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HOP CULTIVATION UNDER OUTDOOR HYDROPONIC CONDITIONS IN ARMENIA

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Soilless culture (hydroponics) is one of the industrial methods for intensive crop production. It showed its viability and progressive nature securing a stable place in the production of vegetable products. Intensive development of hydroponics in Armenia and its introduction into production will give an opportunity of including dozens of thousand hectares of saline, stony lands, and open mines into the production. Many years of scientific experiments conducted in our and other countries showed high efficiency of hydroponic production of plants in controlled environment and root nutrition (Mairapetyan 1989; Dorais et al. 2001; Santich 2003).

Currently there are more than 30,000 ha under hydroponic crop production worldwide. In Armenia there are approximately 10 ha under outdoor hydroponic crop production consisting mainly of a gravel-volcanic slag or variations thereof.

At the Institute of Hydroponics Problems (IHP) more than 40 medicinal, aromatic, dye-bearing, spicy, tree-shrub and other valuable, rare and endangered plant species were introduced into soilless culture. Their hydroponic production technologies were elaborated; studies were conducted on their physiological-biochemical, agrochemical, and pharmacochemical peculiarities.

Despite the increase in the production of various synthetic fragrances and medicines, there is still a great demand especially for essential oils. The intensive production of medicinal plants can assist in supplying these essential oils and other medicinal extracts. The World Health Organization (WHO) estimated that 80% of the population of developing countries depend on traditional medicine, mostly plant-based products for their primary health care. The Current Global market for herbal products including medicines, beauty and toiletry products is estimated at around 62 billion US dollars. Global market for herbal medicine alone is estimated to be around 5 billion US dollars, growing at the rate of 30 to 40% annually and is expected to reach 16 billion US dollars by 2005.

Hop *(Humulus lupulus L.)* is widely used in brewing industry and medicine due to biologically active substances such as volatile oil, resin, lupulin, bitters, flavonoids, tannins, amino acids, estrogenic substances and many others (*Humulus* Genetic Resources, 2003; UIC/NIH Center…, 2004; Hop – Alternative…, 2004). Hop is applied for the treatment of gastrointestinal, dermatological, kidney, gall-bladder, nervous and women's diseases, cold blisters, and cancerous ulcerations. Hop is endowed with anaphrodisiac, anodyne, antioxidant, antiseptic, diuretic, hypnotic, sedative, soporific, stomachic, sudorific, tonic properties (Okada 2001; Estrada et al. 2002; Stevens et al., 2003; Nikolis et al. 2004).

As far back as in the 15th century, records were made about the pharmacochemical significance of *Humulus* by a prominent Armenian doctor Amirdovlat Amasiatzi (Scientific Heritage 1990) in his work "Unnecessary for an Ignoramus" which is considered a summary of development and historical track of Armenian medicine and natural sciences. In Armenian folk medicine hop was known as diuretic and anesthetic means. It was also used for diarrhea. Soporific properties of this medicinal plant have been described. Its stimulating influence on the functioning of stomach and its soothing effects on stomachache has been mentioned. In 1918, another Armenian doctor, S. Shahrimanyan (Torosyan 1983), mentioned the "blood cleaning" property of extract made of its root, as well as the soporific nature of *Humulus* in replacing opium.

Currently, brewing is rapidly developing in Armenia. Two breweries are working: "BEER OF YEREVAN" CJSC and "KOTAYK" Brewery. Their annual demand for hop is estimated to be 25 tonnes.

Hop is widely spread in Armenia, but its natural resources are few and can not provide the industrial quantities. The goal of this work is to introduce Armenian wild hop into hydroponic culture, discover its growth feasibility in soilless conditions and study some biochemical peculiarities in soil and hydroponic culture. Taking into account the feasibility of its large-scale application, the first trials of soilless cultivation were started in 2003 at the IHP.

Outdoor hydroponic station of IHP is situated 900m above sea level, annual average temperature is 11.0-11.8^{0}C, relative humidity is 40%, annual average sum of precipitation is 200-300mm, and average positive temperature per year is 3500-3800^{0}C. The cuttings separated from wild plantlets (SP) grown in environs of Yerevan were planted in outdoor hydroponic plots (10cuttings on 2m^2) at a depth of 0.25cm with 4m^2 total surface filled with volcanic slag (diameter of pieces is 2-10mm) which was disinfected before by 0.05% solution of $KMnO_4$. The plants were supplied with nutrient solution proposed by G.S. Davtyan (Davtyan 1980) once a day in spring and autumn, twice and thrice a day in summer. Female flowers (cones) of hop were collected from one-year-old hydroponic plants (HP), from soil plants (SP) and from Garni plants (GP). The amount of SP and GP cones' yield was not defined as they grow in wild nature, the age and the quantity of plants grown on 1m^2 is not known, any agrotechnical measures were not taken. They underwent only qualitative analysis.

Biometric measurements of test plants were made, and the biochemical and radiochemical analyses (in dry medicinal material) were carried out by the following methods: content of essential oil by distillation of

water steam (Ginzburg 1932), content of alkaloids (summary) was determined by gravimetric scale method, content of tannins by titrometrical method (Grinkevich and Safronich 1983).

Hop plants adapted to soilless conditions. These plants showed normal growth, development and fruiting. A significant difference was noticed between maturity periods of cones. Cones of SP and GP reached maturity in the first ten-day period of August, whereas cones of HP matured in the third ten-day period of September.

The average length of one-year-old hydroponic hop vine reached 4.3 m. The average number of side branches was 29. The average stem thickness was 14mm (see the Table).

