

### **Edamame Variety Trial**

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We have been conducting edamame variety trials in southwest Washington since 1995. Some varieties of edamame are very productive in western Washington while other varieties are not productive. The keys to successful production include planting early maturing varieties, using fresh and healthy seed, and adequate fertilizer and irrigation. Edamame, like all soybeans, are photosensitive and thus flower in response to day length. Varieties that are very photosensitive will not flower at northern latitudes until August and will not mature prior to fall rains or freezing temperatures. Varieties that are less photosensitive will flower in mid-July at northern latitudes and will likely reach maturity in our region. Additionally, edamame are heat-loving plants and not all varieties are well suited to the relatively cool growing season of the Pacific Northwest. In our research trials in western Washington, the varieties that reached maturity and were the most productive are better suited to our cool northern climate.

Each year we obtain new seed from companies to plant in our trial, yet a consistent problem we have found over the course of our studies is poor plant emergence in the field. Emergence has varied dramatically for varieties from year to year and the problem has not been confined to any one variety. Edamame seed does not appear to store well beyond one year, fresh seed may be essential for good emergence and plant establishment, and soil crusting should be avoided as it hinders emergence. Furthermore, seed crop management and seed storage environment likely affect seed quality. Based on our results gained through seven years of edamame variety trials, we recommend that growers evaluate a variety and a seed source based on consistency of seed germination, seed emergence, and plant stand as well as yield potential.

### **Materials and Methods**

In our trial in 2002, we included 13 previously tested varieties, 15 new varieties, and 10 breeding lines from the Asian Vegetable Research and Development Center (AVRDC), Taiwan (Table 1). The trial was planted at WSU Vancouver Research and Extension Unit (REU) and had a randomized complete block design with four replications. The field was prepared in mid-May and edamame varieties and breeding lines were planted on May 28. Variety plots were 2 rows wide and 10 feet long, and breeding line plots were 4 rows wide and 10 feet long. Spacing between rows in both trials was 2 feet, and seeds were spaced 2 inches apart in the row.

The field was certified organic and was maintained accordingly. Plots were weeded as needed from June through August. Mechanical cultivation was used to control weeds between rows and hand weeding was used to control in-row weeds. Overhead irrigation was applied once a week as needed. Number of days for emergence, first flowering, and 50% flowering were noted. Plant stand was measured in 10 feet of row on July 18. Plant height was measured on August 7 from 10 randomly selected plants in each plot. Plant height was measured from the base of the plant (soil surface) to the top node. Plants were harvested from the center 5 feet of two rows, for a total harvest area of 10 feet per plot. Pods were hand picked, sorted into categories (2-3 beans-per-pod; 1 bean-per-pod; and unmarketable), and weighed. 100 pods from the 2-3 beans-per-pod category were weighed, 25 pods were randomly selected, shelled, and the number of their beans were measured. The weight of 25 beans was also measured.

## Results and Discussion

All varieties except Gion, Popper and XAFO 6201-326 emerged in this study (Table 2). All other varieties except Buker's Favorite (16), Kenko (15), and Beer Friend (14.5) emerged 10 – 13 days after planting (DAP), and overall mean DAP for emergence was 11.8. Number of DAP till first flowering varied significantly among varieties and ranged from 50 to 78 days. Beer Friend was the earliest to flower (49.3) and Hiluhilu was the latest (77.5). Except for 9 varieties, all varieties reached 50% flowering in 51.3 to 58.5 DAP. Varieties that reached 50% flower later than 64 DAP did not mature in this study and Midori Giant did not flower at all.

