



Research Article

EVALUATION OF F₁ HYBRIDS OF PUMPKIN (*Cucurbita moschata* Duch. ex Poir.) FOR YIELD ATTRIBUTES

HATWAL P.K., YADAV V.S., SHARMA ATUL, THAKUR RIYA AND MEENA K.K.

Rajasthan Agricultural Research Institute, Durgapura, Jaipur, 302018, Sri Karan Narendra Agriculture University, Jobner, 303329, Rajasthan, India

*Corresponding Author: Email - pvhorti88@gmail.com

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Abstract: An investigation was carried out to study the performance of 28 hybrids of pumpkin (*Cucurbita moschata* Duch. ex Poir.) through diallel mating design excluding reciprocals. Observations were recorded on the traits, viz., number of primary branches per vine, node number at which first female flower appears, days to initiation of first female flower, number of fruits per vine, days to first fruit harvest, fruit weight, fruit size, 100 seed weight, flesh thickness, vine length and fruit yield per vine. Among the 28 hybrids of pumpkin studied, the cross 'Kashi Harit x Punjab Samrat' excelled in yield per vine followed by the cross 'Narendra Upcar x Suvarna'. Thus, first generation hybrids can be well-utilized for exploiting hybrid vigour to achieve improved quality.

Keywords: Evaluation, Hybrids, Pumpkin, Generation, Diallel

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Introduction

Pumpkin (*Cucurbita moschata* Duch. ex Poir.) originated in Central Mexico and is cultivated in the tropical and subtropical regions of the world. It is an important cucurbitaceous vegetable crop of India, constituting a principal ingredient in several Indian dishes. Pumpkin has received little attention in crop improvement compared to other cucurbitaceous vegetables. In pumpkin, the major problem is its large-sized fruits (5-6 kg each). This is not overly preferred by the present nuclear families of three to four members. Further, with increase in number of such families recently in India, customers prefer to buy only whole fruits of medium-size pumpkins, instead of cut pieces. Further, small fruits are easily packed and transported, without any damage. Therefore, developing pumpkin hybrids with small to medium-sized fruits (2-3 kg) is essential [20]. The present study was undertaken to evaluate F₁ hybrids for yield and quality for this purpose.

Material and Methods

The investigation was conducted at experimental farm of Vegetable Crops, Division of Horticulture, Rajasthan Agricultural Research Institute, Durgapura, Jaipur during 2014-15 with 28 F₁ hybrids and their parents obtained through diallel mating design excluding reciprocals. The resulting hybrids of 28 cross combinations were evaluated in a Randomized Block Design with three replications during Summer, 2015. The crop was grown on a raised bed of 52 meters length and 1.0 m width and 15 cm height having sandy loam soil. Between the two beds 2.4 meters distance was kept for proper intercultural operations as well as crop management. On each bed drip line was stretched parallel to bed. Two seeds were sown directly on both side of the bed at 2.0 cm depth. A random sample of five plants from each of the plot (crosses and parents) from each replication and observations on a total of thirteen morphological traits viz., number of primary branches per vine, node number at which first female flower appears, days to initiation of first female flower, number of fruits per vine, days to first fruit harvest, fruit weight, fruit size, 100 seed weight, flesh thickness, vine length and fruit yield per vine were recorded on each of the five randomly selected plants. Statistical analysis of data was done to estimate per se values and degree of significance of various traits [11].

