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Introduction of moisture-holding polymer «Aquasorb» during landing wood-shrubby and fruit plants in the arid conditions of Kazakhstan

The increasing deficiency of water resources in arid conditions of Kazakhstan forces to find the new directions of use of water-conservation technologies. One of perspective alternative technologies is use of water-absorbing synthetic polymers. In article norms and ways of introduction of water absorbent «Aquasorb» during landing wood and shrubby fruit plants in droughty territories of the Republic of Kazakhstan are considered. The aim of method consists in definition of an optimum way of absorbent during landing wood cultures for more effective use of useful properties of this preparation. Field and laboratory researches on light brown loamy soils for this purpose are conducted. As the results of experiences use of the combined method, when on a bottom of a landing hole saturated water polymer is brought is recommended, and the volume of the taken-out soil is added the dry preparation saturated later with water before formation of gel particles. For the tree species landed with the soil it is recommended to do punctures in the created earth lump in which dry polymer at addition of saturated absorbent is fallen asleep for a bottom of a landing hole. This way simplifies entering of polymer into a soil substratum during landing wood cultures and allows distributing evenly in a radical zone of plants.

Keywords: hydro gel, soil, moisture, wood and shrubby cultures, fruit plants.

Introduction

At constant deficiency of an atmospheric precipitation in the arid zones of Kazakhstan measures for providing plants and soils with moisture are necessary. For this purpose along with classical methods as forest plantations, watering drop and on furrows agronomists use hydro gels as an alternative to the existing water-conservation technologies. In recent years for these purposes beaded poly acryl amid hydro gels are tested.

Strongly bulking up polymeric hydro gels (PHG) represent a class of materials which are used in crop production for improvement of water physical properties of the soil. After watering they accumulate a large amount of water and gradually give it to plants. Polymeric hydro gels are porous, well bulking up, but not dissolved in water materials. Content of water in equilibrium bulked-up hydro gels changes in the wide range from 10 to 95 % and more. The main part of the liquid absorbed by hydro gel (up to 90 %) fills the free pore space occupying the main volume of a sample [1–4].

Present days a number of foreign and domestic-owned firms produce the gels of various modifications known under trademarks Aquasorb (France), Stocksorb (Germany), Hydrosorb (USA), Sonvet (Japan), AquaLife, Akrilex P-150 (Russia) and others.

Materials and methodology

For experiences is chosen the preparation Aquasorb which has the high water occluding ability and can be used for improvement of providing plants with necessary amount of moisture. Its feature consists that under the influence of granule water quickly bulk up, holding at the same time in hundreds of times bigger, in relation to the weight, an amount of water and nutritious elements which are contained in its. Hydro gel by structure of the chemical bonds is capable to accumulate and hold moisture concerning 1:200 (1 kg of hydro gel can absorb until 200 liters of water). Positive property of the preparation Aquasorb is that it isn't dissolved in water; it isn't washed away from the soil and therefore keeps the properties [5] for a long time.

The majority of works on using of PHG as a strongly bulking up polymeric gels is executed in crop production for improvement of moisture providing plants [6–8].

The purpose of our researches with the preparation «Aquasorb» is to find the most convenient and optimum way of entering of hydro gel into the soil during landing and determining the maximum absorbing ability of polymeric hydro gel in laboratory and field experiments.

Results and discussion

Our researches are conducted in three climatic zones: Almaty region, Enbekshikazakh district, settlement Aktogay, JSC «Forest Nursery», Almaty region, the Balkhash district, the settlement Bakanas; «Ili botanical garden» — branch of Institute of Botany and Phytointroduction; East Kazakhstany region, Kurchum district, village Saryolen. In these points experiments for cultivation of 10 species of decorative woodshrubby and fruit breeds on the area of 1 hectare in everyone are put. Experience is conducted in five variants. So, the area of 0.6 hectares is engaged in an experiment with moisture-holding Aquasorb polymer, variants I, II, III with the recommended norms of introduction preparation: 1.0 kg/m^3, 1.5 kg/m^3 and 2.0 kg/m^3. In variant IV is used the irrigating system of drop type of 0.20 hectares square. In variant V of 0.20 hectares square is used watering along the furrows according to the scheme of experiences. This variant serves as control.

Each species of wood plants: Acer tataricum L., Padus avium Mill., Tilia cordata Mill., Betula pendula Roth., Crataegus submollis Sard., Malus hybrida sort Zavetnoe, Picea obovata Ledeb., Thuja occidentalis L., were presented by 21 individuals (by 7 samples in each variant). Shrubby plants, as Ribes nigrum L. sort Zabava, Berberis vulgaris L. are presented also by 21 plants (by 7 samples in each variant).

