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RESEARCH PAPER

Genetic variability in local collections of Byadgi chilli (*Capsicum annum* L) for qualitative and quantitative traits

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Abstract: The often-cross pollinated nature of chilli has contributed to the heterogeneous composition of many locally adapted landraces. Byadgi chilli is a famous local variety of chilli grown in Karnataka state and many variants are found. The present work was carried out to assess genetic variability, heritability and genetic advance in 22 Byadgi chilli variants and two checks using RCBD with three replications at seed farm, College of Agriculture, Hanumanamatti, UAS, Dharwad. Analysis of variance revealed presence of significant differences among the variants for all the characters studied. Greater magnitude of heritable variation was observed for number of fruits/plant, fruit weight, capsaicin content and dry fruit yield in both Byadgi kaddi and dabbi as reflected by high PCV and GCV estimates. High heritability coupled with high genetic advance over mean was observed for number of fruits/plants, fruit length, fruit weight, capsaicin content, oleoresin content, and dry fruit yield/ha. This indicates that these traits are governed by additive gene action and selection for these characters will be effective. K-2, K-6 and K-7 were found to be on par with check for fruit yield and fruit colour and significantly superior for fruit wrinkles, capsaicin content and oleoresin content. In dabbi D-5 out-performed for fruit yield and oleoresin content.

Key words: Byadgi dabbi, Byadgi kaddi, Genetic advance, Heritability, Variability

Introduction

Chilli (*Capsicum annuum* L) is one of the most important vegetable cum spice crop of India. It belongs to the genus Capsicum under the Solanaceae family, with chromosome number of 2n=24. Chilli renowned as a versatile spice, serves numerous purposes as a vegetable, condiment and culinary ingredient, apart from its medicinal properties attributed to its rich content of various phytochemicals. The characteristic biting pungency of chillies is due to the alkaloid called 'capsaicin' found in the pericarp and placenta of the fruit. The presence of oleoresin in chillies is particularly significant as it enhances color distribution and imparts a delightful flavour to various food preparations (Maurya *et al*., 2017).

Byadgi chilli is a famous local variety of chilli grown in Karnataka state and tagged with Geographical Indication (GI application No. 129) product of Karnataka. The two main varieties of Byadgi chillies are Byadgi Kaddi and Byadgi Dabbi. The Byadgi chillies have very special quality features expressed in the varieties influenced and stabilized by edaphic, weather and soil factors of the regions. The cultivars are known for their deep red colour (160-180) ASTA, very low pungency (500-5000 SHU), very high rudrakshi wrinkles, low seed content, unique acidic flavour, aroma, volatile oils, taste, good shelf life, consistency in quality and high extractable oleoresin oil from fruits. These features have made these varieties very popular among consumers, spice industries and value addition industries. The genus capsicum is an often cross-pollinated crop and the natural cross pollination may go up to70 per cent depending upon the extent of style exertion, time of dehiscence of anthers, wind direction and insect population (Hosmani,1993). The semi allogamous nature of many chilli varieties has contributed to the heterogeneous composition of many locally adapted landraces. In the farmers field and market, there are many types of Byadgi chilli found. Uniformity and quality of chilli seed stocks are often limited in the varieties grown by most farmers. In this direction it is necessary to assess the genetic variability present in the local variants of Byadgi chilli genotypes for yield and its components and identify variants similar to original Byadgi types which can be further subjected to purification or can be used in breeding programmes.

Material and methods

The experimental material comprised of 22 Byadgi chilli variants collected from the farmers field of chilli growing areas of Haveri, Dharwad, Bagalkot districts and also from the Byadgi market (*kharif* 2021-22). Among these, 11 were Byadgi kaddi type and another 11 were Byadgi dabbi type with two checks (Syngenta hybrids 5531 and 2043). The research work was carried out by conducting two separate experiments, one for Byadgi kaddi and another for Byadgi dabbi chilli collections.

