International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 6, 2020, pp.-9651-9654.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

CORRELATION STUDIES IN SWEET SORGHUM UNDER INTERCROPPING AND DIFFERENT SOURCES OF NITROGEN

SINGH S.*[1] AND KEWALANAND[2]
[1]ICAR-Krishi Vigyan Kendra, Banda, 221 307, Banda University of Agriculture and Technology, Banda, 210001, Uttar Pradesh, India
[2]Department of Agronomy, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, 263145, Uttarakhand, India
*Corresponding Author: Email - shyamsingh15350@gmail.com

Received: March 03, 2020; Revised: March 27, 2020; Accepted: March 28, 2020; Published: March 30, 2020

Abstract: Field experiment was conducted during two consecutive *Kharif* seasons at Instructional Dairy Farm of G.B. Pant University of Agriculture and Technology, Pantnagar to identify inter relationship of economic traits and their association with the yield and quality of sweet sorghum under intercropping system and different nitrogen sources. Correlation has been studied in various growths, quality characters, nutrients content, uptake and yield and quality of sweet sorghum planted in a randomized block design. The linear correlation study revealed positive and highly significant association between growth parameters and stalk, juice, sugar and ethanol yield. Among the juice quality parameters, juice, brix and sucrose percent were positively and available sugar, juice purity coefficient was negatively associated with all the growth parameters and yield. Various growth parameters and nutrient content/uptake were found positively correlated with dry matter accumulation, yield of stalk, juice and calculated ethanol.

Keywords: *Correlation, Sweet Sorghum, Sugar, Brix, Ethanol, Intercropping, Phillipesara*

Citation: Singh S. and Kewalanand (2020) Correlation Studies in Sweet Sorghum Under Intercropping and Different Sources of Nitrogen. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 12, Issue 6, pp.- 9651-9654.

Academic Editor / Reviewer: Oluk Aylin C.

Introduction

Sweet sorghum [*Sorghum bicolor* (L.) Moench.] is one of the most suitable crops for ethanol production; the National Policy of Biofuels, Government of India, has identified sweet sorghum as an alternative feedstock for ethanol production in India [1]. The yield of sweet sorghum being quantitative character, is the resultant of various characters working together during the crop growth which are interdependent in their development. Thus, study of correlation provides an opportunity to assess the magnitude and direction of association of yield with its direct and indirect components, which is essential for formulating an effective and efficient crop improvement scheme. Knowledge of the correlation of component responsible for desired cause forms an integral part of the scheme. For this, knowledge of components having significant positive correlation with yield and quality is essential. Not only the linear correlation between yield and its components essential but inter-relationship of themselves are also of great importance. In view of above the present study was under taken to identify inter relationship of economic traits and their association with the yield and quality of sweet sorghum under intercropping system and different source of nitrogen.

Materials and Methods

Field experiment was conducted at Instructional Dairy Farm of G.B. Pant University of Agriculture and Technology, Pantnagar, India, during two consecutive kharif seasons. The climate is humid sub-tropical with mean annual rainfall of 1369 mm of which 80-90 percent is received from June to October. Soil of experimental site was silty clay loam in texture with pH 7.3 and contained high organic carbon (0.77%), low available nitrogen (280 kg/ha) medium available phosphorus (27.3 kg/ha) and potassium (247 kg/ha). The treatment, three cropping systems (sole sweet sorghum, sole phillipesara, sweet sorghum + phillipesara intercropping) and six different sources of nutrients (100% of recommended N through inorganic source (F1), 75% of recommended N through inorganic source + 25% through vermicompost (F2), 50% of recommended N through inorganic source + 50% through vermicompost (F3), 75% of recommended N through inorganic source + 25% through FYM (F4), 50% of recommended N through inorganic source + 50% through FYM (F5) and 50% of recommended N through inorganic source + 25% through vermicompost + 25% through FYM) were tested in RBD with 4 replications. The phillipesara (Phaseolus trilobus) a leguminous crop was intercropped in between the sweet sorghum rows (1:1) in an additive series.