It is known that the average annual amount of precipitation in these areas also makes low: in Enbekshikazakh district — 273 mm, Balkhash — 200–250 mm, Kurchum — 290 mm. The sum of active temperatures in Almaty region in above the called areas high, from 3000 ºC to 3500 ºC, in Kurchum — 2800 ºC.

For definition of the most convenient way of introduction of hydro gel at planting of trees and bushes reconnoitering experiment has been put in two ways. The first way was to addict hydro gel to the dry soil of 0.027 m^3 which is provided for landing of bushes and in advance took out from a hole. In this hole is brought saturated preparation hydro gel 1:200. Its preparation is executed according to the recommendations of the producer, receiving saturated hydro gel (135 g on 27 liters of water). At the same time there was instantly a full wetting of the soil to formation of soil conglomerates (Fig. 1).

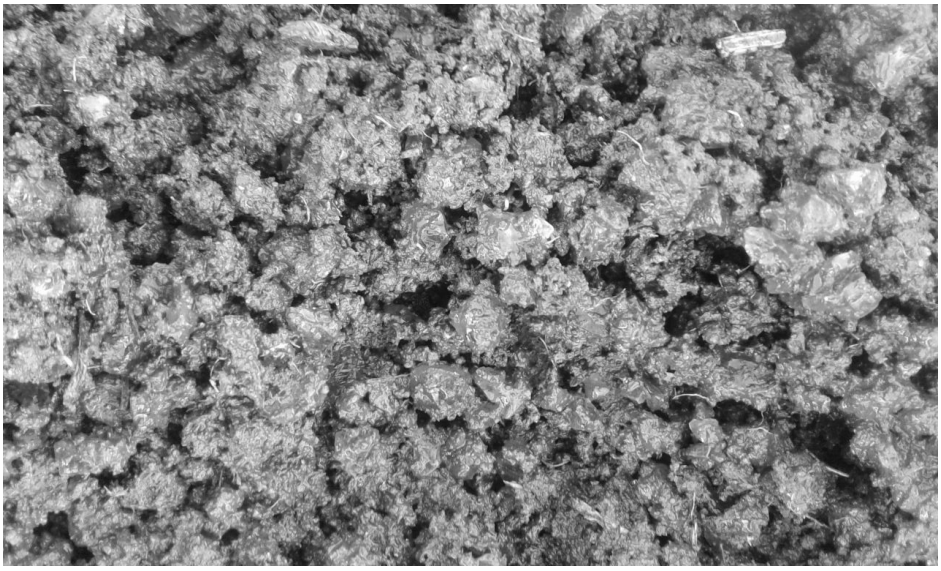

Figure 1. Formation of soil conglomerates at addition of saturated gel «Aquasorb»

Soil mix has taken a form of liquid dirt which is hardly shaken from a shovel. The second method is used the careful hashing of the soil of the same volume and dry granules by weight in 135 g received from calculation at norm — 1.5 kg/m^3 (in the second option) and at consumption of water when watering on one plant of 27 liters. It was received more homogeneous mass, without soil conglomerates. At the first and second ways identical increase in volume of soil mix up to 25–30 % was observed. The second way is most convenient for landing of trees and bushes.

The made experiment has allowed us to recommend a combined method of introduction of hydro gel: under trees on a bottom of a landing hole is sating inflated absorbent, these are 25 g of dry preparation in 5 liters of water which mixes up with the soil. Excess water flows down in the lower layers (Fig. 2).

