisfied. The crops of the second period were characterized by sparse sprouts, while experiencing sharp drops of daily temperatures at the end of the growing season, which ultimately reduced the grain yield and the quality of crop seeds.

Conclusion

An important resource to increase production of buckwheat in the Altai region is to improve the zonal farming technology. Pollination techniques and foliar feeding of the crop is an important reserve for increasing the buckwheat yield. The maximum grain yield is formed by feeding in the early budding stage mixed with the complex pollination by bees and artificial repollination: 1.84 t/ha. The use of cheesecloth levelers gives good results. In the early stages of crop sowing the yield can be reached up to 2.06 t/ha, seed weight of 1000 increases by 0.9 g, the germinative energy is 92%; the germination power – 95%.

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