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EDAMAME

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Edamame

About Edamame

Edamame (pronounced "eh-dah-MAH-may") is a specialty vegetable soybean that originated in China more than 2000 years ago. Today it is known as a traditional Japanese vegetable (Jian 1984). Edamame is a Japanese word which translates to English as "branched bean". In Chinese, this vegetable is called *mao dou* and its English translation is "hairy bean". In the U.S., this crop is most commonly referred to as edamame but is sometimes called vegetable soybean or sweet bean.

In the U.S., edamame is sold as either whole pods or shelled beans. Only edamame beans are eaten and the pods are discarded. Shelled edamame can substitute for green peas or lima beans in any recipe. In China, shelled edamame beans are stir-fried with other ingredients. In Japan, pods are boiled in salted water, beans are squeezed directly from the pod into the mouth, and the pods are discarded (Konovsky et al. 1994).

In addition to having a sweet, nutty flavor, smooth texture, and good digestibility, edamame are also nutritious (Rackis 1978). Edamame contains about 38% protein. One-half cup serving contributes 11 grams of protein towards the average daily adult requirement of 46–56 grams (USDA 2005; Alleman et al. 1999). Edamame is also rich in calcium, vitamin A, and phytoestrogens (plant-produced estrogens).

Botanically, edamame is the same species as grain or field soybean (*Glycine max* (L.) Merrill). However, edamame has traditionally been selected for its large seed size, sweet flavor, and high levels of digestibility over field soybean.

Like other legumes, edamame can fix nitrogen (N) to meet its N fertility needs. In addition, there can be residual nitrogen left in residues after harvest. Thus, edamame can offset nitrogen fertility needs of the following crop, thereby improving the economy of cropping systems. The purpose of this publication is to describe how to grow, market, and use edamame.

Growing Edamame

Edamame plants grow to a similar size as bush green bean plants (Figure 1) and are easy to grow in the Pacific Northwest. Choosing the right cultivar and paying particular attention to planting needs are the keys to success with this crop.

Figure 1. Edamame plants in the field ready for harvest. (Photo: C. Miles)

Cultivar Selection

One of the most critical steps to success in growing edamame is choosing a cultivar that will mature in your area. Another consideration is the cost of edamame seed. Seed costs range from $10–$40 per half pound, depending on the cultivar and source.

Maturation Date

All edamame, except the earliest maturing cultivars, are considered "short-day" plants (Shanmugasundaram 1981). The terms "short-day" and "long-day" refer to photoperiod, or the daily amount of light and darkness. Short-day plants switch from plant growth to flower production when nights are long. Cultivars that do not flower by mid-July may not produce pods before the end of the growing season. Since the Pacific Northwest has long summer days and short nights, combined with relatively cool summer temperatures, growers here must choose a cultivar that is less sensitive to photoperiod and matures early.

Like all soybeans, edamame is ranked in maturity groups, from 000 to X. The 000 group has the earliest maturation, and cultivars in the X group mature the latest (Williams et al. 2012; Weibold 2014). Growers in the Pacific Northwest should choose cultivars in the 000–3 maturity groups. While cultivars in these early maturity groups will be listed as maturing in 70–90 days, in the Pacific Northwest, they will take 100–120 days to mature. Refer to Table 1 for a list of varieties that have been tested in Washington state. Compare days to maturity in this table to the number of days provided by seed catalog as a guide to determine the number of days to maturity for other varieties.

Table 1. Days to vegetable maturity of edamame cultivars tested in Vancouver, Chehalis, and Prosser, in Washington state.

