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Yield and yield component association studies in seed guar (*Cyamopsis tetragonoloba* (L.) Taub.) cultivars under rainfed condition

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Abstract
The aim of study was to identify the yield and yield components in fifteen genotypes of seed guar. It was carryout during *kharif*, 2014 at the "Student Research Farm", College of Horticulture, Dr. Y.S.R. Horticultural University, Mojerla, Mahabubnagar, Telangna state in a Completely Randomized Block Design with three replications. The results revealed that the analysis of variance indicated highly significant differences for all the yield characters among all cultivars studied. Significantly RGC 986 recorded the maximum number of seeds per pod, pod yield per plant, pod yield per hectare, seed yield per plant, seed yield per hectare. While, the cultivar RGC 1038 recorded the maximum seed to pod ratio. The highest 100-seed weight was recorded in HG 2-20. The cultivar HG 884 recorded the maximum harvest index. This complex set of association between various yield components clearly indicated that selection of early genotypes would be reliable to increase the pod length, pod weight, number of pods and ultimately pod yield per plant.

Keywords: Seed guar, yield, performance, genotypes and rainfed

Introduction
Cyamopsis tetragonoloba (L.) Taub. Which is popularly known as *guar*, it a self-pollinated crop belongs to the family Fabaceae having the chromosome number 2n=14. Guar originated in India and Pakisthan and is characterized as a short day erect or bushy annual plant (Purseglove, 1981) [10]. It is a drought tolerant, warm season legume crop with deep and welldeveloped root system, cultivated mainly as rainfed crop in arid and semi-arid regions during rainy (*kharif*) season for vegetable, galactomannan gum, forage and green manure. Guar enhances soil productiveness by fixing atmospheric nitrogen for its own necessities and also for the succeeding crop (Bewal *et al.*, 2009) [2]. Soils with medium to light constituents, without excessive moisture, are suitable for its cultivation. Even soils with poor fertility and depleted plant nutrients are suitable for growing Guar as a green manure crop. Pasture lands receiving little care can also be used for growing guar mixed with grasses.

Guar is predominantly grown in India and Pakistan as a vegetable, fodder and grain crop. Cultivars grown in South India are vegetable types while those in North-West India are grown for seeds. Guar meal, a by-product of guar gum industry is also of considerable value as it contains more than 42 percent protein. In India, guar is being grown mainly in arid and semiarid regions of North Western states of Rajasthan, Gujarat, Haryana, Punjab, parts of Uttar Pradesh, Madhya Pradesh and Tamil Nadu covering about 3.34 million hectares with a production of 0.4 million tonnes of guar seed. Rajasthan occupies the largest area under guard cultivation (82.1%), followed by (8.6%) Haryana (Pathak *et al.*, 2010). The productivity of cluster bean ranges from 474 kg/ha in Rajasthan to 1200 kg/ha in Haryana (Ahlawat *et al.*, 2013) [1]. Clusterbean gum has emerged as the most important agro-chemical, which is non-toxic, eco-friendly and Generally Recognized as Safe (GRAS) by Food and Drug Administration (FDA). Foreign exchange earned from its export has increased from 142 crores in 1994 to 1120 crores during 2007 in India (Henry and Mathur 2008) [4]. Seed guar finds an efficient alternative in the form of guar gum and since then, the derivative of guar ruled out locust bean from this scenario and it was readily accepted for application in many other industries (Kumar, 2002) [5]. It is used for improving quality of paper board by enhancing dry and wet strength and for enhancing sizing degree (Yoshyuki, 1985) [13]. Guar gum also has greater utility in pollution control. It is used as an adsorbent in waste water treatment and in textile industry as a flocculating and exchanging agent. In waste water purification, guar gum is used as a gelatinizing agent (Mathur *et al.*, 1986) [7].

Production of this crop in India mainly confined to the North-West part of India, however certain areas of Andhra Pradesh and Telangana state are highly suitable for cultivation of this crop as suggested by ICAR-high level expert committee report as an alternate crop for sustainability in scarce rainfall zones (CRIDA, 2012) [3]. Moreover, yield is a complex trait influenced by various agro morphological and reproductive traits and hence, there is a need to study the association and their direct and indirect effects on seed yield (Manivannan and Anandakumar, 2013) [6]. This information will help to provide basis for selection and yield improvement in guar, this study will investigate the interrelationship between yield and its components, determine the relative contribution of the different yield components to the final yield and estimate the expected genetic advances and relative efficiencies. As such, before launching any breeding programme, a thorough knowledge of the nature and magnitude of genetic variability and extent of association between yield and other components is very essential.

