Moving Towards Automated Broccoli Harvesting

The changing costs and availability of labor are increasing the desire for automated harvest of broccoli. Uniformity of heads and placement in the canopy can affect head recovery efficiency with automated harvest systems. Varietal attributes and cultural practices impact the traits required for successful automated harvesting.

Harvesting Broccoli

The cost of harvesting broccoli is one of the largest expense factors in the production of broccoli. The cost of labor makes up a large portion of those expenses. With the availability of labor decreasing and the costs of labor increasing, growers are looking for alternative means of harvesting. The idea of automated broccoli harvest systems has been around for many years, but changes in the labor picture have renewed grower interest in this idea.

The current state of mechanization in broccoli harvest is the use of harvest-aids. With these systems, workers manually cut the heads off the plants and place them on the conveyor belt of the harvest-aid. The harvest-aid helps in sorting and packing the crop in the field, but the harvest process is still labor intensive. With the hand-harvesting of broccoli, the crop is usually harvested several times, allowing primary and secondary heads to reach their target size before harvest.

In an automated harvest system, the machinery removes the heads from the broccoli plants. With most of the systems developed so far, this involves a single destructive harvest when the number of marketable heads is at its peak. Two types of automated harvest systems are being investigated, those that are strictly mechanical and those that use computer and robotic components. Strictly mechanical systems are similar to a corn harvester (combine) where the combine head is set to a specific height. Mechanical action cuts the broccoli head and separates the head from unwanted plant debris. With a robotic system, a camera connected to a computer is used to locate and evaluate the head on a plant. If the identified head is acceptable, it is cut at an appropriate height. Robotic systems have the potential to be more efficient, maximizing the recovery rate. They are also more complex and likely to be more expensive to purchase and maintain.

In many areas, broccoli is planted in two- or three-row beds. Depending on the orientation of the beds relative to the track of the sun in the sky, multi-row beds can result in uneven

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of plants in a stand. Broccoli requires a supply of nitrogen throughout early crop development to produce larger head yields, with a rapid uptake of nitrogen beginning as early as three weeks after planting. Studies have shown that maximum yield is obtained when total nitrogen rates are in the range of 150 to 300 lb/acre, depending on season and other soil conditions. Soil phosphorus levels should be at least 50 ppm, and soil potassium levels should be at least 150 ppm to maximize yield and head quality.

Nutrition is another factor that can have a large impact on the uniformity of plant growth. In particular, the levels and uniformity of distribution of nitrogen, phosphorus, and potassium are very important for the uniform development of plants in a stand. Broccoli requires a supply of nitrogen throughout early crop development to produce larger head yields, with a rapid uptake of nitrogen beginning as early as three weeks after planting. Studies have shown that maximum yield is obtained when total nitrogen rates are in the range of 150 to 300 lb/acre, depending on season and other soil conditions. Soil phosphorus levels should be at least 50 ppm, and soil potassium levels should be at least 150 ppm to maximize yield and head quality.

Broccoli growth is dependent on soil moisture levels, and therefore on irrigation management in many areas. Furrow, overhead sprinkler, and drip irrigation are all used in commercial broccoli production. The use of furrow irrigation has declined because it is the least efficient in terms of water use. However, it does result in a more consistent supply of water across the bed and provides a larger reservoir of soil moisture, when compared to drip irrigation. Drip irrigation has the highest water use efficiency of the three methods, but soil moisture may be less evenly distributed, depending on the number and placement of drip tubes in the bed. Drip irrigation may not be best for emergence and seedling establishment, so in some regions it has become common practice to use furrow or sprinkler irrigation initially and then switch to drip irrigation after two to three weeks when seedlings have become established. Planting beds should also be as level as possible to maximize uniformity across the field. Laser leveling a field can considerably increase crop uniformity.

Stand Uniformity

Many factors impact the uniformity of a plant stand. Anything that affects seed germination, emergence, or seedling growth and can affect stand uniformity. For direct-seeded plantings, soil type and planting depth both impact germination and emergence. The optimal planting depth for broccoli is between ¼ and ½ inches. At shallower depths, a lack of soil moisture can inhibit seed germination, while planting too deep can result in delayed and uneven emergence. In sandy soils, seeds can fall through the soil, ending up at a deeper depth than they were planted. Planting in the optimum depth range, along with good seedbed preparation, can help maximize stand uniformity. Seed quality and viability are also important for uniform stand establishment. Growers should always use high-quality seed with high tested germination rates obtained from a reputable source. Seed coatings and seed treatments can help increase the uniformity of stand establishment, and transplanting will usually result in greater stand uniformity when compared to direct seeding.

Varietal Traits

The goal with automated harvesting of broccoli is to have a high percentage of the marketable heads recovered in a once-over harvest. In addition to growing conditions, there are several varietal traits that influence the success of this objective. Harvesting is easiest, especially with automated harvesting, when broccoli heads are above the surrounding foliage. However, heads should not be too tall or there can be problems with lodging and damage from exposure to sun and birds. It is important to select a variety with a uniform head cutting height. Uniformity of stalk diameter, head width, and head length also makes it easier to adjust and calibrate automated harvesting equipment. Varieties with fewer side shoots, no or only small leaves below the head, and a lower canopy densities are also preferred for automated harvesting.

In the meantime, as machines are being developed, using better-adapted varieties and maximizing planting densities to improve uniformity can also help growers increase the efficiency of manual harvest and save on labor costs.

Sources:

For additional agronomic information, please contact your local seed representative.

Performance may vary from location to location and from year to year, as local growing, soil and weather conditions may vary. Growers should evaluate data from multiple locations and years whenever possible and should consider the impacts of these conditions on the grower’s fields. The recommendations in this article are based upon information obtained from the cited sources and should be used as a quick reference for information about broccoli production. The content of this article should not be substituted for the professional opinion of a producer, grower, agronomist, pathologist and similar professional dealing with this specific crop.

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