The recommended dose of NPK applied to sole sweet sorghum was 120-60-40 kg/ha, sole phillipesara was 25-60-0 kg/ha and for intercropping of sweet sorghum + phillipesara was 80-60-40 kg/ha). Nutrients were applied through different sources as per treatments. Nitrogen was applied in three application viz. 50 percent at sowing, 25 percent each at 30 and 50 days after sowing of sweet sorghum while full dose of P and K were applied as basal. In phillipesara, whole amount of N and P was applied as basal. The sowing of both crops was done on 22 and 25 May during first and second year, respectively. The intercrop, phillipesara was harvested at 80 days after sowing for fodder purpose and the harvesting of sweet sorghum was done at 120 days after sowing at late dough stage of crop for cane and ethanol yields. The juice from stalk was obtained using power cane crusher. The juice quality parameters viz. brix, sucrose and available sugar were determined as per method described by Spencer and Meade (1955) [2]. Sugar yield was computed using formula:

Sugar yield (t/ha) = (Available sugar (%) × Juice yield (t/ha)) / 100

The ethanol yield was computed using formula:

Ethanol yield (lit./ha) = Sugar yield (t/ha) × 3.78 × 1000 × 0.8

Observations were recorded on growth parameters viz. plant height, stem diameter,L:S ratio, dry matter accumulation in plant, nutrients content, nutrients uptake, stalk, juice, sugar and ethanol yield, juice quality parameters viz. brix and sucrose percent, available sugar, juice purity coefficient. All these parameters were used for correlation study as per procedure given by Cochran and Snedecor (1994) [3].

Table-1 *Correlation between growth parameters and nutrients content and uptake of sweet sorghum*

Growth parameters	N content		P content		K content		N uptake		P uptake		K uptake	
	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year
Plant height	0.420	0.843*	0.965*	0.920*	0.605	0.556	0.854*	0.892*	0.920*	0.948*	0.930*	0.917*
LAI	0.491	0.884*	0.717*	0.915*	0.837*	0.426	0.672	0.923*	0.772*	0.936*	0.874*	0.928*
Stalk length	0.601	0.840*	0.811*	0.850*	0.751*	0.285	0.816*	0.910*	0.864*	0.886*	0.910*	0.892*
Mid stem diameter	0.147	0.746*	0.427	0.817*	0.358	0.389	0.363	0.746*	0.351	0.850*	0.451	0.733*
Dry matter accum.	0.298	0.884*	0.885*	0.629	0.330	0.093	0.926*	0.724*	0.884*	0.730*	0.860*	0.819*
Internode length	0.030	0.882*	0.535	0.925*	0.485	0.586	0.340	0.772*	0.451	0.946*	0.590	0.811*
Leaf sheath length	0.368	0.724*	0.747*	0.895*	0.395	0.503	0.613	0.838*	0.707	0.896*	0.632	0.791*
Leaf sheath weight	0.427	0.723*	0.771*	0.884*	0.473	0.632	0.835*	0.835*	0.868*	0.890*	0.825*	0.833*
Leaf : stem ratio	0.239	0.638	0.644	0.389	0.150	0.195	0.325	0.505	0.433	0.483	0.476	0.542
Fresh stalk weight	0.494	0.702	0.943*	0.570	0.622	0.190	0.785*	0.723*	0.870*	0.658	0.869*	0.790*

** Significant at 5% level of probability*

Table-2 *Correlation of growth parameters and nutrient with yields of sweet sorghum*