The seedlings were raised in Banashree nursery at Angaragatti, Byadgi (Tq). After 44 days, seedlings of both the types were transplanted to main field during *kharif* 2022-23 at Seed farm, College of Agriculture, Hanumanamatti, University of Agricultural Sciences, Dharwad. Two separate experiments were laid out in randomized complete block design (RCBD) with three replications with a plot size of 8.1 m x 3.6 m with a

Table 1. Analysis of variance for qualitative and quantitative traits in Byadgi kaddi

Source	Df	Dff	Ph (cm)	Nfpp	Fl (cm)	Fd (cm)	Fw (g)	Nspf	Swpf (g)	Pw (g)	Fy (kg/ha)	Fc (Asta)	Wrkl	Capsn (Mg/G)	Oln (%)
Replication	2	0.33	5.81	17.28	0.00	0.00	0.02	19.76	0.01	0.03	4165.74	237.47	0.02	1.89	0.11
Genotypes	11	17.52*	122.77**	1455.29**	0.53**	0.24**	0.39**	1439.37*	0.08**	0.08**	51585.83**	910.36**	2.79**	37.57**	5.41**
Error	22	1.61	7.88	95.51	0.05	0.01	0.01	148.10	0.01	0.02	2958.89	72.34	0.02	2.56	0.88
Total	35	19.46	136.46	1568.08	0.59	0.26	0.41	1607.23	0.10	0.13	58710.46	1220.18	2.83	42.01	46.40

** = Significance at 1% level of probability* = Significance at 5% level of probability

Note= DF= Degrees of freedom, DFF= Days to 50 percent flowering, PH= Plant height, NFPP= Number of fruits per plant, FL= Fruit length, FD=Fruit diameter, FW=Fruit weight, NSPF=Number of seeds per fruit, SWPF=Seed weight per fruit, PW= Pericarp weight per fruit, FY= Dry fruit yield, FC= Fruit colour, WRKL= Fruit wrinkles, CAPSN= Capsaicin content and OLN= Oleoresin content

Table 2. Analysis of variance for qualitative and quantitative traits of Byadgi dabbi

Source	Df	Dff	Ph (cm)	Nfpp	Fl (cm)	Fd (cm)	Fw (g)	Nspf	Swpf (g)	Pw (g)	Fy (kg/ha)	Fc (ASTA)	Wrkl	Capsn (mg/g)	Oln (%)
Replication	2	3.52	0.59	22.14	0.12	0.01	0.01	9.01	0.01	0.00	10243.66	7.41	0.02	0.14	0.02
Genotypes	11	10.84*	200.39*	183.94**	6.30**	0.37**	0.73**	1109.16*	0.11**	0.17*	44146.10*	1737.19**	3.74**	45.78**	36.34**
Error	22	0.98	19.49	16.74	0.48	0.04	0.06	92.32	0.02	0.02	3265.94	103.93	0.02	0.59	0.81
Total	35	15.33	220.46	222.82	6.90	0.42	0.80	1210.50	0.14	0.19	57655.69	1848.53	3.79	46.51	37.17

** = Significance at 1% level of probability* = Significance at 5% level of probability DF= Degrees of freedom, DFF= Days to 50 percent flowering, PH= Plant height, NFPP= Number of fruits per plant, FL= Fruit length, FD=Fruit diameter, FW=Fruit weight, NSPF=Number of seeds per fruit, SWPF=Seed weight per fruit, PW= Pericarp weight per fruit, FY= Dry fruit yield, FC= Fruit colour, WRKL= Fruit wrinkles, CAPSN= Capsaicin content and OLN= Oleoresin content.

spacing of 90 cm x 90 cm with two checks namely Syngenta hybrid 5531 for experiment 1(Byadgi kaddi) and Syngenta hybrid 2043 for experiment 2 (Byadgi dabbi). All the recommended package of practices and plant protection measures were followed to raise the healthy crop. Observations were recorded on 14 qualitative and quantitative characters *viz*., days to 50 per cent flowering, plant height (cm), number of fruits per plant, fruit length (cm), fruit diameter (cm), fruit weight (g), number of seeds per fruit, seed weight per fruit (g), pericarp weight (g), fruit color (ASTA), fruit wrinkles, capsaicin content (mg/g), oleores in content (%) and dry fruit yield (kg/ha). Observations were recorded on five randomly selected plants/variant in each of experimental plots. The selected plants were tagged for taking observations on various growth and yield parameters. The average of five plants was computed and further used for statistical analysis. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), broad-sense heritability (h^2_{bs}) and genetic advance over mean (GAM) were estimated using formulae suggested by Johnson *et al*. (1955) and Hanson *et al*. (1956), Shivasubramanian and Menon (1973).

