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RESEARCH ARTICLE

Evaluation of vegetable soybean genotypes for quality, sensory and yield parameters

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Abstract

The present study was conducted during 2016 in *kharif* at College of Horticulture, UHS Campus, GKVK post, Bengaluru. The experiment was carried out in Randomised Complete Block Design (RBD) with three replications with seventeen genotypes. The research was conducted to identify the elite genotypes for yield, quality and acceptability of genotypes as vegetable types. All the genotypes varied significantly with respect to yield and quality attributes. Among the genotypes evaluated, genotype AGS 433 followed by AGS 432 and COHBSBM-54 were found superior with respect to and yield attributing traits after 60 days of sowing. Similarly, protein and total sugars % were found maximum in genotypes EC 95286 and COHBSBM-8 respectively. While, genotype Karune has recorded higher overall acceptability value followed by the genotypes AGS 433 and GC 110318 during sensory evaluation and hence suitable for the vegetable type.

Key words: Soybean, vegetable soybean, quality, sensory, yield parameters

Introduction

The vegetable soybean (*Glycine max* (L.) Merrill) is a self-pollinating annual with a diploid chromosome number 2n=40, belonging to the family Fabaceae. It is a 'miracle legume' of the 21^{st} century as it contains high amount of quality protein (42%) and oil (20%) (Chouhan *et al.,* 2002).It is called as vegetable soybean, green soybean or edible soybean in North America, edamame in Japanese and maodou in China. This vegetable is cultivated as same as the field-dried soybeans, but they are harvested at an immature green stage (R6) that occurs just as the seeds have filled out the pod. These vegetable soybeans also have larger seeds than other field soybeans, a sweeter, nutty (less beany) taste and are more easily digested. The sweet and savory taste vegetable soybean is attributed to their sucrose, glutamic acid and alanine content. They are good source of protein, dietary fibre, vitamin- C (Ascorbic acid), vitamin- E (Tocopherol), Their demand is growing worldwide, most likely due to their tastiness and the known health benefits of iso-flavones.

These include decreasing low density lipoprotein (LDL) cholesterol levels reducing the risk of cardiovascular diseases, cancer and osteoporosis (Duppong and Valenti, 2005). Calcium and phytoes-trogens. Vegetable soybean is rich in protein, vitamin A, C and E, unsaturated fats, phosphorus, thiamine and riboflavin. Because of its characteristic-pleasing aroma and sweet taste it is widely accepted in Japan and China (Masuda, 1991). Dry vegetable soybean seed is larger (usually over 30 g 100^{-1} seeds), has higher soluble content and a lower number of chemical components associated with negative flavours than grain soybean (Konovsky *et al.*, 1994). Soybean seed has anti-nutritional substances, such as protease inhibitors. One-third of activity of trypsin inhibitor (TI) is less in vegetable form; vegetable soybean is nutritious than grain soybean. Pulses, the food legumes, have been grown by farmers since pre-historic time and this has contributed to alleviation of malnutrition by providing nutritionally balanced food to the undernourished as well as the other population of India and other parts of the world (Swaminathan and Bhavani, 2013). India has been growing more than 12 different pulse crops, which are highly rich in their nutrient status (Anonymous, 2015). Soybean is one of the important nutrient rich pulse and oil seed crop (FAO, 2013) (USDA, 2016).

Vegetable soybean is harvested between R6 and R7 growth stages (approximately 80 per cent maturity) at which pods are full formed and still green. These being comparatively richer and better source of human nutrition, dietary fibre and health promoting phyto-chemicals than the other traditional vegetables, can serve as good source of vegetables or snacks foods for Indians specially the vegetarian representing 65-70 per cent of the total population. As far as India is considered, soybean is mainly cultivated as an oilseed crop. Considering the nutritional importance of vegetable soybean, efforts are being made to breed vegetable soybean (Basavaraja *et al.*, 2005). Therefore, an appraisal of genotypes for their variability with respect to growth, yield and quality under different conditions is essential to improve the production. Evaluation of different genotypes and identification of high yielding genotypes for a particular agro-climatic region for different season would be very useful to the growers. There is a great potential for the commercial production of soybean as vegetable type in the country. Even though number of accessions and genotypes of vegetable soybean has been collected, but very little information regarding their performance in India. Considering the importance of this crop, there is a need to study the vegetable soybean among available genotypes for the eastern dry zone of Karnataka.