	Dry matter accumulation		Cane yield		Juice yield		Sugar yield		Ethanol yield	
	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year
Growth parameters										
Plant height	0.886*	0.762*	0.991*	0.881*	0.980*	0.920*	0.957*	0.927*	0.961*	0.906*
LAI	0.621	0.766*	0.768*	0.826*	0.759*	0.862*	0.700	0.826*	0.703	0.828*
Stalk length	0.740*	0.758*	0.816*	0.901*	0.736*	0.961*	0.727*	0.973*	0.736*	0.983*
Mid stem diameter	0.377	0.708*	0.502	0.807*	0.440	0.877*	0.435	0.902*	0.430	0.895*
Internode length	0.461	0.719*	0.604	0.815*	0.642	0.955*	0.601	0.911*	0.666	0.937*
Leaf sheath length	0.614	0.586	0.814*	0.777*	0.789*	0.949*	0.768*	0.923*	0.762*	0.937*
Leaf sheath weight	0.837*	0.620	0.817*	0.775*	0.790*	0.853*	0.753*	0.840*	0.781*	0.815*
Leaf : stem ratio	0.582	0.766*	0.713*	0.755*	0.754*	0.610	0.847*	0.732*	0.824*	0.718*
Fresh cane weight	0.782*	0.864*	0.932*	0.886*	0.952*	0.628	0.903*	0.764*	0.892*	0.668
Nutrients										
N content	0.298	0.884*	0.401	0.862*	0.396	0.853*	0.206	0.822*	0.212	0.833*
P content	0.885*	0.629	0.978*	0.733*	0.979*	0.926*	0.937*	0.828*	0.939*	0.862*
K content	0.330	0.093	0.550	0.170	0.545	0.506	0.437	0.311	0.545	0.372
N uptake	0.926*	0.724*	0.835*	0.897*	0.812*	0.891*	0.743*	0.916*	0.777*	0.892*
P uptake	0.884*	0.730*	0.908*	0.811*	0.898*	0.839*	0.821*	0.873*	0.842*	0.893*
K uptake	0.860*	0.819*	0.898*	0.932*	0.879*	0.888*	0.824*	0.909*	0.847*	0.883*

** Significant at 5% level of probability*

Table-3 *Correlation between growth parameters and juice quality of sweet sorghum*

Growth parameters	Juice (%)		Brix (%)		Sucrose (%)		Available sugar (%)		Juice Purity coefficient (%)	
	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year
Plant height	0.966*	0.642	0.299	0.575	0.225	0.065	0.107	-0.343	-0.300	-0.107
LAI	0.764*	0.650	0.425	0.383	0.070	-0.115	-0.065	-0.403	-0.298	-0.152
Cane length	0.808*	0.718*	0.398	0.710*	-0.058	-0.291	-0.171	-0.143	-0.313	-0.155
Mid stem diameter	0.398	0.674	0.375	0.682	0.506	0.299	-0.259	-0.158	-0.522	-0.127
DMA	0.840*	0.409	0.130	0.189	0.127	0.202	0.247	0.072	-0.096	-0.187
Internode length	0.872*	0.749*	0.165	0.584	0.452	0.064	0.270	-0.382	-0.117	-0.152
Leaf sheath weight	0.764*	0.697	0.594	0.544	0.079	-0.065	0.210	-0.472	-0.373	-0.244
Leaf : stem ratio	0.776*	0.358	-0.198	0.492	0.454	0.663	0.609	0.419	0.295	-0.066
Fresh cane weight	0.964*	0.405	0.133	0.291	0.026	0.209	-0.020	0.028	-0.167	-0.289

** Significant at 5% level of probability*

Table-4 *Correlation between nutrients and juice quality parameters of sweet sorghum*

Nutrients	Purity (%)		Juice (%)		Brix (%)		Sucrose (%)		Available sugar (%)	
	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year
N content	-0.566	-0.178	0.396	0.621	0.456	0.248	-0.596	-0.096	-0.696	-0.340
P content	-0.273	-0.088	0.969*	0.721*	0.174	0.478	0.087	-0.205	0.020	-0.607
K content	-0.398	0.083	0.557	0.408	0.472	0.125	-0.160	-0.623	-0.262	-0.894*
N uptake	-0.303	-0.214	0.793*	0.658	0.279	0.607	-0.133	0.123	-0.082	-0.237
P uptake	-0.332	-0.112	0.889*	0.710*	0.353	0.466	-0.111	-0.132	-0.048	-0.515
K uptake	-0.282	-0.171	0.873*	0.603	0.343	0.474	-0.003	0.042	0.023	-0.266

