

**Influence of number of days from planting to harvest on growth, development, stage of maturity and nutritional value of three vegetable soybean cultivars in Zimbabwe**

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**Abstract**

A study was carried out in the 2008/09 season at Rattray Arnold Research Station in Zimbabwe, to determine the optimum days to harvest for three vegetable soybean varieties, SC Edamame 1, Santa, and Siesta. The experimental design was a randomised complete block design with three replicates. Harvesting was done at the recommended R6 stage of maturity for fresh pods and R8 stage for dry seed. There were significant differences ( $P < 0.05$ ) among cultivars in the number of days after planting to harvest. The only cultivar with acceptable seed and pod dimensions for use as vegetable soybean was SC Edamame 1. There were significant differences ( $P < 0.05$ ) for plant height and above ground biomass. All three cultivars were found to be well adapted to the environment at Rattray Arnold Research Station. The cultivar, SC Edamame 1 matured earlier in 70 days from planting. There were significant differences among cultivars ( $p < 0.05$ ) for seed crude protein and oil contents at maturity stage R6. There were significant differences in 100 seed weight among cultivars ( $P < 0.005$ ) at both the R6 and R8 stages. Cultivar effect for both pod length and width were also significant ( $P < 0.05$ ). Only one cultivar, Edamame 1, had acceptable pod dimensions for use as a vegetable soybean.

Key words: *Glycine max* (L.) Merrill, vegetable soybean

**Résumé**

Une étude a été réalisée dans la saison 2008/09 à la Station de recherche de Rattray Arnold au Zimbabwe, afin de déterminer les jours optimaux pour récolter trois variétés végétales de soja, SC Edamame 1, Santa et Siesta. Le dispositif expérimental était un dispositif en bloc aléatoire complet avec trois répétitions. La récolte a été faite au stade de maturité recommandé de R6 pour les gousses fraîches et le stade R8 pour les semences sèches. Il y avait une différence significative ( $P < 0,05$ ) chez les cultivars dans le nombre de jours après le semis jusqu'à la récolte. Le seul cultivar avec des semences acceptables et les

dimensions des gousses de soja pour utilisation comme légume était SC Edamame 1. Il y avait des différences significatives ( $P < 0,05$ ) pour la hauteur des plantes et la biomasse aérienne. Tous les trois cultivars ont été trouvés être bien adaptés à l'environnement à la station de recherche de Rattray Arnos. Le cultivar, SC Edamame, était en maturité précoce dans 70 jours à partir du semis. Il y avait des différences significatives entre les cultivars ( $p < 0,05$ ) pour les protéines brutes de semences et la teneur en huile au stade de maturité R6. Il y avait des différences significatives dans une largeur de 100 graines parmi les cultivars ( $P < 0,005$ ) à la fois aux stades R6 et R8. L'effet des cultivars à la fois pour la longueur et la largeur de la gousse était également significatif ( $P < 0,05$ ). Un seul cultivar, Edamame 1, avait les dimensions des gousses acceptables pour une utilisation comme une graine de soja végétal.

Mots clés: *Glycine max* (L.) Merrill, soja végétal

## Background

Staple foods in Africa are mostly based on low protein root crops such as cassava, grain crops such as maize and small grains (Allain et al., 2011). Soybean protein can be blended with low protein grain cereals to constitute a balanced diet (Shanmugsundaram, 1999). Mature seed of soybean however contains a trypsin inhibitor that reduces digestibility of proteins. It also carries raffinose and stachyose that cause flatulence and abdominal discomfort when consumed. Soybean has varieties that can be consumed as vegetables. Vegetable soybean has the advantages of grain soybean but fewer anti-nutritional factors. The levels of trypsin inhibitor are lower because it is harvested green (Kumar et al., 2006). Levels of raffinose and stachyose are also lower (Tsou and Hong, 1991). The optimum harvest date of vegetable soybean requires a compromise to be made between yield quantity and quality. The sugar and amino acid content reach a peak several days before the pods have filled adequately (Konofsky et al., 1994). The objectives of this study were to determine the number of days from emergence to 50% flowering, R6 and R8 stages for the cultivars SC Edamame 1, Santa and Siesta and to quantify the protein, oil and sucrose composition.

## Literature Summary

Soybean (*Glycine max* (L.) Merrill) is an annual legume crop that is native to East Asia (Konovsky et al., 1994). It is the largest source of protein and vegetable oil in the world. In 2000, it accounted for 63% of the world protein meal and 28% of the

edible oil (Rao, *et al.*, 2002). Soybean oil accounts for approximately 30% of the total vegetable oil consumed worldwide (USDA, 2005). Soybean contains approximately 40% crude protein, 20% oil, 35% carbohydrates, vitamin A, B6, B12, C, K, calcium, iron, magnesium, phosphorus potassium, sodium and zinc in trace amounts (Kumar *et al.*, 2006). Soybean protein contains the essential fatty acids, linoleic and linolenic (Henkel, 2000). Soybean can be used as a vegetable crop but needs to be harvested at the right stage.