Materials and methods

The present study was carried out at Vegetable Science Research Block, College of Horticulture, UHS Campus, GKVK (Post), Bengaluru, Karnataka during *kharif* (August 2016 to November 2016). The research farm is situated between 13.05º latitude and 77º East longitudes at an altitude of 924 m above mean sea level. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each replication consists of 17 accessions and are replicated randomly in all the three replications. Each treatment consists of six rows of 66 plants in a plot. The quality parameters are protein content, starch, sugars, reducing sugars, non-reducing sugars, trypsin inhibitory activity and texture. The sensory evaluation was made for colour of vegetable soybean seeds, taste, surface texture, hardiness and over all acceptances. The yield and yield attributing parameters *viz.*, days to first flowering, days to 50 % flowering, pod length (cm), pod width (cm), number of clusters plant^{-1}, number of pods cluster^{-1}, pod yield plant^{-1} (g), pod yield plot^{-1}, pod yield ha^{-1}, number of seeds pod^{-1}, seed size, 100 seed weight , seed yield plant^{-1}, seed yield plot^{-1}, seed yield ha^{-1}.

Results and discussion

Vegetable soybean or edamame is a specialty soybean. Unlike grain-type soybean, edamame pods are harvested at a green and immature stage, and beans are consumed by humans as a vegetable. Based on the ANOVA table 1 all the soybean genotypes varied significantly with respect to yield and quality attributes. Flowering parameters including days taken to first flowering and days taken to 50 per cent flowering (Table 2). It was varied significantly among the genotypes. The time taken for first flowering and for 50 per cent flowering was less in genotype COHBSBM-26 (33.67 and 37 days respectively). Hence, these cultivars were said to be early type. Late flowering was observed in the genotype IC 25763 (37.33 and 43.00 days) both for first and 50 per cent flowering. Early flowering in certain genotypes indicated adaptability of these genotypes in a particular environment, better and efficient utilization of nutrients in a relatively hostile environment which might have resulted in early termination of vegetative phase and initiation of reproductive phase as compared to late flowering genotypes. Similar results have also been reported by earlier worker in vegetable soybean by Ramya and Mummigatti (2015), Sofi *et al.,* (2011). Significant difference was observed for number of clusters per plant among different genotypes of vegetable soybean. The maximum number of pods percluster was noticed in AGS 433 (19.43). This may be attributed to the inherent genetic makeup and environmental factors. These results are in confirmation with the findings of Girish *et al*., (2013). The maximum number of pods per cluster was noticed in the genotype AGS 433 (6.69). This might be due to genetic makeup of the genotypes. Similar results were reported by Parmar *et al.,* (2013), Aditya *et al.,* 2011 in soybean and Arora *et al.,* 2011 in cluster bean, Jetender *et al.,* 2014 in cluster bean. Significant difference was found among the genotypes with respect to pod length. Highest pod length was recorded in the genotype IC 25763 (5.57 cm). However, it may be due to varietal character. Pod width differed significantly among the 17 vegetable soybean genotypes. Genotype COHBSBM-54 has recorded the maximum pod width of 1.16 cm. This may be due to varietal variation which is attributed to their genetic makeup. Sharma *et al.*, (2013) in vegetable soybean. Genotype IC 501197 (3.00) has recorded the more number of seeds per pod. Genotypes showed significant differences with respect to pod yield per plant. The maximum pod yield per plant was recorded in AGS 433 (70.55 g). Similar results were reported by Sciarappa *et al.*, (2007) in vegetable soybean for pod yield per plant. The maximum pod yield per plot was recorded in AGS 433 (4.52 kg).The maximum pod yield per hectare was recorded in AGS 433 (78.40 q). This difference in pod yield per hectare could be attributed due to the highly significant and positive relationship with increase in plant height, number of pods per cluster and number of pods per plant apart from the genetic makeup and the influence of environment. These findings are in conformity with Poornima *et al.,* (2014) in vegetable soybean. Genotype COHBSBM-49 has recorded the higher hundred seed weight (32.37 g). The maximum seed yield per plant was recorded in genotype COHBSBM-8 (36.47 g). Existence of such variation for seed yield per plant were reported by Ramya and Mummigatti (2015) in vegetable soybean. The maximum seed yield per hectare was recorded in genotype COHBSBM-8 (40.65 q) which was followed by COHBSBM-49 (38.50 q) and AGS 432 (37.29 q). Similar findings were reported by Ali *et al.,* (2013), Malek *et al.,* (2014) and Malik *et al.,* (2006) in soybean.