Cultivar	Vancouver	Chehalis	Prosser
Beer Friend	102		
Buker's Favorite	140	110	
Butterbeans (Green)	108	112	103
Early Hachuko	115		
Envy (Green)	102		
Fiskby	89		
Gion	118	118	
Haruno-Mai	102		
Kegon	139	115	
Kitanosuzu	110		
Lucky Lion	114	112	
Mana/Mama	117		
Mikawahima 202	137		
Miki	107		
Misono Green	110	110	105
Osodefuri 200	117		
Sapporo Midori	107		
Sayakomachi	112		
Sayamusume	110	110	103
Shirofumi	112		
Shironomai	112	113	107
Soya #203	106		
Tokita 214	104		
White Lion	109	110	
Yukimusume	110		

Pod Characteristics

Cultivars differ in several ways: seed color, seed size, pod color, and amount of fine hairs, called pubescence. For U.S. customers, pubescence, color, and the number of beans per pod are generally not issues since they do not affect bean quality. However, if you want to market edamame to Asian customers, choose a cultivar with: large, light-colored beans; bright green pods with gray or light brown pubescence; and three beans per pod. Another market exists for dark-seeded edamame, which are used as a dry bean during the New Year in Japan. If there are Asian food stores in your area, consider growing a dark-seeded edamame cultivar for this niche market.

Rotational Considerations

Avoid planting edamame following other legume crops (e.g., peas and beans), to avoid diseases shared by plants within the same family. Also, avoid fields with histories of soil-borne pathogens with wide host ranges, such as Sclerotinia, which causes white mold in soybeans and many other vegetable crops.

Edamame is a warm season annual crop. Avoid planting it in fields with a history of high levels of warm season annual weeds. Pigweed (*Amaranthus* species) for instance, will be more competitive than edamame mid-summer when weather becomes markedly hot and dry. Mechanical cultivation between edamame rows mid-season (before the canopy closes) can provide adequate weed control, but weeds in the row must be hand weeded or sprayed.

For efficient nutrient use, plant edamame after crops that are heavy nitrogen feeders as these crops will leave relatively low levels of residual nitrogen in the soil. Planting edamame after crops that leave large amounts of residual nitrogen in the soil can detract from the benefit of edamame being able to fix nitrogen. Approximately 45%–50% of the total nitrogen in an edamame crop is contained in the beans and pods of the plant at harvest. Therefore, from a typical, well-yielding crop, approximately 50–90 lb of nitrogen may be returned to the soils from edamame leaves and stems. If the entire plant is harvested for sale though, only 10–30 lb of nitrogen will remain in root residues.

Soil Testing and Fertilizer Applications

In the early fall of the year preceding edamame planting, or in the spring prior to planting, conduct a soil test to determine lime and fertilizer requirements.

Table 2. Lime application rates according to Oregon State University soil pH SMP buffer test results (Anderson et al. 2013).

SMP Buffer Test Result	Lime Application (ton/acre)
Below 5.2	4–5
5.2–5.6	3–4
5.6–5.9	2–3
5.9–6.2	1–2
Over 6.2	None

See the Additional Resources section for a description of soil testing and soil nutrition in detail, as well as how to interpret soil test results. The following is a guide to soil nutrition management for edamame.

Soil pH

Edamame can grow in most Pacific Northwest soils. The optimum soil pH for edamame is 6.0–6.5. If soil test results indicate there is a need to raise the pH, apply agricultural lime at the suggested rate. Most soil-testing laboratories will recommend lime application rates based on a soil “SMP buffer test” (Anderson et al. 2013; Horneck et al. 2011). If a specific lime application rate is not provided, Table 2 lists guidelines for lime applications based on general soil pH SMP buffer test results.

Apply any necessary lime in the fall. In order for agricultural lime to be effective, it must fully react with the soil, a process that takes many months and lots of water. Soybeans grown on high pH soils have been known to develop iron chlorosis; this may be a consideration for edamame in the inland PNW where soil pH is commonly higher than in maritime PNW areas.

Phosphorus and Potassium

In the spring, several weeks prior to planting, conduct another soil test to determine the phosphorus and potassium content of your soil. Apply phosphorus and potassium at the recommended rates based on these soil test results, found in Table 3. Apply fertilizer at planting, in a band, next to the seed row. Band the fertilizer approximately 2 in. to the side of the seed row, and 2 in. deep.