Results and discussion

ANOVA

Analysis of variance revealed that mean sum of squares (MSS) due to genotypes were significant for all the traits under investigation indicating variability in the local collections of both Byadgi kaddi and dabbi (Table 1 and 2). It becomes evident that there is ample variability observed for all the traits across the genotypes, suggesting that significant improvement can potentially be achieved through selective breeding. However,

Table 3. Genetic variability parameters for qualitative and quantitative traits of Byadgi kaddi

Characters	Mean	Range		PCV (%)	GCV (%)	h^2(%)	GAM
		Min	Max				
DFF	80.25	77.00	86.00	3.40	2.56	56.87	3.98
PH (cm)	71.78	64.40	84.80	9.73	8.01	67.69	13.57
NFPP	72.02	48.90	120.50	33.46	27.41	67.10	46.25
FL (cm)	8.59	7.99	9.38	5.61	4.08	52.98	6.12
FD (cm)	2.04	1.37	2.30	14.97	12.87	73.84	22.78
FW(g)	1.56	1.00	1.96	21.92	21.22	93.70	42.31
NSPF	101.87	59.50	138.60	24.60	17.88	52.83	26.77
SWPF(g)	0.85	0.48	1.08	22.00	16.82	58.45	26.48
PW(g)	0.63	0.29	0.81	25.65	20.82	65.91	34.82
FY (kg/ha)	391.09	197.19	575.97	36.30	30.51	70.64	52.82
FC(ASTA)	158.38	118.82	188.11	12.24	9.60	61.50	15.51
WRKL	2.96	2.00	5.00	32.96	32.23	95.62	64.92
CAPSN (mg/g)	19.29	10.39	23.95	20.13	16.36	66.10	27.40
OLN (%)	27.61	20.58	34.68	14.50	13.68	89.07	26.60

PCV- Phenotypic coefficient of variation, GCV- Genotypic coefficient of variation,h^2(%)-Heritability in broad sense and GAM – Genetic advance as per cent of mean. DFF= Days to 50 percent flowering, PH= Plant height, NFPP= Number of fruits per plant, FL= Fruit length, FD=Fruit diameter, FW=Fruit weight, NSPF=Number of seeds per fruit, SWPF=Seed weight per fruit, PW= Pericarp weight per fruit, FY= Dry fruit yield, FC= Fruit colour, WRKL= Fruit wrinkles, CAPSN= Capsaicin content and OLN= Oleoresin content.

Table 4. Genetic variability parameters for qualitative and quantitative traits of Byadgidabbi

Characters	Mean	Range		PCV (%)	GCV (%)	h^2(%)	GAM
		Min	Max				
DFF	79.79	77.5	84.5	2.68	2.03	57.47	3.18
PH (cm)	68.88	54.5	83.5	13.49	9.99	54.83	15.23
NFPF	35.04	22.4	45.6	24.27	20.23	69.47	34.74
FL (cm)	8.4	6.1	10.644	19.12	15.16	62.89	24.77
FD (cm)	3.51	2.94	4.05	11.62	8.08	48.33	11.57
FW(g)	2.34	1.67	3.26	23.41	18.36	61.53	29.67
NSPF	128.23	98.9	159.7	16.76	12.99	60.04	20.73
SWPF(g)	0.93	0.71	1.21	17.7	12.79	52.26	19.05
PW(g)	0.85	0.44	1.23	31.61	23.66	56.01	36.47
FY (kg/ha)	329.63	135.46	517.84	39.13	34.65	78.43	63.22
FC(ASTA)	138.61	94.55	183.84	18.85	15.73	69.57	27.02
WRKL	2.79	1	5	40.35	39.68	96.72	80.39
CAPSN (mg/g)	16.3	11.58	25.51	24.43	23.51	92.59	46.59
OLN (%)	24.93	17.73	32.01	14.42	13.48	87.4	25.97