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Table 1:Analysis of variance for quality parameters in different vegetable soybean genotypes

Sr. No.	Source of variation	Replication (RMSS)	Treatments (TMSS)	Error (EMSS)	S.Em±	C. D. @ 5%
1.	Degrees of freedom	2.00	16.00	32.00	-	-
2.	Protein (g $100g^{-1}$)	0.06	3.69**	0.07	0.15	0.43
3.	Starch (g $100g^{-1}$)	0.02	0.42**	0.01	0.04	0.11
4.	Total sugars (%)	0.05	0.84**	0.01	0.04	0.12
5.	Reducing sugars (%)	0.01	0.55**	0.03	0.10	0.29
6.	Non-reducing sugars (%)	0.02	0.45**	0.01	0.07	0.20
7.	Trypsin inhibitory activity (µ mol $min^{-1}mg^{-1}$of sample)	0.0001	0.02	0.0001	0.01	0.03
8.	Texture (g)	151.64	2320.26**	30.15	3.17	9.13

*** and ** Significant @ 5 % and 1 % respectively**

Table2: Mean performance of different vegetable soybean genotypes for various yield and yield parameters

Sr. No.	Genotypes/ Accessions	Days to first flowering	Days to 50 per cent flowering	Number of clusters per plant	Number of pods per cluster	Pod length (cm)	Pod width (cm)	Number of seeds per pod	Pod yield per plant (g)	Pod yield per plot (kg)	Pod yield /hectare (kg)
1	COHBSBM-26	33.67	37.00	14.15	5.94	5.03	0.99	2.50	44.79	2.94	49.72
2	COHBSBM-8	36.00	40.00	17.09	5.58	5.05	1.03	2.13	57.24	3.52	63.24
3	IC 501197	37.00	40.67	11.47	3.69	4.64	1.01	3.00	53.08	3.43	58.75
4	COHBSBM-66	34.00	38.33	9.82	3.70	4.66	1.07	2.30	40.44	2.64	44.51
5	COHBSBM-49	35.33	38.33	16.03	4.97	4.84	1.05	2.47	48.15	3.13	53.39
6	COHBSBM-54	36.33	41.33	14.33	4.02	5.29	1.16	2.17	66.29	4.49	72.84
7	IC 25763	37.33	43.00	14.70	5.20	5.57	1.10	2.07	60.98	4.21	67.71
8	AGS 433	34.33	39.00	19.43	6.69	5.18	1.03	2.50	70.55	4.52	78.40
9	W-80	36.33	40.00	13.93	3.49	5.11	0.93	2.47	43.90	3.03	48.72
10	EC 24207	35.00	40.00	16.03	3.92	5.12	0.97	2.40	39.39	2.50	43.73
11	AGS 432	34.00	37.33	13.13	4.89	5.10	1.07	2.27	63.58	4.29	70.67
12	EC 95286	34.67	40.00	10.25	4.30	4.68	0.93	2.23	50.05	3.43	55.69
13	Karune	36.00	39.67	15.79	3.91	4.87	0.94	2.80	61.55	4.19	68.34
14	IC 501164	37.00	40.00	9.40	3.99	4.88	1.02	2.17	43.48	2.66	48.21
15	IC 501164	34.11	37.67	10.90	3.92	4.90	1.00	2.41	31.54	2.32	35.00
16	GC 110318	36.33	40.67	9.90	5.89	5.37	1.06	2.00	59.91	3.68	66.55
17	EC 103153	37.00	42.00	13.94	4.20	4.10	0.92	2.53	37.67	2.28	41.80
	S. Em±	0.21	0.22	0.25	0.09	0.05	0.02	0.08	1.33	0.10	0.26
	CD at 5%	0.62	0.62	0.73	0.27	0.14	0.07	NS	3.84	0.30	0.76