Table 3. Phosphorus (P) and potassium (K) application rates based on soil test results (Anderson et al. 2013).

Soil Test P (ppm)	Phosphate Application (lb/acre of P_2O_5)	Soil Test K (ppm)	Potassium Application (lb/acre of K_2O)
0–15	120–150	0–75	90–120
16–60	90–120	76–150	60–90
60–100	90–60	151–200	40–60
>100	0	>200	None

Nitrogen and Seed Inoculation

Edamame form nodules on their roots that house rhizobia, a type of bacteria commonly found in soils. Bacteria within the nodules fix nitrogen from the atmosphere in exchange for carbon from the plant. Specific species of rhizobia fix nitrogen (‘N-fixation’) for specific species of legumes and are needed in sufficient numbers to assure strong N-fixation. The species *Bradyrhizobium japonicum* is needed for N-fixation in soybeans. If your field has never before been planted with edamame, or any type of soybean, purchase *Bradyrhizobium japonicum* soybean inoculant through companies that offer soybean seed. Be aware that inoculant for soybeans is not the same as bean, clover, or pea inoculant.

Inoculating edamame seed is the most economical method of meeting the crop’s nitrogen needs. In terms of giving inoculated edamame additional nitrogen, experiments in Oregon suggest that inoculated edamame response to supplemental N is variable and does not reliably boost harvestable yield (Shober and Taylor 2014; McGrath et al. 2013). It may also detract from N-fixation and delay flowering. Applying up to 50 lb of nitrogen per acre to inoculated edamame *may* only boost yield in *some* instances, such as if: (1) soil nitrogen levels at planting are negligible, (2) soil health is poor (low inherent fertility), or, (3) if yield potential is exceptionally high.

If the seed is ***not*** inoculated, 100–120 lb per acre of supplemental nitrogen will be needed. In this case, only apply 25 lb of nitrogen at planting, along with phosphorus and potassium. Apply remaining nitrogen in a band, 4 in. to the side of the crop row and 2 in. deep, during the growing season, about 6 weeks after planting.

If using manure or compost, broadcast it 2 to 4 weeks before planting. Thoroughly incorporate the manure or compost into the soil during final field preparation. See Additional Resources for a detailed description of manure application.

Planting

Seedbed Preparation

Edamame seeds are sensitive to mechanical damage that occurs during handling and planting. Handle seed very gently when placing in a seed hopper (Figure 2) to avoid breaking the seed skin, which decreases germination. Although edamame seeds are large, they tend to be temperature and moisture sensitive. They will not emerge well or grow uniformly when field conditions are unsuitably cold or wet (Figure 2). To avoid these problems, plow and harrow soil prior to planting to ensure a smooth, level seed bed. Otherwise, low spots will flood and seed will not emerge in those areas. Although there is an increasing understanding of no-till soybean production systems, there is no information specifically on edamame emergence and establishment in no-till scenarios. Growers should test this planting system using small plots before planting an entire field.

Figure 2. Edamame seed in a seed hopper at planting (left); poor edamame stand in a field where soil temperatures were low and soil was too wet at planting (right). (Photo: C. Miles)

Timing

In the Pacific Northwest, growers should plant between late April and mid-June, when soil temperature is at least 55^{o}F. To ensure good emergence, plant on well-drained soils as they warm up faster, and they are less likely to have soil-borne diseases. For information regarding soil type, refer to the NRCS soil survey for your area (USDA NRCS 2015).

Soil Moisture

Plant seed into moist soil. Edamame is large-seeded and needs enough moisture to saturate the seed for germination. If the soil is too dry, irrigate prior to planting. Irrigating after planting can cause a crust to form on the surface of the soil, which can prevent emergence (Mansour 1998 pers. comm.). If a crust forms, apply irrigation for short periods to weaken the crust. Do this just until the soil begins to crack.

