Plant Archives Vol. 14 No. 1, 2014 pp. 51-54 *ISSN 0972-5210*

PHYSIOLOGICAL BASIS OF YIELD VARIATION IN VEGETABLE SOYBEAN AND ORGANOLEPTIC TEST FOR ACCEPTANCE

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Abstract

Vegetable soybean [*Glycine max* (L.) Merill] is rich in protein than any other pulse crop. It is also rich source of calcium, iron, potassium, ascorbic acid and vitamin E. So, it can be better fresh vegetable source to combat mal nutrition in India. After harvest of pods at green stage, the leaves can be used as green manure. With all these advantages, the vegetable soybean is not popular in India. Hence, an attempt has been made to screen the vegetable soybean on the basis of physiological parameters, yield, yield attributes and taste. Ten AVRDC vegetable soybean genotypes AGS 339, AGS 380, AGS 406, AGS 447, AGS 457, AGS 459, AGS 460, AGS 461, Swarna Vasundhara along with a local grain soybean cultivar JS-335 as check for comparison were grown in *Kharif* 2013 at MARS, UAS, Dharwad (Karnataka), India. The genotypes had distinct morphological features at R_6 stage (60-74 days to reach R_6 stage). The organoleptic test for sweetness indicated variation among the genotypes. The mean value of fresh seed weight, TDM, seed weight, seed protein and 100 seed weight varies from 30.9 gm, 21.2 gm, 17.4 gm, 32.8% and 35 gm, respectively. The mean value of photosynthetic rate, transpiration and Water Use Efficiency (WUE) varies from 33.45, 4.5 and 5.9, respectively. All the genotypes showed significant variation among each other for all the parameters. The vegetable soybean types are similar in physiology to grain soybean and more sweeter and tasty at R_6 stage than grain soybean. The vegetable genotypes AGS 406 and AGS447 were found superior to rest of the genotypes on the basis of morphological, physiological and organoleptic tests.

Key words : Vegetable soybean (Edamame), organoleptic test, R6 Stage, SPAD, WUE, TDM.

Introduction

The protein malnutrition is common in Indian poor and increases further with the growing population by 2025. There is a need of a versatile crop mitigating the protein mal nutrition and suitable for cropping system in India. Vegetable soybean, *Glycine max* (L.) Merill is called *edamame* in Japan and *maodou* in China. *Edamane* is large–seeded, sweet flavour, bright green colour, light hilum and soft textured vegetable type of soybean. The pods are harvested at the completely seed filled stage while pods and plants are still green.

Vegetable soybean is rich in protein (13%), cholesterol-free fatty acids (57%), TSS (6.5%), phosphorus (158 mg/100g), calcium (78 mg/100 g), vitamin B1 (0.4 mg/100g) and vitamin B2 (0.17 mg/100g). In addition to high protein content, it is a natural sources of isoflavones and tocopherols. The nutritional value and protein content is an important characteristic of vegetable soybean, which is superior to the meat, cow milk and eggs, this vegetal protein could heal malnutrition in people in substitution to the animal protein. In addition, it fixes dinitrogen and forms a good source of green manure when buried after harvest of green pods at R_6 stage.

In India, inspite of all these advantages, vegetable soybean is not yet popularly accepted either for domestic consumption or in the farming systems. It is because of non availability of a suitable genotype in the transitional tract of Karnataka and also due to lack of awareness. Hence, an attempt has been made to identify the suitable AVRDC genotypes based on physiological characters and organoleptic tests as a basis for further introduction in to a agricultural production chain.

Materials and Methods

Vegetable soybean genotypes procured from AVRDC-The World Vegetable Center, ICRISAT Campus, Hyderabad, India, namely AGS 339, AGS 380, AGS 406, AGS 447, AGS 457, AGS 459, AGS 460, AGS 461 and Swarna Vasundhara (Swarna) were selected and compared along with a local grain soybean *var* JS-

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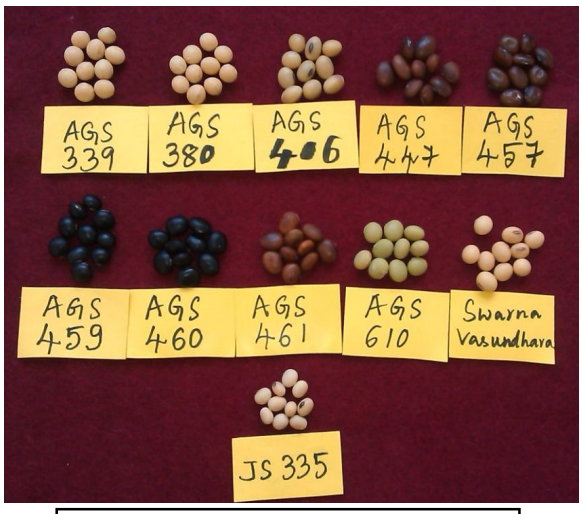
A. Variation in pod size and pubescence

B. Variation in seed size at R_6 stage



C. Seed colour and pod colour at harvest

Plate 1 : Morphological characteristics of seed and pod at R_6 and harvest stage in different vegetable genotypes.