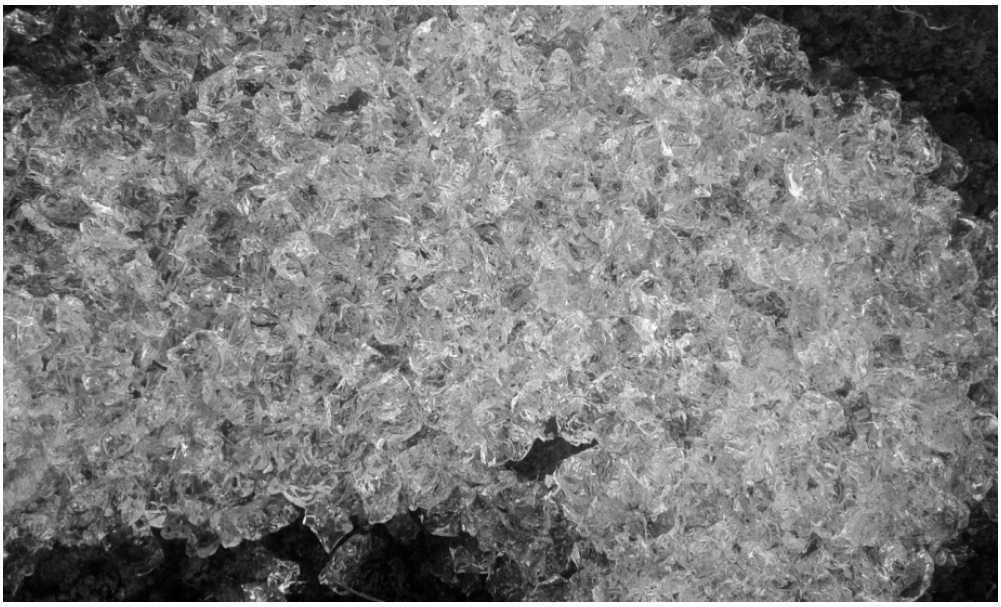

Figure 2. The inflated absorbent for introduction on a bottom of a landing hole

From the recommended norms on introduction of hydro gel for trees in the first variant — 1 kg/m^3, in the second variant — 1.5 kg/m^3 and the third variant — 2.0 kg/m^3. With assessment of the taken-out volume of the soil of 0.125 m^3 (at the sizes of a landing hole 0.5×0.5×0.5 m) have received the corresponding values, in the first variant — 125 g, in the second variant — 188 g, in the third variant — 250 g (Table 1).

Table 1

Combinative introduction of moisture-holding Aquasorb polymer under trees and bushes

Breed, species	Variant, doze of introduction of hydro gel, kg/m^3	Norm of introduction of hydro gel per one plant, gram	Norm of introduction of hydro gel on a bottom of landing hole, gram — litter	Norm of introduction of hydro gel in zone of root system's spreading, gram
Trees with open root system: *Acer tataricum* L., *Padus avium* Mill., *Tilia cordata* Mill., *Crataegus submollis* Sard., *Malus hybrida,* sort Zavetnoe	I — 1 II — 1.5 III — 2	125 188 250	25 — 5 25 — 5 25 — 5	100 163 225
Trees with closed root system: *Picea obovata* Ledeb., *Thuja occidentalis* L., *Betula pendula* Roth.	I — 1 II — 1.5 III — 2	125 188 250	25 — 5 25 — 5 25 — 5	100 163 225
Bushes with open root system: *Ribes nigrum* L. sort *'Zabava',* *Berberis vulgaris* L.	I — 1 II — 1.5 III — 2	90 135 180	12.5 — 2.5 12.5 — 2.5 12.5 — 2.5	77.5 122.5 167.5

Under *Picea obovata* in each variant on a bottom of a landing hole brought saturated Aquasorb — 25 g in 5 liters of water and in punctures from 8 to 12 pieces with a diameter of 1 cm, in a dry form in the first variant by 12.5–8.3 g depending on quantity of punctures, in the second variant by 20.3–13.6 g accordingly; in the third variant by 28.1–18.7 g respectively.

Considering that landing holes for bushes are provided the smaller sizes 0.3×0.3×0.3 m (volume of the taken-out soil of 0.027 m^3), we recommend for a bottom of a landing hole to bring — 2.5 liters of saturated hydro gel. Its preparation required 12.5 g of dry preparation. Also from the recommended norms of introduction of hydro gel the first variant — 1 kg/m^3, the second variant — 1.5 kg/m^3 and the third variant — 2.0 kg/m^3 has received amount of hydro gel on one plant; in the first variant it is brought — 90 g, in the second variant — 135 g, in the third variant — the 180 g. Hydro gel is brought locally in landing holes by a combined method. The amount of polymer is added to the soil according to calculations before filling of its saplings. Hashing of layers «gel — soil» is made carefully.

For specification of consumption rates of water during watering depending on the maximum keeping of water at preparation saturated moisture-holding polymer Aquasorb are conducted laboratory trials. In the cylinder with a capacity of 1000 ml is filled up 5 g of preparation and added gradually spring water by 50 ml — 12 times, generally 600 ml. Saturation continued within 3 hours, volume has increased to 1 liter. Then further changes in volume weren't observed. Therefore, the absorbing ability of hydro gel was 1:120 (according to technical requirements 1:200). From here it is possible to draw a conclusion on reduction of water during receiving the hydrated preparation for 35–40 % (Table 2). For comparison data on the recommendations of the producer are provided.