Seeding Rate and Planting Depth

One pound of edamame seed contains 1200–1600 seeds. Space rows approximately 30 in. apart, however spacing can vary plus or minus 6 in. based on available planting and cultivating equipment. Plant seeds 2–4 in. apart within the row. In this case, plant populations should be equivalent to 52,000–70,000 plants per acre. This seeding rate is equivalent to 40–60 lb per acre. Planting depth should be no deeper than 0.25–0.5 in.; edamame seedlings are not strong, and any greater depth will reduce emergence. In sandy soils, seeding should be at the deeper end of the recommended depth spectrum. Plants should emerge 1–2 weeks after planting.

Irrigation Rate

Growing edamame in the Pacific Northwest requires irrigation. West of the Cascade Mountains, seasonal precipitation during the growing season (late May to the end of September) is 2–6 in., whereas in the inland Pacific Northwest, rainfall during this time may be negligible. Knowing crop evapotranspiration (ET) rates can be helpful for irrigation management. ET is a measure of soil water lost to surface evaporation + crop use. Real-time, location-specific, daily soybean ET rates and online irrigation scheduling apps can be accessed via www.weather.wsu.edu. Maximum edamame ET west of the Cascades is likely to approximate 13–16.5 in., while east of the cascades ET may be as high as 23–25 in. (Bennett et al. 1999, Rogers 2016, Norberg et al. 2010). Besides germination and emergence, the most critical period for water availability is flowering through pod fill (R1–R6), when ET rates may be 0.1–0.3 in. per day.

For a simplified Edamame irrigation schedule, locations west of the Cascades will need up to 0.75–1 in. of water per week from emergence through harvest; for locations in the Inland Northwest, up to 1–1.5 in. of water per week will be needed.

For a more targeted irrigation schedule, apply proportionally less water during the crop's early vegetative development stage (V1–R1). Further, apply more water during periods of crop growth that have the highest water demands: flowering (R1–R3), followed by the pod fill stage (R3–R6). Soil moisture measurements can also be used for targeting irrigation. Based on experiments in eastern Oregon, irrigation should be applied to inland PNW fields when the soil-water tension at an 8-inch depth reaches 60 centibars (cb) (Norberg et al. 2010). In these areas, maintain 65%–70% available water in the soil. West of the Cascades, 50% available water in the soil should be adequate. Adjust irrigation rates as needed, based on crop response; Irrigation intervals more frequent than every 3–5 days can increase risk of disease.

Weed Control

Previously applied herbicides can affect soybeans if rotation restrictions are not carefully followed. Be sure to check herbicide product labels for pre-harvest intervals as well; field soybean usually has a longer interval than edamame.

Control early-season weeds to prevent crop competition. At least two weedings are usually necessary. Mechanical cultivation between rows (Figure 3), and hand cultivation in the row, are efficient weed control methods. See Peachey et al. (2017) for current herbicide recommendations. As the season progresses and the plant canopy closes in, the need for weed control will drop.

Figure 3. Tractor cultivating between rows of edamame; in-row weed control is done by hand. (Photo: C. Miles)

Insect, Disease and Animal Control

Several insect pests attack edamame, including wireworms, cucumber beetles, and two-spotted spider mites. Slugs can also be problematic. For a complete list of insect pests (including slugs) that affect edamame, and management recommendations, see Hollingsworth (2017). For a list of disease pests and management recommendations, see Pscheidt and Ocamb (2017).

Birds can cause extensive damage to young plants. Both elk and deer can be devastating to mature plants. Contact the agency charged with managing wildlife in your state for specific information on animal control.

Harvesting

Timing

Harvest edamame when the pods are plump and the beans almost touch within the pod (soybean growth stage R6, shown in Figure 4). Pods grown for traditional markets should be bright green in color, similar to snow peas. By the time pods show any yellow, the optimum time for harvest has passed and beans have become starchy, losing their sweet, nutty flavor. The window for harvesting can be as short as 3–4 days, so monitor the plants frequently as the pods approach maturity. Determine when the majority of pods are mature, then harvest the entire plant.