** Significant at 5% level of probability*

Results and Discussion

Correlation between growth parameters and nutrients

All the growth parameters were found to be positively correlated with NPK content and uptake during both the years, Positive linear correlation between leaf: stem ratio and content and uptake of all the nutrients was non-significant during both the years. All the growth parameters were non significantly correlated with K content during both the years, except LAI and stalk length during first year. All the growth parameters, except leaf: stem ratio and fresh stalk weight showed significant positive association with nitrogen content during second year and with phosphorus content during both the years, except mid stem diameter, internode length during first year, dry matter accumulation during second year and leaf: stem ratio during both years. A significant positive association was noticed between all growth parameters and NPK uptake during both the years except between LAI and nitrogen uptake, mid stem diameter, internode length and NPK uptake during 2007 and between leaf sheath length and N, K uptake during first year [Table-1] .It suggested that the growth parameters are dependent on nutrient content and uptake thus, higher values of these two parameters ultimately resulted in higher dry matter accumulation and yields.

Table-5a *Correlation among juice quality parameters of sweet sorghum*

Quality Characters	Purity coefficient (%)		Juice (%)		Brix (%)		Sucrose (%)		Available sugar (%)	
	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year
Purity coefficient (%)	–	–	-0.156	-0.677	-0.767*	-0.071	-0.165	-0.075	0.597	0.127
Juice (%)	–	–	–	–	0.174	0.558	0.135	-0.064	0.172	-0.473
Brix (%)	–	–	–	–	–	–	0.049	0.578	-0.243	0.045
Sucrose (%)	–	–	–	–	–	–	–	–	0.449	0.833*

Table-5b *Correlation between juice quality parameters and yields of sweet sorghum*

Quality Characters	Juice yield		Sugar yield		Ethanol yield		Stalk yield	
	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year
Juice (%)	0.995*	0.815*	0.972*	0.727*	0.966*	0.777*	0.978*	0.604
Brix (%)	0.215	0.691	0.121	0.725*	0.130	0.738*	0.271	0.506
Sucrose (%)	0.194	0.102	0.337	0.315	0.326	0.260	0.242	0.296
Available sugar (%)	-0.155	0.370	0.322	-0.125	0.334	-0.207	0.132	0.000
Purity coefficient (%)	-0.226	-0.230	-0.118	-0.236	-0.115	-0.227	-0.302	-0.285

* *Significant at 5% level of probability*

Therefore, adequate availability of nutrients throughout the growing season is essential for boosting growth parameter which intern enhances the yield.

Correlation of growth parameters and nutrients with yields

Growth parameters were found to have significant positive linear correlation with dry matter accumulation, stalk, juice, sugar and ethanol yields during both the years, except between LAI and dry matter accumulation during first year, leaf sheath weight and dry matter accumulation, leaf : stem ratio and juice yield, fresh stalk weight and ethanol yield during 2008, mid stem diameter, internodes' length and dry matter accumulation, stalk, juice, sugar and ethanol yield during first year, leaf sheath length and dry matter accumulation during both the years [Table-2]. It suggests that in sweet sorghum, it is possible to enhance the yield by enhancing the growth parameters like plant height, stem diameter, L:S ratio and dry matter accumulation. The work of Roodogi *et al*., (2001) [4] on sugarcane indicating significant positive correlation between yield and number of internodes, cane weight, millable cane, length of internode, cane girth confirms the present findings. A strong correlation between green stalk and juice yield reported by Gajanan et. al. (2016) [5] also confirm these results. Nutrients content and uptake was positively correlated with yields during both the years. Uptake of nutrients by plants had significant correlation with dry matter accumulation, stalk, juice, sugar and ethanol yields during both the years. Positive but non-significant correlation expressed between potassium content and yields. Phosphorus content was found to be significantly and positively associated with the stalk, juice, sugar and ethanol yield during both the years, while nitrogen content established significant positive correlation with yields during second year [Table-2]. It suggested that the growth parameters are dependent on nutrient content and uptake thus, higher values of these two parameters ultimately resulted in higher dry matter accumulation and yields. Acreche, (2017) [6] have also reported positive association between nutrient use efficiency (NUE) traits with sugar yield and cane yield in sugarcane.