335 as a check and were sown in RCBD design with three replications in *Kharif* 2013 in black clay loamy soil. The major growth and physiological parameters like, number of leaves/plant, leaf area/plant, plant height, SPAD were recorded. The photosynthesis, transpiration and water use efficiency were recorded at R_6 stage of crop growth using IRGA (LICOR). Yield parameters like pod number/plant, seed weight/plant, pod dry weight/plant, TDM were recorded at harvest stage. The protein content was indirectly calculated by analyzing the nitrogen content of leaf and seed using Auto Nitrogen Analyzer. Other distinct morphological features like a pod pubescence, seed colour and days to R_6 stage were recorded. Fresh seeds at R_6 stage have sweet taste like pea seeds. To test the sweetness and public acceptance for consumption, an organoleptic test was carried out using 0-5 scale. The results were presented as mean ± standard deviation (SD). The statistical analysis of experimental data was done using ANOVA.

Results and Discussion

Full seed stage also known as "green bean stage" or beginning full seed (R_6), the stage starts with a pod containing green seed that fills the pod cavity at one of the four uppermost nodes on the main stem. This is the peak seed growth stage at which pods harvested fresh and seeds are consumed. Days required to attain the stage (R_6) varied among the genotypes however, it was less in all vegetable types compared to check grain soybean (JS335) (74 days). The vegetable genotype AGS 447 was the earliest to attain this stage in only 60 days followed by AGS 339 and AGS 380 62 days each (table 1) (Shanmugasundram, 2001).

The data on other morphological characters at R_6 stage presented in table 2 indicated a wide variation. The plant height ranged from 23 to 49 cm. The vegetable genotypes had significantly lower plant height than grain soybean JS-335 (49 cm) except AGS 459 (43 cm) and AGS 460 (42 cm), which found to be on par with JS-335. The genotype AGS 459 (518 cm^2) had significantly higher leaf area. The TDM was higher in the genotypes AGS406 (30.5 gm), AGS 447 (26.1 gm) and AGS 459 (26 gm) and fresh wt. of pods was higher in AGS 447 (62 gm), AGS 406 (57.8 gm), AGS 459 (57.6 gm) and fresh seed weight was higher in AGS 447 (47.1 gm) and Swarna (39.4 gm). The higher TDM in these genotypes was attributed either to significantly higher height, larger leaf area or longer duration compared to rest of the genotypes. Thus, it is indicated that the basic morphological parameters contribute to TDM increase in genotypes. The most important characters of vegetable soybean at

Table 1 : Variation in morphological characters and olganoleptic test.

Genotypes	Days to R_6 stage	Pod pubescence	Organoleptic test at R_6 stage (0-5 scale)	Seed colour at maturity
AGS339	62	Hairy	1	Ivory
AGS380	62	Hairy	1	Ivory
AGS406	64	Non hairy	5	Ivory
AGS447	60	Hairy	4	Brown
AGS457	63	Less hair	4	Brown
AGS459	66	Less Hair	1	Jetblack
AGS460	67	Hairy	2	Jetblack
AGS461	63	Hairy	2.5	Brown
AGS610	67	Non hairy	2	Light green
Swarna	72	Hairy	0	Ivory
JS-335	74	Non hairy	0	Ivory

Table 3 : Physiological characters and leaf nitrogen content of the genotypes at R_6 stage.

Genotypes	SPAD	Photosynthetic rate ($\mu mol\ m^{-2}s^{-1}$)	Transpiration ($mmol\ s^{-1}\ m^{-2}$)	WUE (mg/g)	Leaf nitrogen (%)
AGS 339	33.1	30.3	4.4	6.9	3.1
AGS 380	31.8	25.6	4.0	6.3	3.0
AGS 406	31.8	27.5	4.2	6.7	4.6
AGS 447	36.8	24.7	4.4	5.6	3.8
AGS 457	35.0	21.2	3.9	5.5	2.4
AGS 459	33.3	20.6	4.6	4.5	4.8
AGS 460	32.7	30.8	5.4	5.8	4.4
AGS 461	32.8	27.1	4.4	6.2	3.1
AGS 610	32.8	31.2	5.3	5.9	4.5
Swarna	33.8	28.0	4.6	6.1	4.6
JS-335	33.9	27.0	4.9	5.5	4.5
Mean	**33.5**	**26.7**	**4.5**	**5.9**	**3.9**
CD@ 5%	**2.1**	**2.5**	**0.4**	**0.4**	**6.4**
S.Em ±	**0.7**	**0.9**	**0.1**	**0.1**	**0.1**

R_6 stage are pod number, pod fresh weight and seed fresh weight, these too differed significantly among the genotypes. The pod fresh weight of the vegetable genotypes was significantly higher compared to grain soybean except in AGS 461. As regards to seed fresh weight is concerned, it was significantly lower in AGS 460, AGS 461 and JS 335, whereas rest of the genotypes had significantly higher seed fresh weight. Yan Sheng LI *et al*. (2012) has observed similar results for diverse varieties of vegetable soybean.