Haruno-mai, Envy, Beer Friend, and Sapporo Midori were early maturing in this trial (102-103 DAP), and IA-1010, IA-1011, and IA-2040 LF matured late (127 DAP). Bellesoy, Buker's Favorite, Green Lion, Hiluhilu, Kanaloha, Koapaka, and Sayanishiki failed to reach maturity by the end of September. Kenko and Lucky Lion reached maturity in this study, but plant stand for these 2 varieties was so poor that we did not collect maturity or yield data. We planted 80 seeds per 10-feet of row and overall mean plant stand was 64.9. Envy, IA-1010, Kitanosuzu, Sapporo Midori and Sayamusume had approximately 100% emergence (Table 3). Overall mean plant height at harvest was 63.7 cm (25 in), and IA-1010 was the tallest variety in the study (106.65 cm, 42 in) and Envy was the shortest (55.73 cm, 22 in).

In our studies we evaluated pods that contain 2-3 beans and pods that contain single beans. Consumers who are accustomed to edamame generally prefer pods that contain 2-3 beans per pod. However, we anticipate a growing market for shelled edamame, thus pods that contain 1 bean would also be considered marketable. IA-1010 had the highest yield of 2-3-bean-pods per 10 feet of row (2216.56 g, 4.9 lb), and eight varieties had total marketable yields greater than 2000 g (4.4 lb) (Table 3). Butterbean had the highest unmarketable pod weight (288.45 g, 0.63 lb).

100 pods were randomly selected and weighed from the 2-3 beans per pod category. Mean weight of 100 pods for all varieties was 292.3 g (0.64 lb), and Mana had the greatest 100-pod weight (407 g, 0.9 lb) as well as the greatest weight of 25 beans (42.5 g, 0.1 lb) (Table 4). Envy had the lowest 100 pod weight (212.1 g, 0.5 lb) and the second lowest weight of 25 beans (26.6 g, 0.06 lb). Varieties that produced the largest beans were Mana, Yukimusume, Haruno-mai, Misono green, Sayakomachi, Beer Friend and Sapporo Midori.

Table 5 summarizes the yield (g) of pods with 2-3 beans per 10 feet of row for all edamame varieties included in our trials from 1995 to 2002. Of the varieties that have been tested for two or more years, Misono Green (1429 g, 3.14 lb) and Sayakomachi (1368 g, 3 lb) produced the greatest yield. All the varieties in 2002 yielded greater than in previous years, and yield in 1999 was extremely low for all varieties due to a shortage of irrigation in the study area. Since 1998, disease-like symptoms have been observed in edamame grown in our studies. In 2002, Misono Green, Envy, Bellesoy, Green Lion, Kanaloha, Koapaka, and the breeding line AGS-346 were all found to be affected by a poty virus.

In October 2002, a panel of 14 members of the general public evaluated the flavor of eight edamame varieties. The varieties had been blanched and frozen immediately after harvest, and for the taste test, frozen whole pods were added to boiling water, cooked for 1 minute and served

warm in the pod. Sayakomachi, Sapporo Midori and Kitano-suzu were all rated the highest in terms of overall flavor while IA 1010 and Misono Green were rated the lowest (Table 6).

### **Breeding Lines**

All breeding lines were late to commence flowering in this study, and the earliest line reached 50% flowering at 76.5 DAP compared to a mean of 61 DAP for the varieties in neighboring plots (Table 7). Only the breeding line AGS 292 reached maturity and was harvested in the third week of September (115 DAP). Plant height at harvest was 65.8 cm (25.9 in), plant stand was 31 in 10 feet of row, and yield of 2-3 bean-pods was 710 g (1.6 lb) (Table 8). Pods of AGS 292 had light green color pods (color score 2) at harvest. One hundred beans of AGS 292 were dried till they reached a constant weight and were found to have 67% moisture. A 500 g sample of 2-3 bean-pods contained 122 pods and weight of 100 beans was 75.5 g (0.17 lb) (Table 9).