PCV- Phenotypic coefficient of variation, GCV- Genotypic coefficient of variation, h^2(%)- Heritability in broad sense and GAM – Genetic advance as per cent of mean DFF= Days to 50 percent flowering, PH= Plant height, NFPP= Number of fruits per plant, FL= Fruit length, FD=Fruit diameter, FW=Fruit weight, NSPF=Number of seeds per fruit, SWPF=Seed weight per fruit, PW= Pericarp weight per fruit, FY= Dry fruit yield, FC= Fruit colour, WRKL= Fruit wrinkles, CAPSN= Capsaicin content and OLN= Oleoresin content.

relying solely on the analysis of variance may not provide a comprehensive explanation of the inherent genotypic variance in the collection. Similar findings were reported by Ahmed *et al.* (2022).

Genetic variability

In the present work, the PCV values were higher than GCV estimates for all the traits studied, indicating the influence of environment on the expression of these traits (Table 3 and 4). These results are in conformity with Mishra *et al*. (2001), Bendale *et al.* (2006) and Sushmitha *et al.* (2019). Very high phenotypic and genotypic coefficient of variations were observed for number of fruits per plant (33.46% and 27.41%), fruit weight (21.92 and 21.22%), pericarp weight (25.65 and 20.82%), fruit wrinkles (32.96 and 32.23%), capsaicin content (20.13 and 16.36%) and dry fruit yield (36.30 and 30.51%) indicating the presence of sufficient variability for these traits in Byadgi kaddi and number of fruits per plant (24.27 and 20.23%), fruit weight (23.41 and 18.36%), pericarp weight (31.61 and 23.66%), fruit wrinkles (40.35 and 39.68%), capsaicin content (24.43 and 23.51%) and dry fruit yield (39.13 and 34.65%) in Byadgi dabbi collections and these traits have better scope for improvement through selection. Similar findings were reported by Shirshat *et al*. (2007), Yogeshkumar *et al.* (2018), Nagaraju *et al.* (2018) Ahmed *et al.* (2022) and Saisupriya *et al.* (2022).

Moderate phenotypic and genotypic coefficient of variations were observed for fruit diameter (14.97 and 12.87%), number of seeds per fruit (24.60 and 17.88%), seed weight per fruit (22.00 and 16.82%) and oleoresin content (14.50 and 13.68%) in Byadgi kaddi and fruit length (19.12 and 15.16%), number of seeds per fruit (16.76 and 12.99%), seed weight per fruit (17.70 and 12.79%), oleoresin content (14.42% and 13.48%) and fruit colour (18.85 and 15.73%) in Byadgi dabbi variants indicating moderate level of variability for these characters. These results are in conformity with Rekha *et al.* (2016), Pandiyaraj *et al.* (2017) and Patel *et al.* (2022).

Low phenotypic and genotypic coefficient of variations were observed for days to 50 per cent flowering (3.40 and 2.56%) pant height (9.73 and 8.01%) and fruit length (5.61 and 4.08%) in Byadgi kaddi genotypes and low variation was observed for