Results and Discussion

In Pumpkin hybrids exhibited significant differences for all the characters under study for growth, yield and quality, thus offering scope for selecting high-yielding hybrids with good quality traits. Results of per se performance of hybrids are presented in [Tables-1 and 2]. The sca effect of a hybrid denotes deviation from performance prediction based on gca of the parents [1]. The sca effect seen is due to dominance, epistasis and environmental influence. Under certain favourable conditions, all the non-additive gene functions may be triggered and may result in high sca effect and mean value of a responding hybrid [12]. Thus, evaluation of a hybrid for high per se and sca effect is also an important criterion. Hybrids with high per se and sca effect were evaluated for selecting the best hybrids [5]. The gca and sca values of parents and hybrids are presented in [Tables-3 and 4], respectively. Number of primary branches per vine is an important parameter for obtaining high fruit yield in crops like the pumpkin. The present study of 28 pumpkin crosses, the cross Ambili x Kashi Harit (P1 x P3), Anand Pumpkin-1 x Kashi Harit (P2 x P3) and Kashi Harit x Narendra Upcar (P3 x P5) exhibited the high SCA and mean performance for number of primary branches per vine. The sca variances of number of primary branches per vine were greater than those of gca suggesting the better role of non-additive genetic factors than that of additive action. Similar results were found in bitter melon in the cross 'Pocha Seed x PSPL' [18]. In these crosses, the parents, Narendra Upcar, Kashi Harit, Punjab Samrat and Pusa Vishwas exhibited good general combining ability for number of primary branches per vine. The predominant role of non-additive gene action for number of primary branches per vine was reported in pumpkin [19]. Per se and sca performance for node number for first female flower appearance in the 28 crosses was favorable in Narendra Upcar x Suvarna (P5 x P8) followed by Kashi Harit x Narendra Upcar (P3 x P5) and Ambili x Narendra Agrim (P1 x P4). For this character, the sca variances were greater than those of gca suggesting the role of non-additive gene action. This is in agreement with the findings in bitter melon [8]. Days taken to first female flower appearance is considered as one of the essential criteria for selecting for earliness in hybrids. Among the 28 pumpkin crosses studied, the hybrid 'Ambili x Pusa Vishwas (P1 x P7)' was identified as the best.

Table-1 Mean performance of F₁ hybrids of pumpkin for growth parameters

Hybrid	Number of primary branches per vine	Node number at which first female flower appears	Days to initiation of first female flower	Number of fruits per vine	Days to first fruit harvest	Vine Length (m)
P ₁ XP ₂	1.67	14.45	52.00	2.37	118.82	3.40
P ₁ XP ₃	1.70	12.32	42.48	2.75	103.95	4.27
P ₁ XP ₄	1.57	11.2	40.90	2.01	93.85	2.97
P ₁ XP ₅	1.80	17.57	53.45	4.28	110.36	2.48
P ₁ XP ₆	1.95	11.85	54.53	3.29	109.78	3.95
P ₁ XP ₇	1.57	14.95	43.35	2.57	101.08	4.40
P ₁ XP ₈	1.53	15.88	55.62	2.35	111.5	3.92
P ₂ XP ₃	1.80	14.63	53.08	2.95	100.28	4.35
P ₂ XP ₄	1.73	11.70	40.10	5.13	96.88	2.92
P ₂ XP ₅	1.67	13.08	54.38	3.14	108.27	2.32
P ₂ XP ₆	1.65	12.23	44.28	2.73	105.57	4.32
P ₂ XP ₇	1.83	13.45	55.97	2.32	118.12	4.9
P ₂ XP ₈	1.80	11.67	55.87	2.43	101.67	3.03
P ₃ XP ₄	1.67	10.75	39.92	3.11	95.03	2.07
P ₃ XP ₅	1.70	11.45	54.35	3.10	108.25	4.15
P ₃ XP ₆	2.20	10.47	41.00	4.20	94.35	4.55
P ₃ XP ₇	1.67	12.27	53.95	2.20	123.25	4.85
P ₃ XP ₈	1.73	13.20	57.28	2.75	99.80	3.28
P ₄ XP ₅	1.67	11.13	54.80	2.55	108.35	2.53
P ₄ XP ₆	1.67	9.90	53.3	3.07	98.50	2.32
P ₄ XP ₇	1.83	14.62	55.55	2.72	113.87	3.90
P ₄ XP ₈	1.45	11.47	54.95	2.49	96.98	2.32
P ₅ XP ₆	2.33	11.73	47.43	3.34	100.78	4.05
P ₅ XP ₇	1.67	14.72	54.20	2.41	118.05	3.99
P ₅ XP ₈	1.85	10.88	55.27	3.3	94.98	4.65
P ₆ XP ₇	2.15	11.65	47.99	3.31	125.78	4.78
P ₆ XP ₈	1.73	11.68	49.17	2.66	110.25	2.25
P ₇ XP ₈	1.80	14.48	54.6	3.18	123.9	3.98
Mean	1.76	12.69	50.71	2.95	106.87	3.6
SEd	0.06	0.31	0.58	0.08	0.93	0.11
CD (P=0.05)	0.15	0.67	1.24	0.18	2.00	0.23

