

BASIC CHARACTERISTICS OF HOP PRODUCTION

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Abstract

Hops are one of four essential ingredients in beer. Brewing industry requires traditionally its raw materials of a high quality. The production structure in the hop industry sector varies greatly across the EU countries. However, the main production procedures in a hop industry are common since the product is usually offered on a global market. This article summarizes in the main technological aspects of the hop industry from hop planting to its processing – including hop fields characteristics, production works on hop fields, hop harvest and storage of hops.

Key words: hop, *Humulus lupulus* L., hop industry, production technology, farm management

OSNOVNE ZNAČILNOSTI PRIDELAVE HMELJA

Izvleček

Hmelj predstavlja eno od štirih osnovnih sestavin v pivu. Pivovarstvo ima visok standard kakovosti za vhodne surovine. Struktura pridelave hmelja v državah EU je zelo raznolika, vendar pa je tehnologija pridelave hmelja precej podobna, saj je pretežni del pridelave namenjen izvozu na globalne trge. Članek zgoščeno povzema ključne postopke pridelave hmelja vse od sajenja do predelave – vključno z značilnostmi hmeljišč, tehnološkimi opravili, obiranjem in skladiščenjem hmelja.

Ključne besede: hmelj, *Humulus lupulus* L., hmeljarstvo, tehnologija pridelave, kmetijsko podjetništvo

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1 INTRODUCTION

Hops (*Humulus lupulus* L.) are a specialty crop produced for the female flowers (cones), which either raw or processed, are an essential ingredient in the beer production. Lupulin glands of the hop cones contain soft resins (alpha-acids and beta-acids) and essential oils that impart bitterness, flavor, aroma, foam (head) characteristics, and preservative qualities to beer. The total amount and percentage composition of these compounds vary with variety, region, growing conditions, and production technique. Since the brewing industry depends on hops to provide distinctive and proprietary characteristics to beer, a stable supply of high-quality hops is its high priority. To remain globally competitive, hop and brewing industry must respond to the ever-changing needs of consumers by providing appropriate hops and hop products.

2 PRODUCTION IN THE HOP INDUSTRY

2.1 Hop plants

Hops are perennial herbaceous plants that climb around a support. Hops are dioecious, i.e. they have either male or female flowers. Only female plants are grown in hop fields, while male plants are not desired, since they may pollinate the female plants. The life expectancy of a hop plantation ranges from 10 to 20 years and depends on growth conditions, the variety and treatment methods. Botanically, the hop species belong to *Cannabaceae* family.

A hop plant consists of underground vegetative parts and parts above ground with vegetative and generative organs. The parts above ground wither at the end of each growing season, leaving only underground parts to overwinter. These are the rhizome or stump and the main and lateral roots.

The parts of the hop plant above ground include the stem (bine), leaves, lateral shoots and flowers. When the bine reaches around 50 centimeters in height, it gains the ability to climb. The bines climb by winding clockwise around the support whereby using hooked hairs.

The color of the bine ranges from green to red, depending on the variety and phenophase. A hop bine can grow to a height of 7 to 9 meters. When the plant reaches the top of its support, lateral shoots sprout out. Cones develop from lateral shoots. The leaves on the stem and horizontal sprouts are distributed evenly and are found opposite each other. Older leaves are mainly three- or five-patched, while its

edges are mainly coarsely toothed. The surface of the leaves is hairy, while the color varies from light to dark green.

Its generative organs include male flowers, which are small and joined into grape-like flower clusters, and female flowers, which grow mainly in clusters. A cone is a mature female inflorescence, 20 to 30 millimeters in size, depending on the variety. In nature, it also contains developed seeds, which, however, is undesirable in hop growing. At the bottom of cover leaves and bracts, lupuline glands are formed that contain essential oil, bitter resins and tannins. Cones are the only commercial products for the brewing industry (Čeh et al., 2012).