Material and Methods

The experiment was conducted at Student Research Farm, College of Horticulture, Dr. Y.S.R. Horticultural University, Mojerla, Mahabubnagar, Telangna state during kharif, 2014. The experiment was laid out in a Completely Randomized Block Design. Seeds of each cultivar were sown with a spacing of 30 x 30 cm in 3× 2 m plots in three replications. Before sowing Soil, samples were drawn at random (from 0-30 cm depth) from the experimental field and the composite sample was analysed for physico-chemical properties. Mojerla falls under semi-arid tropical climate, situated at an altitude of 346 m above the Mean Sea Level. Geographically, it lies at latitude of 16.26^0 N and longitude of 77.56^0 E. The monthly mean meteorological data recorded during the crop growth period (August, 2014 to December, 2014) at Meteorological observatory, Krishi Vigyan Kendra, Madanapuram. At all the stages of the crop growth, the weather was congenial for growth and development of seed guar. 10% sugar or jaggery solution was prepared in boiling water. This sugar solution was allowed to cool. On cooling 3-4 packets of guar bacterial culture (*Rhizobium japonicum*) was mixed with solution to make a thin paste. This paste was coated over to the seed. Seed was dried under shade for 30-40 minutes before sowing. All the package of practices to raise the crop was followed as recommended for seed guar under exploited vegetable crop. The need-based plant protection measures were taken to raise the healthy crop. Data recorded on eleven different characters on five randomly selected competitive plants in each of the accession at various phenophases of the crop. The mean values of five competitive plants were averaged and expressed as mean of the respective character. The recorded data were subjected to analysis of variance as per the procedure given by Panse and Sukhatme (1985) [8].

Result and Discussion

The results of analysis of variance for 15 cultivars in seed guar are furnished in Table 1. Highly significant differences among the cultivars were observed for all the yield and yield component characters studied. Mean performance pertaining to the yield associated characters are presented in the Table 2. Significantly number of seeds per pod ranged from 5.30 to 9.00 with a grand mean of 7.40. The maximum number of seeds per pod was recorded in RGC 986 (9.00) and the minimum number of seeds per pod was recorded in RGC 1031(5.30). Seven cultivars have exceeded the general mean value. Seed to pod ratio ranged from 45.73 to 50.53% with a grand mean of 48.53%. The maximum seed to pod ratio was recorded in RGC 1038 (50.53%) and the minimum seed to pod ratio was recorded in RGC 1025 (45.73%). Seven cultivars have exceeded the general mean value. The pod yield per plant ranged from 17.33 to 45.00 g with a grand mean of 28.62 g. The cultivar RGC 986 recorded the maximum pod yield per plant (45.00 g) and the minimum pod yield per plant was recorded in RGC 1031 (17.33 g). Five cultivars have exceeded general mean value (plate1). The pod yield per hectare ranged from 19.25 to 49.99 q/ha with a grand mean of 31.80 q/ha. The cultivar RGC 986 recorded the maximum pod yield per plant (49.99 q/ha.) and the minimum pod yield per plant was recorded in RGC 1031 (19.25 q/ha.). Five cultivars have exceeded general mean value. These results are in conformity with Rambabu *et al.* (2017) [11] in cowpea.

Table 1: Analysis of variance for yield and yield components of seed guar (*Cyamopsis tetragonoloba* (L) Taub.) cultivars.