Where, P₁ = Ambili, P₂ = Anand Pumpkin-1, P₃ = Kashi Harit, P₄ = Narendra Agrim, P₅ = Narendra Upcar, P₆ = Punjab Samrat, P₇ = Pusa Vishwas, P₈ = Suvarna**Table-2** Mean performance of F₁ hybrids of pumpkin for yield parameters

Hybrid	Average fruit weight (kg)	Fruit size (cm ²)	100 seed weight(g)	Flesh thickness(cm)	Fruit yield per vine (kg)
P ₁ XP ₂	2.27	278.88	988%	2.41	5.37
P ₁ XP ₃	2.24	222.17	1092%	1.85	6.17
P ₁ XP ₄	1.73	211.17	974%	2.11	3.49
P ₁ XP ₅	1.47	261.62	993%	2.91	6.31
P ₁ XP ₆	2.32	215.65	9.85	3.25	6.48
P ₁ XP ₇	2.51	307.85	9.63	3.06	7.56
P ₁ XP ₈	1.65	232.32	9.37	2.82	2.56
P ₂ XP ₃	2.65	290.08	12.02	2.85	7.27
P ₂ XP ₄	1.84	192.63	11.68	1.65	5.05
P ₂ XP ₅	2.85	337.78	12.23	2.91	6.08
P ₂ XP ₆	2.7	296.22	10.05	2.82	6.37
P ₂ XP ₇	2.84	302.35	10.77	3.13	6.58
P ₂ XP ₈	1.73	254.95	12.3	2.46	3.73
P ₃ XP ₄	2.51	195.88	12.87	2.08	5.8
P ₃ XP ₅	2.59	209.32	12.03	3.31	8.03
P ₃ XP ₆	3.07	295.45	10.41	3.64	10.17
P ₃ XP ₇	4.34	340.21	13.23	3.19	7.28
P ₃ XP ₈	1.91	261.77	9.63	1.81	4.46
P ₄ XP ₅	2.2	220.26	9.8	1.87	5.61
P ₄ XP ₆	2.53	222.18	11.47	2.9	7.17
P ₄ XP ₇	3.62	308.58	10.95	2.63	7.4
P ₄ XP ₈	2.33	192.42	10.83	2.65	5.45
P ₅ XP ₆	2.31	217.15	9.92	2.79	6.88
P ₅ XP ₇	2.23	316.45	12.08	3.2	3.98
P ₅ XP ₈	2.95	291.73	14.17	3.37	9.73
P ₆ XP ₇	3.2	287.53	10.53	3.72	8.11
P ₆ XP ₈	2.35	242.05	12.02	2.95	6.25
P ₇ XP ₈	2.88	297	10.13	2.91	8.08
Mean	2.49	260.77	11.02	2.76	6.34
SEd	0.05	2.58	0.13	0.05	0.15
CD (P=0.05)	0.11	5.5	0.29	0.12	0.33

Where, P₁ = Ambili, P₂ = Anand Pumpkin-1, P₃ = Kashi Harit, P₄ = Narendra Agrim, P₅ = Narendra Upcar, P₆ = Punjab Samrat, P₇ = Pusa Vishwas, P₈ = Suvarna

Table-3 General combining ability effects of pumpkin parents

Parents	No. of primary branches/ vine	Node no. at which 1 st female flower appears	Days to initiation of 1 st female flower	No. of fruits/ vine	Days to 1 st fruit harvest	Fruit weight (kg)	Fruit size (cm ²)	100 seed weight (g)	Flesh thickness (cm)	Vine length (m)	Yield/vine (kg)
P ₁	-0.06**	1.07**	-1.33**	0.30**	3**	-0.41**	-8.89**	-1.02**	-0.13**	0.25**	-0.58**
P ₂	-0.11**	-0.3**	-0.32**	-0.01	0.84**	-0.10**	11.33**	0.61**	-0.10**	0.08**	-0.32**
P ₃	0.07**	-0.72**	-2.15**	0.02	-5.11**	0.21**	-4.65**	0.29**	-0.06**	0.29**	0.64**
P ₄	-0.23**	-1.4**	-2.94**	-0.01	-9.12**	-0.07**	-32.85**	-0.21**	-0.46**	-0.75**	-0.26**
P ₅	0.09**	0.88**	2.87**	-0.17**	2.02**	-0.12**	1.22*	0.38**	0.02	-0.20**	-0.13**
P ₆	0.39**	-1.25**	-1.54**	0.10**	-1.54**	0.07**	-6.77**	-0.14**	0.42**	0.09**	0.65**
P ₇	0.23**	1.35**	1.77**	-0.20**	10.21**	0.52**	44.28**	-0.12**	0.43**	0.72**	0.94**
P ₈	-0.38**	0.37**	3.65**	-0.36**	-0.3	-0.07**	-3.66**	0.21**	-0.11**	-0.48**	-0.94**
SE gi	0.01	0.07	0.13	0.01	0.21	0.01	0.57	0.03	0.01	0.02	0.04