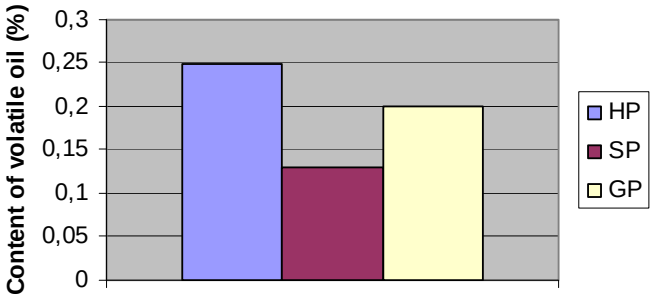
Table. Biometric and yield data of hop plant grown under hydroponic conditions

Vine №	Height of the plant (m)	Quantity of side branches (piece)	Thickness of the stem (mm)	Vine weight (g) Fresh	Vine weight (g) Dry	Cone weight (g) Fresh	Cone weight (g) Dry
1	4.8	36	20	1990	591	990	235
2	3.8	24	10	976	278	522	117
3	4.2	29	12	882	266	403	99
4	4.5	27	14	1264	383	585	140
average	4.3	29	14	1278	380	625	148

Aerial green mass (leave, stem, cone) of one hop vine grown in soilless culture was over 1278g including the cone which was 625g. Dry mass of vine and cone reached 380g and 148g, respectively. Almost the half (49%) of green mass of hop vine made up cones, whereas in case of dry mass lessening of that index was observed by 10% (39%). Air-dry mass of cone comprised over Ω (24%) of cone wet weight. Generally, wet weight of cone obtained from $1m^2$ nourished hydroponic area was 2938g, dry weight was 719g (Table 1).

Hydroponic plants and Garni soil plants showed high content of essential oils (0.25 and 0.20% respectively). In hydroponic plants (HP) essential oil content exceeded mother soil plants (SP) 1.9 times (see Fig.1).

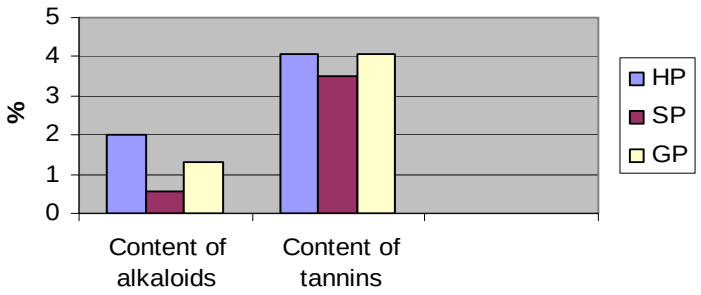
Figure1. Content of volatile oil in dry cones of HP, SP and GP. HP-0.25˚0.04[1], SP-0.13˚0.09, GP-0.2˚0.06
[1] Average ˚ S.E. in 95% probability level



In studied variants, essential differences of alkaloids content in cones were observed. These differences are not only evident between hydroponic and soil plants, but also between soil plants growing in various ecological conditions. HP exceeded SP and GP by intensity of alkaloids biosynthesis 3.6 and 1.5 times. In its turn, soil plants (GP) of Khosrov Preserve growing in ecologically more favorable conditions (low pollution level of air and land stratum, etc.) exceeded SP 2.4 times (see Figure 2).

In cones the accumulation of tannins conditioning bactericide and anti-inflammatory properties of hop was expressed weakly according to variants. In HP and GP almost the same content of tannins was observed (4.08 and 4.06 respectively) which exceeded SP by 17% (see Figure 2).

Figure 2. Content of alkaloids and tannins in dry cones of HP, SP and GP. Content of alkaloids-HP-2.0˚0.281, SP-0.56˚0.16, GP-1.33˚0.29. Content of tannins-HP-4.08˚0.06, SP-3.49˚0.11, GP-4.06˚0.04
[1] Average ˚ S.E. in 95% probability level



Soilless culture of hop in Armenia is feasible and according to preliminary results it is efficient and prospective. In soilless conditions 1m^2 nourished hydroponics produced 719g dry cone. They don't concede soil plants by their qualitative properties (volatile oil, alkaloids and tannins) but even have certain advantages. Preliminary data obtained serve as a basis for deeper studies of hop in hydroponic conditions.

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ԳԱՅԼՈՒԿԻ ԱԶԵՑՈՒՄԸ ԲԱՑՕԹՅԱ ՀԻԴՐՈՊՈՆԻԿԱՅԻ ՊԱՅՄԱՆՆԵՐՈՒՄ ՀԱՅԱՍՏԱՆՈՒՄ

Ա.Հ.Թադևոսյան, Ջ.Ս.Ալեքսանյան, Բ.Թ.Ստեփանյան, Ռ.Ժ.Բունիաթյան

ՀՀ ԳԱԱ Գ.Ս.Դավթյանի անվան հիդրոպոնիկայի պրոբլեմների ինստիտուտ

Առաջին անգամ հիդրոպոնիկ եղանակով մշակվել է սովորական գայլուկը (*Humulus lupulus* L.): Ապացուցվել է դրա անհող աճեցման հնարավորությունը: Ստացված նախնական արդյունքները հիմք են տվել դատելու, որ գայլուկի հիդրոպոնիկ մշակումը արդյունավետ է և հեռանկարային Արարատյան դաշտի պայմաններում: Փորձարկումները շարունակվում են:

ВЫРАЩИВАНИЕ ХМЕЛЯ В АРМЕНИИ В УСЛОВИЯХ ОТКРЫТОЙ ГИДРОПОНИКИ

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Впервые в гидропоническую культуру интродуцирован хмель обыкновенный (Humulus lupulus L.). Доказана возможность его беспочвенного выращивания. По полученным предварительным данным можно заклэючить, что гидропонические культивирование хмеля в условиях Арартской долины эффективно и перспективно. Опыти продолжаются.