Quality parameters

Protein per cent in vegetable soybean significantly differed among the genotypes and highest protein content was recorded in the genotype EC 95286 (10.00 g 100g^{-1}) (Table 3). The protein percentage varies depending on genotypes, environment and growing conditions. The results are in agreement with Sharma *et al.*, (2014) and Carson (2011) *et al.*, in vegetable soybean and Kempohalli and Chandrashekharaiah 2013 in legume mucuna. Highest starch content was recorded in the genotype AGS 433 (1.32 g 100g^{-1}) starch content in vegetable soybean is a heritable trait and is highly influenced by genotypes variability. The results are in agreement with Sharma *et al.*, (2013) in vegetable soybean. The maximum total sugar was recorded in COHBSBM-8 (3.60 %). Total sugar content in vegetable soybean is a heritable trait and is highly influenced by genotypes variability. The results are confirmed with Sharma et al. (2013) in vegetable soybean. The maximum reducing sugar per cent was recorded in COHBSBM-8 (2.57 %). The differences in reducing sugars content among different varieties may be attributed to the genetic makeup of the cultivars. The maximum non-reducing sugar was recorded in W-80 (1.56 %) followed by EC 25986 (1.35 %) and COHBSBM-26 (1.30 %). The variation in the non-reducing sugar level among various soybean genotypes may be attributed to adaptability potential under agro-climatic conditions of the area and may also be due to their genotypic differences. The lowest trypsin inhibitory activity was recorded in the genotype COHBSBM-26 (0.19 µ mol min^{-1}mg^{-1}). The variation in the trypsin inhibitory activity among various soybean genotypes may be attributed to their genotypic differences Sharma *et al.*, (2013).

Table 3: Mean performance of quality parameters of different vegetable soybean genotypes

Genotypes/ Accessions	Protein (g 100^{-1})	Starch (g 100^{-1})	Sugars (%)			Trypsin inhibitory activity (µ mol min^{-1} mg^{-1} / sample)	Texture (g)
			Total sugars	Reducing sugars	Non-reducing sugars		
COHBSBM-26	8.56	1.22	3.33	2.03	1.30	0.19	260.17
COHBSBM-8	6.35	0.91	3.60	2.57	1.03	0.25	326.03
IC 501197	9.62	0.72	3.40	2.42	0.98	0.30	308.23
COHBSBM-66	9.20	0.65	2.63	1.93	0.70	0.39	290.33
COHBSBM-49	7.63	1.02	2.83	2.32	0.51	0.25	306.67
COHBSBM-54	8.29	0.96	2.50	1.42	1.08	0.45	258.53
IC 25763	8.74	1.22	2.37	1.79	0.58	0.34	315.13
AGS 433	7.09	1.32	2.96	2.43	0.53	0.40	288.37
W-80	7.68	0.85	2.60	1.04	1.56	0.44	327.60
EC 24207	8.62	1.08	2.27	1.16	1.11	0.30	253.60
AGS 432	7.61	1.23	2.87	2.45	0.42	0.34	310.57
EC 95286	10.00	0.74	2.40	1.05	1.35	0.39	284.20
Karune	6.53	0.90	2.63	2.02	0.61	0.21	255.63
IC 501164	9.66	1.06	2.40	1.81	0.59	0.24	240.87
GC 99013-5	9.66	1.21	3.03	2.33	0.70	0.38	311.53
GC 110318	7.78	0.56	3.27	2.24	1.03	0.29	281.73
EC 103153	8.78	1.28	3.33	2.14	1.19	0.25	262.30
Mean	8.34	1.00	2.78	2.00	0.93	0.32	287.15
S. Em±	0.15	0.04	0.04	0.10	0.07	0.01	3.17
CD at 5 %	0.43	0.11	0.12	0.29	0.20	0.03	9.13

There were significant differences were observed in sensory evaluation of vegetable soybean (Table 4). For taste soybean genotype AGS 433 (8.57) was recorded highest taste value. Genotype COHBSBM-66 recorded highest surface texture (8.37). The genotype Karune registered higher overall acceptability of 8.57 (score out of 9). Similar results were reported by Carson (2011) et al in soybean.

In conclusion we noted that seed yield and quality parameters in vegetable soybean were significantly influenced by genotypes. The maximum seed yield per plant, per plot and per hectare was recorded in genotype COHBSBM-8 The protein per cent in vegetable soybean was highest in EC 95286 (10.00 g 100g-1), the highest starch content was recorded in AGS 433 (1.32 g 100g-1), the maximum total sugar and reducing sugar was recorded in COHBSBM-8 (3.60 % and 2.57 % respectively). The maximum non-reducing sugar per cent was recorded in W-80 (1.56 %).

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