Where, P₁ = Ambili, P₂ = Anand Pumpkin-1, P₃ = Kashi Harit, P₄ = Narendra Agrim, P₅ = Narendra Upcar, P₆ = Punjab Samrat, P₇ = Pusa Vishwas, P₈ = Suvarna

Table-4 Specific combining ability effects of hybrids for different traits

Parents	No. of primary branches/ vine	Node no. at which 1 st female flower appears	Days to initiation of 1 st female flower	No. of fruits/ vine	Days to 1 st fruit harvest	Fruit weight (kg)	Fruit size (cm ²)	100 seed weight (g)	Flesh thickness (cm)	Vine length (m)	Yield/vine (kg)
P ₁ XP ₂	-0.51**	0.23	2.39**	-0.14**	7.52**	0.5**	31.14**	-0.83**	0.03	-0.34**	1.14**
P ₁ XP ₃	0.61**	-1.48**	-5.3**	0.13*	-1.4*	0.17**	-9.58**	0.53**	-0.57**	0.32**	0.75**
P ₁ XP ₄	0.04	-1.92**	-6.1**	-0.35**	-9.03**	-0.06	7.62**	-0.15	0.1**	0.06	-0.92**
P ₁ XP ₅	0.04	2.16**	65%	3.26**	-2.12**	-0.27**	24**	-0.56**	0.41**	0.83**	2.81**
P ₁ XP ₆	0.45**	-1.43**	6.14**	-0.02	0.87	0.37**	-13.98**	-0.12	0.36**	0.21**	0.86**
P ₁ XP ₇	0.5**	-0.93**	-8.35**	0.72**	-19.58**	0.12**	27.17**	-0.35**	0.16**	0.37**	2.33**
P ₁ XP ₈	-0.17**	0.99**	2.04**	-0.5**	1.34*	-0.15**	-0.43	-0.95**	0.46**	0.74**	-1.29**
P ₂ XP ₃	0.58**	2.21**	4.29**	0.04	-2.9**	0.27**	38.11**	0.05	0.39**	0.58**	0.81**
P ₂ XP ₄	0.34**	-0.04	-7.9**	-0.42**	-7.78**	-0.27**	-31.15**	0.16	-0.4**	0.19**	2.46**
P ₂ XP ₅	0.09*	-0.94**	0.57	0.07	-2.04**	0.51**	79.94**	0.12	0.38**	-0.96**	2.7**
P ₂ XP ₆	0.38**	-1.01**	-5.12**	-0.27**	-1.18*	0.45**	46.36**	-1.54**	-0.12**	0.75**	0.35**
P ₂ XP ₇	-0.11**	-1.05**	3.25**	-0.38**	-0.38	0.14**	1.45	-0.84**	0.19**	0.7**	-0.73**
P ₂ XP ₈	-0.16**	-1.85**	1.28**	-0.11*	-6.33**	-0.37**	1.98	0.35**	0.06	0.03	-1.2**
P ₃ XP ₄	-0.44**	-0.58**	-6.26**	0.19**	-12.2**	0.1*	-11.9**	1.67**	-0.01	-0.87**	0.75**
P ₃ XP ₅	0.51**	-2.16**	2.37**	0.07	3.88**	0.23**	-32.54**	0.24**	0.74**	0.66**	0.84**
P ₃ XP ₆	0.29**	-1.01**	-6.58**	2.25**	-18.66**	0.89**	61.58**	-0.86**	0.66**	0.77**	4.93**
P ₃ XP ₇	-0.5**	-1.81**	3.06**	-0.53**	12.85**	1.33**	55.29**	1.95**	0.21**	0.44**	1.29**
P ₃ XP ₈	-0.34**	0.1	4.52**	0.18**	-2.25**	-0.5**	24.78**	-1.99**	-0.63**	0.07	-1.11**
P ₄ XP ₅	-0.51**	-1.8**	3.6**	-0.52**	7.99**	0.11**	6.6**	-1.49**	-0.3**	0.08	-0.68**
P ₄ XP ₆	0.4**	-0.9**	6.51**	0.08	-7.3**	0.25**	16.52**	0.69**	0.33**	-0.42**	0.7**
P ₄ XP ₇	0.09*	1.22**	5.45**	0.02	5.33**	0.79**	28.88**	0.16	0.06*	0.53**	2.47**
P ₄ XP ₈	0.4**	-0.95**	2.98**	-0.05	-3.06**	0.2**	-16.37**	-0.3**	0.52**	0.14*	0.34**
P ₅ XP ₆	0.42**	-1.35**	-5.16**	0.16**	-7.15**	0.08*	-22.59**	-1.45**	-0.25**	0.76**	0.52**
P ₅ XP ₇	0.41**	-0.97**	-1.71**	-0.48**	-1.63**	-0.45**	25.66**	0.71**	0.15**	0.07	-2.12**
P ₅ XP ₈	-0.38**	-2.47**	-2.51**	1.18**	-9.29**	1.08**	51.87**	2.45**	0.61**	-0.43**	3.81**
P ₆ XP ₇	0.21**	-1.9**	-3.51**	0.5**	9.66**	0.32**	4.74**	-0.33**	0.27**	0.57**	2.33**
P ₆ XP ₈	-0.7**	-0.89**	-4.21**	0.01	4.64**	0.07	7.19**	0.82**	0.45**	-0.77**	-0.13
P ₇ XP ₈	0.6**	-0.69**	-2.08**	0.82**	6.54**	0.14**	11.09**	-1.08**	-0.01	0.33**	3.33**
SE Sij	0.04	0.18	0.36	0.05	0.58	0.04	1.58	0.09	0.03	0.06	0.12
** Significant at 1 % level								* Significant at 5 % level			