Correlation between growth parameters and juice quality

All growth parameters were positively correlated with juice, brix and sucrose content of juice during both the years, except leaf: stem ratio and brix during first year, LAI, leaf sheath fresh weight, stalk length and sucrose percent during second year, stalk length and sucrose percent during first year. This positive correlation between growth parameters and juice, brix, sugar percent was significant only during first year and between all growth parameters and juice percent, except mid stem diameter and juice percent, during both the years. During second year, stalk length, internode length was found to be significantly and positively associated with juice percent. Also, significant positive correlation was noticed between stalk length and brix percent during second year [Table-3]. Higher leaf and stem ratio has been found to enhance quality characters of forage sorghum Chaudhary, *et al*., (2007) [7] and Rai, *et al*., (1980) [8].In sorghum, positive correlation was noticed between inter node length and plant height which was found to be highly correlated with biomass yield by Burks *et al*., (2015) [9] and Shukla *et al*., (2017) [10]. Negative correlation between all the growth parameters and available sugar, juice purity coefficient was noticed during both the years, except between plant height and available sugar (first year), leaf : stem ratio, dry matter accumulation and available sugar (both years), internode length, leaf sheath fresh weight and available sugar (first year), however, the association were found to be non-significant during both the years [Table-3]. Also various growth parameter were positively correlate with sucrose per cent, thereby a negative association was observed between purity coefficient and growth parameters. Juice per cent had significant positive correlation with cane length and internode length during both the years. Since juice accumulation take place in canes result in more sink for juice storage, this concept confirms present findings.

Correlation between nutrients and juice quality

Both content and uptake of all the nutrients were found to be negatively associated with purity coefficient, sucrose percent and available sugar percent, while brix percent and juice percent had positive correlation with nutrient content and uptake during both the years [Table-4]. The negative correlation was significant only between potassium content and available sugar during second year. However, juice percent was significantly and positively associated with phosphorus content and uptake during both the years, with nitrogen and potassium uptake during first year. An inverse relationship between higher amount of nutrients specially nitrogen and sucrose content of juice noticed by Kapoor *et al*., (1993) [11], confirm the results of present investigation where sucrose (%), available sugar (%) and purity coefficient have inverse correlation with nutrient content and uptake.

Correlation among juice quality parameters and with yields

The purity coefficient was negatively associated with juice percent, brix, sucrose percent and positively associated with available sugar percent, during both the years. Juice content in stalk was positively correlated with brix (both years), sucrose and available sugar (first year). A positive correlation was noticed between brix and sucrose percent during both the years. However, brix was negatively associated with available sugar during first year. Sucrose and available sugar had positive association during both the years; however, it was significant only during second year [Table-5a]. Significant linear correlation between the brix and total sugar content of the juice is well established [12]. It was also reported by Erdurmus *et al.,* (2018) [13] that there is a linear correlation with total sugar content and brix in Sweet Sorghum and thus, the total sugar content can be calculated from the brix. This concept confirms the results of present study. Sandeep *et al*., (2011) [14] were in agreement with the above results. Since sucrose is non-reducing sugar its higher percentage in total soluble solids of juice, decreases purity coefficient which also confirms the results of present investigation, where purity coefficient was found negatively correlated with sucrose content [Table-5a]. Also, various growth parameter was positively correlate with sucrose percent, thereby a negative association was observed between purity coefficient and growth parameters. Correlation between juice quality parameters and yields was found positive during both the years, except between purity coefficient and all yields during the years, available sugar and juice yield during first year, available sugar and ethanol yield during second year.

A significant positive association was noticed only between juice percent and all yields during both the years, except in case of stalk yield during second year. Also, brix had significant positive correlation with sugar yield and ethanol yield during second year [Table-5b]. The linear positive, non-significant correlation between cane yield and quality characters *viz*. cane girth, commercial cane sugar percentage, sucrose percentage and purity percentage in case of sugarcane have also been reported earlier by Roodogi *et al*., (2001) [4] and in sweet sorghum by Sandeep *et al*., (2011) [14]. Juice yield is a function of stalk yield and juice percentage in cane. Significantly higher stalk yield and juice percentage might have contributed to significantly higher juice yield. Sugar yield was computed using available sugar content and juice yield and significantly higher values of these parameters resulted in significant increase in sugar yield and thus shows positive correlation. Sugar yield is the main factor contributing in ethanol computation [15]. Thus, ethanol yield was also found significantly higher due to higher value of sugar yield.