Table 5. Mean performance of Byadgi kaddi local collections

Entries	Fy (q/ha)	Dff	Ph (cm)	Nfpp	Fl (cm)	Fd (cm)	Fw (g)	Nspf	Swpf (g)	Pw (g)	Fc (ASTA)	Wrkl	Capsn (mg/g)	Oln (%)
K-1	4.37	77.0	68.05	50.30	8.4	2.16*	1.86*	138.6	1.081	0.782*	174.41	2.0*	20.30*	32.67*
K-2	5.18	79.0	69.90	88.10	8.3	2.26*	1.96*	118.4	1.042	0.746*	173.1	2.5*	21.60*	30.02*
K-3	3.09	86.0*	65.70	100.80	8.9	1.64	1.58*	94.7	0.838	0.518*	155.06	3.0*	20.41*	34.68*
K-4	1.97	81.0	67.80	57.20	7.2	2.30*	1.72*	104.4	0.885	0.618*	151.04	3.0*	19.99*	23.76
K-5	2.97	79.0	84.80	70.60	8.6	1.84*	1.04	59.5	0.644	0.442*	149.57	3.0*	18.16*	29.10*
K-6	5.23	79.0	72.80	120.50*	7.9	2.19*	1.57*	105.7	0.876	0.464*	155.64	2.0*	17.50*	28.57*
K-7	5.62	81.0	75.50	89.90	8.5	2.17*	1.94*	109.0	0.923	0.456*	157.36	3.0*	22.39*	27.95*
K-8	4.06	80.0	81.80	75.80	9.6*	2.05*	1.78*	115.1	0.992	0.59*	149.9	2.0*	21.81*	27.72*
K-9	2.95	82.5*	72.60	63.60	8.8	2.08*	1.17	102.0	0.823	0.576*	171.95	2.0*	18.51*	26.87
K-10	2.86	81.5	72.50	54.00	8.2	2.25*	1.41*	100.3	0.789	0.678*	188.11	4.0	23.95*	24.75
K-11	2.93	79.5	65.50	48.90	7.2	2.22*	1.73*	111.2	0.834	0.412*	118.82	5.0	16.52*	20.58
5531 (C)	5.75	77.5	64.40	74.50	8.8	1.37	1.00	63.5	0.476	0.112	155.55	4.0	10.39	24.63
C.D. (5%)	1.1	3.94	8.74	30.42	0.73	0.34	0.19	37.88	0.27	0.21	26.47	0.45	4.98	2.91
C.V. (%)	12.95	2.23	5.53	19.19	3.85	7.66	5.50	16.89	14.18	14.97	7.59	6.90	11.72	4.79

Table 6. Mean performance of Byadgi dabbi local collections

Entries	FY (q/ha)	DFF	PH (cm)	NFPP	FL (cm)	FD (cm)	FW (g)	NSPF	SWPF (g)	PW (g)	FC (ASTA)	WRKL	CAPSN (mg/g)	OLN (%)
D-1	3.48	77.5	74.20*	26.90	7.4	3.5	2.47	121	0.98*	1.10*	183.84*	2.0	17.90	26.73
D-2	1.35	79.0	75.30*	43.80	8.8	3.8	2.39	142*	1.01*	0.78	112.59	2.5	17.90	21.74
D-3	2.75	79.5	66.20	39.30	7.6	3.3	1.72	118	0.88	0.64	139.73	2.0	13.56*	26.52
D-4	3.67	78.0	60.00	22.40	8.8	2.9	2.55	130	0.91	0.91*	158.26	3.0	25.51*	23.76
D-5	5.17*	78.5	83.50*	43.80	6.8	3.8	2.46	140*	1.07*	0.50	161.13	4.0	20.75*	32.01*
D-6	3.93	81.0	66.40	35.10	8.0	3.7	3.26*	150*	1.09*	0.71	116.69	3.0	14.41*	17.73*
D-7	2.63	81.0	61.15	29.90	7.9	3.6	3.05*	96	0.79	1.26*	134.48	5.0	14.12*	24.84
D-8	3.82	84.5	64.30	41.10	5.8	3.0	1.67	144*	1.21*	0.24	94.55*	3.0	13.01*	24.75
D-9	1.95	80.0	72.30*	25.10	7.5	4.0*	2.03	135	0.80	0.73	134.73	2.0	13.62*	25.87
D-10	3.41	80.5	74.70*	33.80	8.0	3.8	2.19	113	0.84	1.11*	140.47	2.0	11.58*	22.77
D-11	4.61	78.0	74.00*	45.60	8.1	3.3	2.46	116	0.89	0.84*	154.57	1.0	15.68	27.80
2043 (C)	4.63	80.0	54.50	33.70	8.4	3.3	1.83	109	0.71	0.41	132.35	4.0	17.53	24.63
C.D. (5%)	0.5	3.07	13.74	12.76	2.2	0.65	0.75	29.91	0.25	0.39	31.73	0.45	2.39	2.81
C.V.(%)	18.61	1.75	9.06	16.54	11.65	8.35	14.52	10.60	12.23	20.97	10.40	7.31	6.65	5.12

days to 50 per cent flowering (2.68 and 2.03%) in Byadgi dabbi genotypes. Low genotypic coefficient of variation coupled with moderate phenotypic coefficient of variation was observed for fruit colour (12.24 and 9.60%) in Byadgi kaddi genotypes and for plant height (13.49 and 9.99%) and fruit diameter (11.62 and 8.08%) in Byadgi dabbi genotypes indicating the existence of limited variability in the local collections evaluated and the need for generation of new variability for these traits. Similar findings were reported by Kadwey *et al.* (2016), Pujar *et al*. (2017) and Jayasree *et al.* (2018).