Where, P₁ = Ambili, P₂ = Anand Pumpkin-1, P₃ = Kashi Harit, P₄ = Narendra Agrim, P₅ = Narendra Upcar, P₆ = Punjab Samrat, P₇ = Pusa Vishwas, P₈ = Suvarna

However, the parents, Narendra Agrim, Kashi Harit and Punjab Samrat had favorable negative gca value. Similar results were found in bottle gourd [17] and in pumpkin [4]. Fruit number per vine is a preferable trait for screening the hybrids for high yield. The hybrids Ambili x Narendra Upcar (P₁ x P₅), Kashi Harit x Punjab Samrat (P₃ x P₆), Narendra Upcar x Suvarna (P₅ x P₈) and Pusa Vishwas x Suvarna (P₇ x P₈) recorded the highest per se coupled with significant gca and sca effect for fruit number per vine. In these crosses, as the female parents Kashi Harit (P₃) and Pusa Vishwas (P₇) had already proved as a good general combiner for this trait. In pumpkin, higher fruit number per vine in ten crosses and five parents in a partial diallele analysis wherein the cross 'CM-45 x CM-14' showed

highest per se performance and sca for this trait [21]. Earliness in terms of days to first fruit harvest is useful to select hybrids for commanding a premium price for fruits in the early markets [7]. The cross combinations for days to first fruit harvest revealed that Ambili x Pusa Vishwas (P₁ x P₇) followed by Kashi Harit x Punjab Samrat (P₃ x P₆), Kashi Harit x Narendra Agrim (P₃ x P₄) and Narendra Upcar x Suvarna (P₅ x P₈) could be selected as the best performing hybrids as they proved their superiority through per se, and SCA values. Similar trend of earliness was observed in ash gourd hybrids [6]. The crosses 'Monsoon Miracle x Holly Green' and 'The largest x Indian Prime' gave significant and negative sca for days to first fruit harvest in bitter gourd [10].