**Table 1.** Twenty-eight edamame varieties planted at WSU Vancouver REU in 2002 and the companies that supplied seed.

<b><u>Entry No.</u></b>	<b><u>Variety</u></b>	<b><u>Seed Company</u></b>
1	Beer Friend	Territorial
2	Bellesoy	Wannamaker Seeds
3	Buker's Favorite	Nichols
4	Butterbeans (Green)	Johnny's
5	Envy (Green)	Johnny's
6	Gion	American Takii
7	Green Lion	Wannamaker Seeds
8	Haruno-Mai	Snow Brand
9	Hiluhilu	H&L Ag Products
10	IA-1010	Iowa State University
11	IA-1011	Iowa State University
12	IA-2040 LF	Iowa State University
13	Kanaloa	H&L Ag Products
14	Kenko	Seedex, Inc
15	Kitanosuzu	Snow Brand
16	Koapaka	H&L Ag Products
17	Lucky Lion	American Takii
18	Mana	H&L Ag Products
19	Midori Giant	Wannamaker Seeds
20	Miki	H&L Ag Products
21	Misono Green	Snow Brand
22	Popper	
23	Sapporo Midori	Snow Brand
24	Sayakomachi	Snow Brand
25	Sayamusume	Snow Brand
26	Sayanishiki	Snow Brand
27	XAFO62401-326	H&L Ag Products
28	Yukimusume	Snow Brand

**Table 2.** Days after planting (DAP) for emergence, first flowering, 50% flowering, and number of days from 50% flowering to harvest of edamame varieties at WSU Vancouver REU in 2002.

<b>Variety</b>	<b>Emergence</b>	<b>1<sup>st</sup> Flower</b>	<b>50% Flower</b>	<b>Harvest</b>	<b>Days from 50% Fl. to Harvest</b>
Haruno-mai	12.8	49.8	51.3	101.8	50.6
Envy (Green)	10.0	52.0	54.3	101.9	47.7
Beer Friend	14.5	49.3	51.3	102.4	51.2
Sapporo Midori	11.5	50.8	53.0	102.8	49.8
Miki	12.5	56.5	58.5	105.0	46.5
Kitanosuzu	11.3	51.3	53.3	107.5	54.3
Sayamusume	12.8	51.0	53.3	107.6	54.3
Butterbeans	11.0	54.8	56.5	108.0	51.5
Misono green	11.0	51.5	53.5	108.5	55.0
Yukimusume	11.8	51.5	54.8	109.8	55.1
Sayakomachi	12.0	51.0	52.8	111.9	59.2
Mana	12.5	54.0	56.5	116.5	60.0
IA-1010	11.0	58.3	60.3	127.0	66.8
IA-1011	11.5	59.0	63.5	127.0	63.5
IA-2040 LF	10.8	55.8	57.8	127.0	69.3
Kenko	15.0	54.0	55.3	n/a <sup>1</sup>	
Lucky Lion	12.0	54.0	55.5	n/a	
Bellesoy	11.3	66.0	67.5		
Buker's Favorite	16.0	66.5	69.0		
Sayanishiki	10.5	69.0	71.3		
Koapaka	12.0	73.0	75.5		
Kanaloa	12.5	70.0	76.0		
Green Lion	11.3	75.8	79.0		
Hiluhilu	11.0	77.5	80.0		
Midori Giant	11.3				
Gion	No emergence				
Popper	No emergence				
XAFO62401-326	No emergence				
<b>Mean</b>	<b>11.8</b>	<b>58.0</b>	<b>61.0</b>	<b>111.0</b>	<b>56.0</b>
<b>P Value</b>	0.0000	0.0000	0.0000	0.0000	

<sup>1</sup> Plant stand was insufficient for data collection.

Blank cells indicate varieties did not mature.

**Table 3.** Number of plants in 10-foot row of varieties that reached maturity, average plant height (cm), weight (g) of 2-3 bean pods, weight of 1 bean pods, total marketable yield, and weight of unmarketable pods (g) at WSU Vancouver REU in 2002.