## Study Description

An experiment was conducted at Rattray Arnold Research Station (17.67°S, 31.17°E; 1452 m.a.s.l.) in Zimbabwe during the 2008-09 season. It receives an annual average of 803 mm of rainfall. The soil is a red sand clay loam. Three cultivars namely SC Edamame 1, Santa and Siesta were planted on the 8<sup>th</sup> of January 2009. All cultivars are determinate, white flowered and have broad leaflets. The experimental design was a Randomised Complete block with three replicates. The experimental plots were fertilised with compound L (4% N: 17% P<sub>2</sub>O<sub>5</sub> and 11% K<sub>2</sub>O) and 300kg/ha the seeds were sown in 8 row plots each 3m long at a spacing of 75cm x 6cm. Days to 50% flowering was recorded as the number of days from planting to the date when 50% of the plants in a plot had one fully opened flower. Days to the R6 stage was determined as the days from planting to the date when 80% of the plants in a plot had reached the R6 stage. The R6 stage is when at least one of the top four nodes has a pod containing a green seed filling the pod cavity (Ritchie *et al.*, 1994). The R8 stage was recorded as the number of days from planting to the date when 80% of the plants in the plot had reached the R8 stage. A plant is deemed to be at the R8 stage when 95% of the pods attain their mature brown color (Pedersen, 2008). Crude protein and oil content were measured from fresh blanched pods. Fresh pods were blanched in boiling water for one minute and then shelled. The seeds were then sun dried to constant weight and a random sample of 50g was drawn from each pot and used to determine sucrose and protein content (Brown, 2006). Sucrose content was analysed from random 100g seed samples taken from each plot using the Mumson-Walker reduction method for reducing sugars according to the Association of Official Analytical Chemists (AOACC). The mean length and width of the pods was determined by measuring fifty, 2 - seeded pods with a Vernier Caliper when 80% of the plants in the plot had reached the R6 stage. The 100 seed weight was determined as the mass of a random sample of 100 seeds from the blanched sample

from the plot. To determine the above ground biomass, ten plants were randomly sampled from each plot by cutting the stem at ground level using secateurs. These were dried to constant weight; and sample weight recorded as the above ground biomass.

### Research Application

There were significant differences among cultivars ( $P < 0.05$ ) for percent crude protein and oil at the R6 stage. However, the cultivar effect on crude protein and percent oil was non-significant ( $P > 0.05$ ) at the R8 stage (Table 1).

**Table 1. Mean percentage seed crude protein, oil, and sucrose, content, of three vegetable soybean cultivars grown at Rattray Arnold Research Station, Zimbabwe, during the 2008/09 season.**

Cultivar	Crude protein %		Oil %		Sucrose %	
	Growth stage					
	R6	R8	R6	R8	R6	R8
SC Edamame 1	44.67	43.67	14.17	15.2	1.05	0.7
Santa	45.57	44.05	14.13	15.27	0.41	0.6
Siesta	42.93	42.38	14.90	16.00	0.54	1.08
Mean	44.39	43.37	14.4	15.49	0.67	0.79
CV%	0.3	1.2	0.40	1.6	65.7	38.2
Significance of F	***	ns	**	ns	ns	ns
LSD <sub>0.05</sub>	0.4	1.9	0.38	-	-	-

\*, \*\*, \*\*\*, denote significance at  $P = 0.05$ , 0.01 and 0.001 respectively. ns = not significant.

The range in crude protein at the R6 stage was 42.9 - 45.57. The 100 seed width was also significantly ( $P < 0.05$ ) affected by cultivar at both the R6 and R8 stages (Table 2). SC Edamame 1 had a significantly higher 100 seed weight compared to the other cultivars. The 100 seed weight ranged from 19.2g for Siesta to 25.4 g for SC Edamame 1 at the R6 stage. Pod length and width were also significantly affected by cultivars. . Pods of acceptable pod size are those that measure over 4cm. Only cultivar SC Edamame 1 had a size acceptable for use as a vegetable.

There were significant difference in above ground biomass among the cultivars ( $P < 0.05$ ) at all sampling dates. Cultivar SC Edamame 1 reached maximum above ground biomass at 70 days and began to lose weight thereafter. This is because the pods had reached maturity (R8) stage, and was nearly 60 days earlier than cultivar Santa.

**Table 2. Mean 100 seed weight at R6 and R8 stges and pod dimensions at R6 for three soybean cultivars grown Rattray Arnold Research Station, Zimbabwe, during the 2008/09 season.**

	100 seed weight (g)		R6 Stage	
	R6	R8	Length (cm)	Width (cm)
SC Edamame 1	25.4	29.8	4.7	1.0
Santa	19.5	26.2	3.5	1.1
Siesta	19.2	23.3	4.0	1.2
Mean	21.33	26.6	4.1	1.1
CV%	2.5	1.3	1.9	1.7
Significance of F	*	**	**	*
LSD <sub>0.05</sub>	4.2		0.34	0.12

\*, \*\*, \*\*\*, denote significance at P=0.05, 0.01 and 0.001 respectively. ns = not significant.

**Table 3. Mean above ground biomass in g/plant for three vegetable soybean cultivars at different days after planting grown Rattray Arnold Research Station, Zimbabwe, during the 2008/09 season.**

Cultivar	Days after planting						
	10	30	50	70	90	110	130
	----- gm -----						
SC Edamame 1	1.3	7.2	13.4	33.1	26.2	2.5	2.1
Santa	1.1	4.4	4.8	22.2	37.7	45.1	58.9
Siesta	0.8	5.4	6.8	23.2	41.3	31.0	48.6
Mean	1.1	5.7	8.3	26.2	35.1	16.9	36.5
CV%	0.8	0.8	14.1	7.0	11.5	12.5	12.0
Significance of F	ns	*	*	*	**	***	***
LSD <sub>0.05</sub>	-	0.026	4.7	4.3	10.4	12.5	8.9

\*, \*\*, \*\*\*, denote significance at P=0.05, 0.01 and 0.001 respectively. ns = not significant.

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