As regards to SPAD, photosynthesis and transpiration, the genotypes differed significantly. The SPAD value was significantly higher in AGS 447 (36.8) and AGS 457 (35). The WUE of all the soybean genotypes was considerably higher than JS335 except AGS 459, which had lowest WUE due to lowest photosynthetic rate at R_6 stage indicating the vegetable types are broadly WUE in nature than grain soybean. The leaf nitrogen content at R_6 stage though it differed significantly, it did not correlate with seed protein content at harvest stage indicating the variation in nitrogen content and its translocation to seeds or pods during seed filling stage (table 3). The seed protein content was highest in AGS 447 (44.2) followed by AGS 406 (44.0) and was on par with JS335 (42.3) (Keatinge *et al*., 2011).

The seed coat colour varied like black, brown and ivory attributed to the anthocyanin content. However, the seeds invariably at R_6 stage had only green colour (plate 1-B), as matured the seeds attained attractive colours (plate 1-C) due to anthocyanin accumulation in the seed coat. Pod size and pod pubescence also varies distinctly among the genotypes indicating there is lot of diversity among the genotypes (plate 1-A) (Shanmugasundaram and Yang, 2001).

The genotype AGS 447 is the earliest to attain R_6 stage had higher fresh seed and pod weight with significantly higher dry matter and found suitable for green manuring purpose also. In addition the organoleptic test has indicated its second highest acceptability with score of 4, where as AGS 406 with its highest acceptability of 5 and with good amount of pod fresh weight and moderate seed fresh weight with higher dry matter at maturity stood as next best to AGS 447 (Izzy Esker, 2011).

To conclude, the vegetable soybean types are similar in physiology to grain soybean and more sweeter and tasty at R_6 stage than grain soybean. The vegetable genotypes AGS447 and AGS 406 were found superior

Table 2 : Morphophysiological characters of vegetable soybean genotypes at R_6 and harvest stage.

Varieties	R_6 stage						Harvest stage				
	Plant height (cm)	Leaf area/plant (cm^2)	No. of pods/ plant	Pod fresh weight/ plant (gm)	Seed fresh weight/ plant (gm)	TDM/ plant (gm)	100 seed weight (gm)	Dry wt/plant (gm)	Seed weight/ plant (gm)	TDM/ plant (gm)	Seed protein (%)
AGS339	23	285.8	25.7	49.2	35.5	18.4	35.9	3.0	13.4	16.4	25.4
AGS380	24	237.0	20.0	55.2	28.6	17.3	33.2	3.1	15.0	18.1	37.9
AGS406	26	419.0	36.7	57.8	34.1	30.5	42.5	6.8	29.9	36.7	44.0
AGS447	39	343.0	34.3	62.0	47.1	26.1	37.4	4.4	16.1	20.5	44.2
AGS457	28	220.4	27.0	45.2	34.6	17.7	37.8	3.2	13.9	17.1	38.6
AGS459	43	518.0	37.7	57.6	36.1	26.0	34.0	4.7	15.3	20.0	33.3
AGS460	42	443.0	28.7	49.1	16.3	22.6	37.5	5.8	18.8	24.6	29.3
AGS461	36	447.0	32.0	31.0	18.8	13.2	37.6	3.7	12.9	16.7	21.4
AGS610	33	224.4	21.7	48.6	28.3	18.9	34.6	5.4	18.3	23.8	26.7
Swarna	40	377.0	33.3	39.1	39.4	21.2	38.4	10.3	25.4	35.7	17.8
JS-335	49	440.0	43.7	32.0	21.4	20.8	15.7	2.8	12.6	15.4	42.3
Mean	34.8	369.1	31.0	48.2	30.9	21.2	35.0	4.8	17.4	22.3	32.8
CD @ 5%	12.3	98.5	4.6	2.6	6.4	4.3	11.4	0.9	6.4	9.0	2.5
S Em±	4.2	33.4	1.6	0.9	2.2	1.5	3.9	0.3	2.2	3.1	0.8

to rest of the genotypes on the basis of morphological, physiological and organoleptic tests. These further needs to be confirmed and introduced in the farming system.

Acknowledgement

Dr. Ramakrishnan M. Nair, Vegetable Breeder-Legumes, AVRDC-Regional center for South Asia, ICRISAT Campus, Patancheru-502 324, Hyderabad (Andhra Pradesh), India.

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