Table 2

Water consumption rate during landing wood-shrubby and fruit plants with water-absorbing ability according to technical requirements 1:200 and to calculations 1:120, depending on variants

Sort, species	Variant, norm of introduction of Aquasorb, kg/m^3	Norm of introduction of hydro gel per one plant, gram	Water-absorbing ability per 1gram	Expense of waters per 1 plant, liter	Water-absorbing ability per 1gram	Expense of waters per 1 plant, liter
Trees: *Acer tataricum* L., *Padus avium* Mill., *Tilia cordata* Mill., *Crataegus submollis* Sard., *Betula pendula* Roth., *Malus hybrida,* sort «Zavetnoe», *Thuja occidentalis* L., *Picea obovata* Ledeb.	I — 1 II — 1.5 III — 2	125 188 250	200 200 200	25.0 37.6 50.0	120 120 120	15.0 22.5 30.0
Bushes: *Ribes nigrum* L., sort «Zabava», *Berberis vulgaris* L.	I — 1 II — 1.5 III — 2	90 135 180	200 200 200	18.0 27.0 36.0	120 120 120	10.8 16.2 21.6

The conducted experiments have shown that the humidity in the soil hydro gel system doesn't change (remains) during 8–10 days. Physical evaporation took place in both experiences equally.

Conclusion

Data of experiences show that introduction of hydro gel during landing plants by the offered combined method is most optimum as there is a uniform distribution of granules in a soil substratum that excludes a possibility of emergence of sites with the high or low content of hydro gel. Also the labor productivity increases.

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Қазақстанның аридті жағдайында ағаш-бұта және жеміс өсімдіктерін отырғызу кезінде «Aquasorb» ылғал ұстайтын полимерін енгізу

Қазақстанның құрғақ аудандарындағы өсіп келе жатқан су ресурстарының тапшылығы су үнемдейтін технологияларды қолданудың жаңа бағыттарын іздеуге итермелейді. Болашақта балама технологиялардың бірі болып су жұтқыш синтетикалық полимерлерді қолдану есептеледі. Мақалада Қазақстанның құрғақ аудандарындағы ағашты-бұталы және жемісті өсімдіктерді отырғызу кезінде «Aquasorb» сулы абсорбентінің нормасы мен енгізу әдістері қарастырылды. Зерттеудің мәні препараттың пайдалы қасиеттерін тиімді пайдалану үшін, ағаш өсімдіктерді отырғызу кезінде абсорбентті ең оңтайлы жергілікті енгізу әдістерін анықтау болып табылады. Осы мақсатта ашық каштан сазды топырақта далалық және зертханалық зерттеулер жүргізілді. Тәжірибелердің қорытындысы бойынша аралас әдісті қолдану ұсынылды, отырғызу шұңқырына қаныққан, ал суырып алынған жердің көлеміне құрғақ, кейін сумен қаныққан гель тәрізді бөлшектері пайда болатын препаратты енгізеді. Топырақпен бірге отырғызылған ағаш тұқымдарына қалыптасқан жер кесектерінде тесіктер жасау ұсынылды, ол тесіктерге отырғызу шұңқырына қаныққан абсорбентті қосу кезінде құрғақ полимер көмілді. Бұл әдіс ағашты тұқымдарды отырғызу кезінде жер субстратына полимерді енгізуді жеңілдетеді және оны өсімдіктің тамыр аймағында біркелкі үлестіруге мүмкіндік береді.

Кілт сөздер: гидрогель, топырақ, ылғал, ағаш-бұталы өсімдік тұқымын, жеміс, қолдану, далалық және зертханалық зерттеулер.

Т.А. Вдовина, А.А. Винокуров, О.А. Лагус, Е.А. Исакова

Внесение влагоудерживающего полимера «Aquasorb» при посадке древесно-кустарниковых и плодовых растений в аридных условиях Казахстана

Возрастающий дефицит водных ресурсов в аридных условиях Казахстана вынуждает искать новые направления использования водосберегающих технологий. Авторы отмечают, что одной из перспективных альтернативных технологий является применение водопоглощающих синтетических полимеров. В статье рассмотрены нормы и способы внесения водного абсорбента марки «Aquasorb» при посадке древесно-кустарниковых и плодовых растений на засушливых территориях Республики Казахстан. Суть заключается в определении оптимального способа локального внесении абсорбента при посадке древесных культур для более эффективного использования полезных свойств препарата. Для этого были проведены полевые и лабораторные исследования на светло-каштановых суглинистых почвах. По итогам опытов рекомендовано использование комбинированного способа, когда на дно посадочной ямы вносится насыщенный водный полимер, а в объем вынутой почвы добавляется сухой препарат, насыщаемый позднее водой до образования гелеобразных частиц. Для древесных пород, высаживаемых с почвой, рекомендуется делать проколы в сформированный ком земли, в который засыпается сухой полимер при добавлении насыщенного абсорбента на дно посадочной ямы. Данный способ упрощает внесение полимера в почвенный субстрат при посадке древесных культур и позволяет равномерно распределить его в прикорневой зоне растений.

Ключевые слова: гидрогель, почва, влага, древесно-кустарниковые породы, плодовые растения, полевые и лабораторные исследования.

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