<b>Variety</b>	<b>Plant Stand</b>	<b>Plant Height (cm)</b>	<b>Wt of 2-3 Bean/pod (g)</b>	<b>Wt of 1 Bean/pod (g)</b>	<b>Total Market Yld (g)</b>	<b>UM Pods (g)</b>
Beer Friend	45.0	62.3	1106.0	198.7	1304.7	49.7
Butterbeans	58.8	58.4	1156.2	473.8	1630.0	288.5
Envy (Green)	77.8	55.7	1389.0	650.9	2039.9	148.3
Haruno-mai	50.5	61.0	1447.5	273.8	1721.3	119.8
IA-1010	77.3	106.7	2216.6	670.1	2886.7	193.6
IA-1011	56.8	93.6	1774.9	285.7	2060.6	179.5
IA-2040 LF	74.3	103.8	1286.7	501.6	1788.3	258.2
Kitanosuzu	78.5	60.0	1535.0	483.0	2018.0	220.5
Mana	47.0	97.5	1378.8	716.3	2095.1	208.3
Miki	48.0	57.5	708.0	235.0	943.0	129.0
Misono Green	68.6	60.2	1456.9	519.2	1976.1	143.4
Sapporo Midori	77.0	65.4	1342.8	392.3	1735.0	115.2
Sayakomachi	64.0	59.1	1945.5	524.4	2469.9	180.1
Sayamusume	78.0	67.2	1706.1	438.3	2144.3	232.4
Yukimusume	72.5	70.2	1385.2	711.8	2097.0	166.0
<b>Mean</b>	<b>64.9</b>	<b>71.9</b>	<b>1455.7</b>	<b>471.6</b>	<b>1927.3</b>	<b>175.5</b>
<b>P Value</b>	0.0126	0.0000	0.0242	0.0005	0.0000	0.0000

**Table 4.** Weight (g) of 100 pods and 25 beans, and number of beans from 25 pods at WSU Vancouver REU in 2002.

<b>Variety</b>	<b>100 Pod Wt (g)</b>	<b>Wt of 25 Beans (g)</b>	<b>No. of Beans of 25 Pods</b>
Beer Friend	263.0	37.3	59.0
Butterbeans	291.7	28.0	57.5
Envy (Green)	212.1	26.6	58.5
Haruno-mai	297.5	40.0	60.3
IA-1010	252.6	33.9	59.0
IA-1011	248.5	24.0	60.8
IA-2040 LF	243.6	30.0	55.8
Kitanosuzu	292.0	31.7	62.3
Mana	407.5	42.5	54.0
Miki	271.0	27.7	59.0
Misono Green	290.8	39.6	57.0
Sapporo Midori	285.0	35.5	59.5
Sayakomachi	333.3	39.3	54.0
Sayamusume	348.1	38.9	59.8
Yukimusume	347.1	40.6	54.3
<b>Mean</b>	<b>292.3</b>	<b>34.4</b>	<b>58.0</b>
<b>P Value</b>	0.0000	0.0389	0.5111

**Table 5.** Marketable yield (g) from 10-foot row of edamame varieties included in WSU variety trials in southwest Washington from 1995 to 2002; overall average for each variety; and overall mean each year.