Figure 4. Edamame is ready to harvest when pods are plump and the beans almost touch within the pod. (Photo: C. Miles)

Method

Most small-scale growers harvest edamame by hand, however, mechanical harvesting can be done. Edamame cultivars best suited for mechanical harvest have a compact growth habit, with pods that are concentrated on the main stem 6–12 in. above the soil surface, and that mature all at the same time (Figure 5). Green bean harvesters can be used with some mechanical adjustments (Figures 6 and 7). About 15% of pods may remain in the field after mechanical harvest and some crop debris will be harvested along with the pods (Figures 6 and 7).

If hand harvesting, clip the plant at the soil surface. Then, either sell the whole plant, minus most leaves, with pods still attached to the stem, or remove individual pods from plants. To remove pods from the plant, give the pods a firm tug; they do not come off easily. A stationary pod stripper can be used to this end. For cost calculations, one person can hand harvest whole plants at roughly 50–60 row-feet per hour (Culbertson 1999 pers. comm.).

Figure 5. Edamame plants suitable for mechanical harvest tend to have a more compact growth habit, pods are concentrated on the main stem 6–12 in. above the soil surface, and pods mature all at the same time. (Photo by Alec McErlich)

Figure 6. Mechanical harvest of edamame with a single-row green bean harvester (left); pods and crop debris that result from mechanical harvest (right).

Figure 7. Mechanical harvest of edamame with a multi-row green bean combine (left); plants with some pods remaining after mechanical harvest (right). (Photo: C. Miles)

Yield

Expected yield is one pound of marketable pods per 3 row-feet, or about 5,000–6,000 lb per acre. To maintain freshness and flavor, pre-cool harvested edamame down to temperatures between 32–37^{o}F (Tsay and Sheu 1991). Air-cooling, vacuum-cooling, and using ice water are three effective pre-cooling methods. Store edamame at 32^{o}F and 95% relative humidity to maintain green pod color, flavor, and weight (Chiba 1991). In proper storage, edamame will retain its flavor and appearance for up to 2 weeks.

Marketing

In deciding how to sell your edamame, consider your customer and the labor involved.

By the Bunch

Traditionally, edamame are sold as a whole plant, with the pods attached to the stem. Keeping pods on the stem maintains freshness, flavor, and quality; beans retain sugars for several days, and quality remains high (Konovsky et al. 1994). Selling the whole plant requires the least amount of time and labor. Bunch 4–6 plants together and remove the leaves from the tops of the plants, exposing the pods.

By the Pod

All undamaged pods are marketable, however, pods with 3–4 beans are generally preferred. Quality and flavor of the beans are not influenced by the number of beans per pod.

By the Bean

Customers may not want to take time to pick pods, shell beans, or dispose of crop residue. Marketing shelled edamame may be a good option. Shelling edamame is easy with the right equipment. Both small- and large-scale commercial equipment is available to easily separate beans from pods.

In the U.S., shelling equipment used for black-eyed peas works well for edamame. Equipment from Japan is also available. Shelling by hand can be labor intensive. In small-scale operations, it is easiest to shell edamame once pods are first cooked for 3–5 minutes in boiling water (Figure 8). When shelling uncooked edamame beans by hand, the pericarp (inner skin of the pod), which is not desirable, tends to cling to the bean (Figure 8).

Figure 8. Cook edamame pods approximately 5 minutes in boiling water (left). If you shell uncooked edamame beans by hand, the pod pericarp (inner skin of the pod) can cling to the beans, which is undesirable (right).

Additional Resources

Fertilizing with Manure and Other Organic Amendments (Bary et al. 2016).

Soil Testing: A Guide for Farms with Diverse Vegetable Crops (Collins 2012).

Soil Test Interpretation Guide (Horneck et al. 2011).

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