Vine length is an important parameter for obtaining high fruit yield in crops like the pumpkin. Among the 28 hybrids of pumpkin studied, the crosses Ambili x Narendra Upcar (P1 x P5), Kashi Harit x Punjab Samrat (P3 x P6) and Narendra Upcar x Punjab Samrat (P5 x P6) exhibited the high sca and mean performance for vine length. Similar results were recorded in bitter melon in the cross 'Pocha Seed x PSPL' [21]. The sca variances of vine length were greater than those of gca suggesting the better role of non-additive genetic factors than that of additive action [13]. The predominant role of non-additive gene action for vine length was reported by various researchers in pumpkin [9].

Fruit weight is a primary trait to be considered in any hybrid development programme, as, it directly contributes towards yield. In this study, of the 28 pumpkin hybrids studied, highest fruit weight and sca effect was registered by Kashi Harit x Pusa Vishwas (P3 x P7) followed by Narendra Upcar x Suvarna (P5 x P8), Kashi Harit x Punjab Samrat (P3 x P6) and Narendra Agrim x Pusa Vishwas (P4 x P7). Higher fruit weight in hybrids was reported in ridge gourd [3]. However, lately, small-to medium-sized pumpkin fruits of 2-3 kg weight each are preferred. However, the gca value of Narendra Agrim (P4) was positive but non-significant. Therefore, transgressive segregants can be related for cyclic relation. Parent Suvarna (P8) is a poor combiner, while the female parents were good combiner for fruit weight. Similar results were recorded in ridge gourd [15]. In the case of fruit size, the hybrid i.e. Anand Pumpkin -1 x Narendra Upcar (P2 x P5) was good combiner. The hybrid combinations Kashi Harit x Punjab Samrat (P3 x P6), Kashi Harit x Pusa Vishwas (P3 x P7) and Narendra Upcar x Suvarna (P5 x P8) are proved its superiority in terms of high per se and sca also. These results were supported in pumpkin [11]. For any hybrid seed development programme higher seed number per fruit is favorable as it would reduce the cost of seed production. The estimates of sca effect for hundred seed weight, the cross Narendra Upcar x Suvarna (P5 x P8) followed by Kashi Harit x Pusa Vishwas (P3 x P7) exhibited additive gene action by this trait. It was observed that seed weight was governed by recessive gene [10]. These results were found almost equivalent with the results obtained in bitter melon [16]. In pumpkin, flesh thickness is yet another important character determining market preference. The present investigation revealed that the hybrid 'Kashi Harit x Narendra Upcar (P3 x P5)' possessed highest flesh thickness and sca among the twenty eight hybrid combinations. The hybrids Kashi Harit x Punjab Samrat (P3 x P6) and Narendra Upcar x Suvarna (P5 x P8) also recorded the highest per se coupled with significant sca effect for fruit flesh thickness. This is in accordance with the report in pumpkin involving twenty five crosses and five parents in a partial diallel analysis wherein the cross 'P4 x P3' showed highest per se performance and sca for flesh thickness [14]. Expression of yield to the fullest potential of the crop is the prime trait to be considered in any hybridization programme. Based on per se performance and sca of hybrids, the crosses Kashi Harit x Punjab Samrat (P3 x P6) followed by Narendra Upcar x Suvarna (P5 x P8) and Pusa Vishwas x Suvarna (P7 x P8) proved to be the best specific combiners for yield which proved their superiority through per se, gca and sca values. The Similar results in the crosses MS1 x Punjab Sunheri and MS1 x Hara Madhu exhibited the highest sca effect and recorded the highest fruit yield per vine in muskmelon [2]. Evaluation of hybrids for per se and sca revealed that the cross Kashi Harit x Punjab Samrat (P3 x P6) was adjudged as the best hybrid, since it recorded the highest mean and sca effect for more number of traits of study viz., earliness in terms of early female flowering, fruit number per vine, days to first fruit harvest, fruit weight, fruit size, flesh thickness, vine length and total yield per vine. The next best hybrid, Narendra Upcar x Suvarna (P5 x P8) could also be justified as the better combination through less node number for first female flower appearance, fruit number per vine, fruit weight, hundred seed weight, flesh thickness and fruit yield per vine.

Application of research: The above crosses may be further studies for commercial exploitation of hybrid vigour.

Research Category: Vegetable Breeding

Abbreviations: Kg- Kilogram, CM- Centimetre

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***Research Guide:** Dr V. S. Yadav

University: Sri Karan Narendra Agriculture University, Jobner, 303329, Rajasthan
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