Heritability and genetic advance over mean

High heritability coupled with high genetic advance over mean was observed for number of fruits per plant (67.10 and 46.25%), fruit weight (93.70 and 42.31%), pericarp weight (65.91 and 34.82%), fruit wrinkles (95.62% and 64.92%), capsaicin content (66.10 and 27.40%) and dry fruit yield (70.64 and 52.82%) in Byadgi kaddi and number of fruits per plant (69.47 and 34.74%), fruit weight (61.53 and 29.67%), fruit wrinkles (96.72 and 80.39%), capsaicin content (92.59 and 46.59%) and dry fruit yield (78.43 and 63.22%) in Byadgi dabbi collections indicating these traits are under the control of additive gene action and improvement of these traits through selection would be effective. Similar results were reported by Nagaraju *et al.* (2018), Hameedi *et al*. (2022) Ahmed *et al.* (2022) and Saisupriya *et al.* (2022).

Moderate heritability coupled with high genetic advance over mean was observed for number of seeds per fruit (52.83 and 26.77%) and seed weight per fruit (58.45 and 26.48%) in Byadgi kaddi genotypes suggesting that the trait has a strong genetic component that can be leveraged for improvement. These results are in conformity with Rekha *et al*. (2016) and Raghuveer *et al*. (2017). Moderate heritability coupled with moderate genetic advance was observed for plant height (54.83 and 15.23%), fruit diameter (48.33 and 11.57%), seed weight per fruit (52.26 and 19.05%) and pericarp weight (56.01 and 36.47%) in case of Byadgi dabbi genotypes indicates that these traits are governed by both additive and non-additive gene action suggesting that, such traits can be improved through careful selection. Similar findings were reported by Rekha *et al*. (2016).

Moderate heritability coupled with low genetic advance was observed for days to 50 per cent flowering (56.87 and 3.98%) and fruit length (52.98 and 6.12%) in Byadgi kaddi genotypes and only days to 50 per cent flowering (57.47 and 3.18%) in Byadgi dabbi genotypes indicating that these traits are governed by non-additive gene action and highly influenced by environmental factors where selection is not effective in improving the concerned trait. Similar findings were reported by Mishra *et al.* (2015), Bundela *et al.* (2017) and Hameedi *et al*. (2022).

Mean performance of variants

Among the kaddi collections, three variants *viz.,* K-2 (5.18 q/ha), K-6 (5.23 q/ha) and K-7 (5.50 q/ha) were found to be statistically on par with the check 5531 (5.45 q/ha) for fruit yield/ha (Table 5). These three variants exhibited superiority over check for traits like number of fruits per plant, fruit length, fruit diameter, fruit weight, number of seeds per fruit, seed weight per fruit and pericarp weight. Additionally, these were significantly superior to check for fruit wrinkles, capsaicin content and oleoresin content and on par for fruit colour (Table 5). In case of dabbi collections D-5 out-performed the check for fruit yield (5.17 q/ha) coupled with significant superiority for oleoresin content (32.01%) (Table 6). These superior variants can be tested further and used in breeding programmes. Similar findings were reported by Singh *et al.* (2013) and Kadwey *et al.* (2016) for fruit length and fruit yield per ha.

Conclusion

The analysis of variance unveiled notable differences among Byadgi chilli variants for all the characters studied, demonstrating the presence of substantial genetic variation among these variants. Characters like number of fruits per plant, fruit weight, pericarp weight, fruit wrinkles, capsaicin content and dry fruit yield displayed significant levels of genetic variability, indicating that these traits are primarily influenced by additive gene effects, selecting genotypes based on these traits is likely to be effective. Days to 50 percent flowering, plant height, fruit length and fruit colour exhibited less genetic variability, but still there is a scope for improvement of these traits through selective breeding.

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