2.2 Hop trellis - wirework

The main support for a hop plant is a **wirework**. There is a string attached to the wire around which the plant climbs. The main parts of the wirework are wooden or concrete poles, the wire netting and anchors. These are set up on flat terrain and are rectangular in shape. It is very important to carry out regular maintenance works on wires, as this reduces the possibility of the wires collapsing and prolongs their lifespan. Anchors, attached to trellis cables, surround the yard and hold the trellis upright under the weight of the developing crop. Plant spacing depends mostly on hop variety and growing area, with 2.4 to 3.2 m row distance and about 1.1 to 1.7 m between plants within rows. The height of the wires in traditional hop fields range from 6 to 7 meters (Pavlovič, 2012a).

2.3 Production procedures on hop fields

In the spring, before pruning, the soil that covers hop plants is partially removed. Care is required so that the roots are not injured or even ploughed out. Soil can also be removed simultaneously with pruning, thus rationalizing production. The mechanical equipment for soil removal is connected to the front part of the tractor, while the cutter is in the back (Čeh et al., 2012).

Pruning (cutting) is one of the most important agro-technical measures in hop production. During pruning, one-year-old wood is removed and, with it, the redundant eyes developed on it. By pruning, we may control the dynamics of plant growth and development (by prolonging the start of the growth). In addition, we manage infections with plant diseases as well as the level of crops. The beginning of pruning depends on environmental conditions and the characteristics of the hop variety. As a rule, too early or too late pruning results in lower yield or lower quality (Anon., 2011).

By **stringing** (twining) a necessary support for hop plants in the field is provided before the hops sprout. To support hops, various types of training strings are used worldwide (metal, coir i.e. coconut fiber, polypropylene or even paper). A crew using tractor-drawn elevated platforms tie the twine to overhead trellis wires and secure the lower end of the twine near main roots of hop plants.

Training of bines onto strings is an agro-technical measure that substantially influences the quantity and quality of the crop. It is done exclusively by hand and requires entirely individual work with plants. This work stage includes the process of picking out the sprouts and winding them onto strings clockwise. By doing this, we can considerably correct mistakes made when pruning.

In order for the hop plants to obtain adequate nutrients, hops have to be **fertilized** appropriately during their growth and development. By fertilizing, adequate amounts of nitrogen, phosphorus, potassium, calcium, sulphur and magnesium are added. Micronutrients, if needed, are ordinarily applied to the plants foliarly. This means that hops are fertilized with a solution of fertilizer sprayed over the leaves. Fertilization with organic manure improves the structure of the soil. This also enhances the capacity of the soil to retain moisture, the aeration of the soil is better and the temperature regime of the soil is balanced (Čeh et al., 2012).

Irrigation is unavoidable agro-technical measure in a hop growing. Proper irrigation requires regular monitoring of the soil moisture content in hop fields. Drip irrigation is the predominant method used to provide water to hop plants, along with movable sprinkler methods. Both irrigation techniques have their strengths and weaknesses. However, drip irrigation has an important advantage in smaller consumption of water and rationalization of labor work (Čerenak et al., 2002; Čeh et al., 2012).

Diseases and pests are controlled by applying **plant protection** products. The primary goal behind this is a careful, economical and environmentally acceptable application of appropriately prepared chemical preparations onto targeted areas in order to reduce any negative consequences to the largest possible extent. Therefore, spraying has been carried out in the hop industry according to prognosis for over twenty years. Plant protection products are applied using sprinklers. To spray hops, classical pulling axial sprinklers are most often used that can have two types of nozzles built in: the classical whirling and the latest nozzles for reducing the application of plant protection products (Darby, 2010; Čeh et al., 2012).

2.4 Hop harvest

Hop harvest (apart from training of hop bines) represents the second working peak in hop production and starts when hops are technologically ripe. This is when the cones have the highest content of alpha-acids, reach their maximum length and mass as well as their typical structure of essential oils, thus ensuring quality machine picking. Technological ripeness in hops depends on the variety, technological measures and weather conditions during the growth period and on soil attributes. This happens at the end of August or in beginning of September. Hop picking is divided into three procedures: harvesting the crop in the field, transporting the plants to the picking machine and harvesting the crop at a picking machine. In the hop field, plants are cut and torn together with guides from the supporting strings of the wire, allowing them to fall onto the loading attachment pulled by the tractor in the direction of plant picking. Plants are cut mechanically, in some cases also by hand. Cutters cut the plants at the height of 120 to 150 cm above ground.