S. No.	Character	Mean sum of squares		
		Replications (d.f=2)	Treatments (d.f=14)	Error (d.f=28)
1.	Number of seeds per pod	0.87	2.92**	0.27
2.	Seed to pod ratio	1.54	6.81**	0.63
3.	Pod yield per plant (g)	3.36	190.66**	1.52
4.	Pod yield per hectare (q./ha.)	4.15	235.37**	1.88
5.	Seeds yield per plant (g)	1.03	45.95**	0.71
6.	Seed yield per hectare (q./ha.)	1.27	56.72**	0.87
7.	100-seed weight (g)	0.01	0.21**	0.03
8.	Harvest Index (%)	0.68	43.09**	0.24

Table 2: Mean performance of fifteen cultivars of seed guar (*Cyamopsis tetragonoloba* (L.) Taub.) for yield and yield component characters

Cultivars	No. of seeds per pod	Seed to pod ratio	Pod yield per plant (g)	Pod yield per ha. (q/ha)	Seed yield per plant (g)	Seed yield per ha. (q/ha)	100 seed weight (g)	Harvest Index (%)
RGC 197	6.67	48.21	29.00	32.22	13.70	15.22	4.39	66.80
RGC 936	7.33	50.00	27.67	30.73	13.67	15.18	4.17	70.93
RGC 963	8.67	50.19	33.33	37.03	16.73	18.59	4.03	72.25
RGC 986	9.00	49.07	45.00	49.99	21.93	24.36	4.09	69.15
RGC 1002	6.00	46.72	19.33	21.48	9.03	10.03	4.36	78.75
RGC 1025	7.67	45.73	27.33	30.37	12.50	13.89	4.03	76.45
RGC 1031	5.33	47.12	17.33	19.25	8.17	9.07	3.88	78.00
RGC 1033	7.33	48.19	35.33	39.25	17.03	18.92	3.84	74.60
RGC 1038	7.67	50.53	27.67	30.73	13.00	14.44	4.17	71.03
RGC 1066	7.33	50.02	24.00	26.66	12.00	13.33	4.24	74.80
HG 365	7.00	48.30	24.00	26.66	11.67	12.95	4.09	78.80
HG 884	8.00	50.52	27.00	29.99	13.63	15.14	3.86	79.10
HG 2-20	8.67	47.85	44.33	49.25	21.07	23.40	4.79	72.67
JJ-1	6.67	46.95	23.00	25.55	10.80	11.99	3.77	76.75
JG-2	7.67	48.54	25.00	27.77	12.13	13.48	3.88	75.63
Mean	7.4	48.53	28.62	31.80	13.80	15.33	4.11	74.38
Range lowest	5.3	45.73	17.33	19.25	8.17	9.07	3.77	66.80
Range highest	9	50.53	45.00	49.99	21.93	24.36	4.79	79.10
C.V. (%)	7.04	1.64	4.31	4.31	6.09	6.09	4.23	0.66
S.E. ±	0.30	0.46	0.71	0.79	0.48	0.54	0.10	0.29
C.D. at 5%	0.87	1.33	2.06	2.29	1.41	1.56	0.29	0.83
C.D. at 1%	1.18	1.79	2.78	3.09	1.90	2.10	0.39	1.11

Plate 1: Seed guar pods in experimental plot

The seed yield per plant ranged from 8.17 to 21.93 g with a grand mean of 13.80 g. The cultivar RGC 986 recorded the maximum seed yield per plant (21.93 g) and the minimum seed yield per plant was recorded in RGC 1031 (8.17 g). Five cultivars have exceeded general mean value. The seed yield per hectare ranged from 9.07 to 24.36 q/ha with a grand mean of 15.33 q/ha. The cultivar RGC 986 recorded the maximum seed yield per plant (24.36 q/ha.) and the minimum seed yield per plant was recorded in RGC 1031 (9.07 q/ha.). Five cultivars have exceeded general mean value. The character 100 seed weight ranged from 3.77 to 4.79 g with a total mean of 4.11 g. The cultivar HG 2-20 recorded the maximum 100 seed weight (4.79 g) and JJ-1 recorded the minimum 100 seed weight (3.77 g). Six cultivars have exceeded general mean value. Singh *et al.* (2011) and reported for days to first flowering, days to 50 percent flowering, number of pods per plant, pod weight, pod length, pod width, number of seeds per pod, 100 seed weight and pod yield per plant in hyacinth bean. Harvest index among 15 cultivars ranged from 66.80 to 79.10%. Highest value was recorded by the cultivar HG 884 (79.10%), whereas lowest was recorded by RGC 197 (66.80%). Nine cultivars exceeded the general mean value (74.38%). Hence these three superior genotypes may be further tested in different locations for their stable performance and thereafter may be selected as parental source for future breeding programmes. Being an underexploited vegetable, the package of practices for commercial cultivation has to be standardized and its nutritional quality may be exploited.

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