Conclusion

Various growth parameters and nutrient content/uptake were found positively correlated with dry matter accumulation and yield of stalk, juice and calculated ethanol. Similar was the association between growth parameter and nutrient uptake. It suggested that the growth parameters are dependent on nutrient content and uptake thus, higher values of these two parameters ultimately resulted in higher dry matter accumulation and yields. Therefore, adequate availability of nutrients throughout the growing season is essential for boosting growth parameter which intern enhances the yield. So, it is recommended that for higher yield of cane, juice, sugar and ethanol, and better quality of juice, sweet sorghum should be intercropped with phillipesara and the nitrogen should be applied 50 percent through inorganic source and 50 percent through vermincompost.

Application of research: Study will help researchers in selection of traits for varietal evaluation and to farmers in formulation of the right doses and combination of organic and inorganic sources of nutrients for getting higher and sustainable yield with good quality of juice and sugar.

Research Category: Intercropping of legume

Abbreviations: NPK, N= Nitrogen, P= Phosphorus, K= Potassium

Acknowledgement / Funding: Authors are thankful to Director, Experimental Station, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, 263145, Uttarakhand, India.

****Research Guide or Chairperson of research: Dr Kewalanand**
University: G.B. Pant University of Agriculture and Technology, Pantnagar, 263145, Uttarakhand, India
Research project name or number: PhD Thesis

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: IDF, G. B. Pant University of Agriculture and Technology, Pantnagar

Cultivar / Variety / Breed name: Sweet Sorghum- SSV-84, Phillipesara - Local

Conflict of Interest: None declared
Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] ICRISAT (2017) *Happenings Newsletter*, May, 2017, No. 1741.
[2] Spencer G.L. and Meade G.P. (1955) *Cane sugar Hand Book. A manual for cane sugar manufacturers and their chemists. John Willey & Sons, Inc. N.Y. Chapman and Hall Ltd., London.*
[3] Cochron G.W. and Snedecor W.G. (1994) *Statistical methods, 8th ed. Oxford and IBH Pub. Co. Pvt., Lt.d. Calcutta.*
[4] Roodogi L.I., Itnal C.J., Karabantanal S.S. and Rachappa V. (2001) *Indian Sugar*, LI (3), 159-163.
[5] Sawargaonkar G.L. and Wani S.P. (2016) *Current Science*, 110, (9), 1699-1703.
[6] Acreche M. M. (2017) *Plant Breeding*, 136, 174-181.
[7] Chaudhary D.P., Chain S., Muker H.S. and Bhardwaj B.L. (2007) *Forage Research*, 33(1),65-66.
[8] Rai R., Verma M.L. and Rai S.D. (1980) *Forage Res*., 6,39-49.
[9] Burks P.S., Kaiser C.M., Hawkins E.M. and Brown P.J. (2015) *Crop Sci.,* 55, 2138-2148.
[10] Shukla S., Felderhoff T., Saballos A. and Vermerris W. (2017) *Field Crops Research*, 203,181-191.
[11] Kapoor M.L., Singh Y. Singh B. and Meelu O.P. (1993) *Fertilizer News*, 38(11), 27-31.
[12] Ma Z.H., Li D. and Ning X.B. (1992) *J. Shenyang Agric. Univ*., 23(3), 187-191.
[13] Erdurmus C., Yucel O., Cınar A., Yegin B. and Oten M. (2018) The *International Journal of Engineering and Science*, 7(11) Ver. II, 21-26.
[14] Sandeep R.G., Gururaja Rao M.R., Venkatesh Bhat B., Rao S.S., Kulkarni R.S., Hittalmani S. and Srinivasa Murthy C.A. (2011) *Electronic Journal of Plant Breeding*, 2(2), 244-247.