<b>Variety</b>	<b>Marketable pod yield (g/10 row ft)</b>								<b>Average</b>
	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	
Beer Friend								1106	1106
Buker's Favorite				2079			1687		1883
Butterbeans	663	770	617	1649	327	501	1088	1156	846
Early Hakucho	495	120	468						361
Envy	332		379			478	755	1389	667
Fiskby	631	61							346
Gion	687	321	735		198	753	190		481
Haruno-Mai/SB 1002					90	341	603	1447	620
IA-1010								2217	2217
IA-1011								1775	1775
IA-2040 LF								1287	1287
JSMO 168		663							663
JSY 1004		884							884
JYKO 189		536							536
Kegon			1382	1270			846		1166
Kenko (SE-4)					95	778			437
Kitanosuzu					226	923	1285	1535	992
Lucky Lion	614	736	593	450	183	625	570		539
Mana								1379	1379
Mikawahima 202			321						321
Miki								708	708
Misono Green				1602			1228	1457	1429
Osodefuri 200		472							472
Sapporo Midori		408	397		138	431	446	1343	527
Sayakomachi							791	1945	1368
Sayamusume	699			1945	202	852	591	1706	999
Shirofumi	220		586				649		485
Shironomai	743	728	931			835	480		743
Soya # 203			360						360
Tokita 214		22							22
White Lion	810	731	585		212	324	644		551
Yukimusume					154	529	742	1385	703
<b>Mean</b>	<b>589</b>	<b>496</b>	<b>613</b>	<b>1499</b>	<b>183</b>	<b>614</b>	<b>787</b>	<b>1380</b>	<b>745</b>

**Table 6.** Taste evaluation where 1 is poor and 5 is excellent of eight varieties of edamame conducted by a panel of 14 general public tasters in October 2002.

<b>Varieties</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>Avg</b>
Sayakomachi	1	4	3	3	4	4	4	4	4	3	5	3	4	4	3.6
Sayamusume	4	4	3	2	1	2	3	3	4	2	4	2	5	5	3.1
Sapporo Midori	5	3	4	3	1	4	2	4	4	2	5	3	4	4	3.4
IA 1010	1	2	2	3	1	1	2	3	4	2	3	2	2	4	2.3
Misono Green	2	3	2	3	1	3	0	2	3	2	3	4	3	2	2.4
Kitanosuzu	3	5	4	4	2	3	3	4	3	3	2	4	3	0	3.1
IA 1011	0	3	2	5	2	1	5	2	4	1	3	4	2	3	2.6
Butterbean	3	4	3	4	1	1	4	5	3	2	3	3	1	2	2.8
<b>Average</b>	<b>2</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>2</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>2</b>	<b>4</b>	<b>3</b>	<b>3</b>	<b>3</b>	

**Table 7.** Average DAP for first flowering, 50% flowering and harvest of edamame breeding lines at WSU Vancouver REU in 2002.

<b>Lines</b>	<b>1st flower</b>	<b>50% flower</b>	<b>Harvest</b>
AGS 364	74.0	76.5	
AGS 378	77.5	80.5	
AGS 381	93.0	99.0	
AGS 292	94.5	100.0	115
AGS 379	100.5	103.0	
AGS 362	101.0	104.5	
AGS 380	102.5	105.5	
AGS 360	106.0	108.5	
AGS 346	107.0	109.0	
AGS 377	109.0	112.5	
<b>Mean</b>	<b>96.5</b>	<b>99.5</b>	

**Table 8.** Length and width of 2-bean/pods, plant stand, and yield of harvested breeding line at WSU Vancouver REU in 2002.

<b>Line</b>	<b>2 Bean/Pod (cm)</b>		<b>Plant Stand at Harvest</b>	<b>Yield (kg)</b>		
	<b>Length</b>	<b>Width</b>		<b>Total Pod Wt*</b>	<b>&gt; 2 Beans</b>	<b>Total M Wt**</b>
AGS 292	6.5	1.4	31	1.4	0.63	1.26

\* Weight of 1bean pod + 2-3 bean pod + unmarketable pods

\*\* Total pod weight - weight of unmarketable pods

**Table 9.** Moisture content, number of pods with 2 or more beans in 500g, weight of 100 beans from pods with 2 or more beans, and pod color score of harvested breeding lines at WSU Vancouver REU in 2002.

<u>Line</u>	<u>% Moisture Content</u>	<u>No of Pods Per 500 g</u>	<u>100 Bean Weight (g)</u>	<u>Pod Color Score<sup>1</sup></u>
AGS 292	66.5	122	75	2

<sup>1</sup> 1= Dark green, 2= Green, 3=Yellow-green, and 4=Yellow