At the picking machine, bines are inserted in the grips of the inserting track. Plants are put in with the cut-off part first. The cleaning part of picking machines consists of a ventilation and conveyor belt component. The role of the ventilator is to remove the major part of the leaf mass from the cones. Sorting conveyor belts then separate the remaining leaves, parts of stems and other parts from the cones. Sorting conveyor belts require that the plant mass enter evenly, with such layer thickness that still allows the cones to roll. According to this principle, the separation of cones from other plant components takes place on sorting conveyor belts.

Picking machines must operate as flawlessly as possible. Machines have to be cleaned regularly during picking and adapted to the variety of the hop and weather conditions. This way, the share of damaged cones and other components is decreased. When operating - a picking machine and safety at work should be observed at all times (Čeh et al., 2012; Pavlovič, 2012b).

2.5 Drying and moisturizing hops

Drying and moisturizing hops are the final technological stages in hop production. Through incorrect or inaccurate drying and moisturizing, we can actually destroy the quality of hops in merely half an hour. Technologically mature hops contain between 77 and 80 % of moisture. While drying, moisturizing, loading and storing hops, care is to be taken primarily to preserve the quality of hops and reduce energy consumption. Hop dryers are either multi-storey or conveyor-belt dryers.

Multi-storey dryers achieve a better utilization rate of thermal energy and have a larger capacity of drying per surface unit of the drier.

In order to achieve the optimal storage durability, cones have to be dried to the moisture content ranging between 9 and 11 %. Hop varieties differ from one another in physical, chemical and morphological properties of cones. The flow of the drying air can be regulated with the thickness of the poured layer of hop. During the drying process, hops must not be heated to temperatures exceeding 60°C. Higher temperatures may cause accelerated evaporation of easily evaporative essential oil components or a disintegration of bitter ingredients, in extreme cases also a change in the color of lupuline. After about six hours of drying, when hops are technically dry, the moisture content is between 8 and 9 %.

Since it is difficult to remove the moisture from the spindle, hops have to be over-dried during the drying process. Over-dried hops crumble easily and are, as such, not suitable for packaging. The purpose of moisturizing is to restore elasticity to the cone and hop moisture to the desired 9 to 11 %. Hops can be moisturized on a pile, with a conveyor belt moisturizer or in a chamber. The latest variations of moisturizing chambers are automated (Anon., 2011).

2.6 Storage of hops

Packing dry hops according to the market demands is the final task. Properly moisturized hops can be “stuffed” into RB-60 “cube” bags or “bale” production bags. Only properly moisturized hops can be “stuffed”. Hops that are too dry will crumble, while hops that are too damp will go moldy. Such hops are technically useless and have no market value.

If hops are stuffed into “cubes”, attention must be paid to the moisture content of the hops, which is to be 9 %, because hops are more compressed in these bags and, therefore, more prone to harmful influences. A properly filled RB-60 bag should weigh 60 kg. Hops that are filled in the production bag (“bale”) are moisturized to between 10.5 and 11.0 %. A properly filled (“stuffed”) production bag weighs between 50 and 70 kg. Irregularities in the storage of hops can also influence the quality of the produced hops.

A storage room that is not selected properly affects the increase of moisture in the hop, resulting in a lower microbiological stability of hops. The storage room must be dark, cold and dry. The relative humidity of the air in the storage room cannot exceed 65 % if hops are to retain 11 % of moisture (Pavlovič, 2012b).

3 CONCLUSIONS

Wherever beer is produced around the world, regardless of the type or brand, it is hops which preserve beer, make it bitter and provide its unique hop aroma. Unlike malted barley, which can be supplemented by rice, wheat or maize, hops have no substitute as a raw material for brewing. Furthermore, to suit various brewing industry requirements, research programs in hop breeding, hop physiology, production and processing of hops into hop products and quality management, used to be intensified during the last few decades. However, in spite of many improvements such as development of new hop varieties, modern growing techniques, implementation of new plant protection measures, nowadays even some of the biggest and the most respectable hop research organizations are faced with the plain endurance and share the future of farmers.

Plentiful, quality and healthy hops give pride to the hop grower, are welcomed by the hop merchant and brewer and provide pleasure to the consumer - a beer drinker.

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