Journal of Spices and Aromatic Crops
Vol. 22 (2) : 222–227 (2013)

Indian Society for Spices

Performance of paprika and paprika alike chillies (*Capsicum annuum* L.) under warm humid tropics

K N Shiva*, T J Zachariah, N K Leela & P A Mathew

Indian Institute of Spices Research, Marikunnu, Kozhikode-673 012, Kerala, India.
**E-mail: knshiva5@gmail.com*

Received 21 March 2013; Revised 4 May 2013; Accepted 8 May 2013

Abstract

A study was conducted to evaluate the performance of 21 paprika alike chillies (indigenous germplasm) and nine paprika lines (exotic collections) under rain-shelter. Highly significant variation was recorded among the genotypes for all the characters. The results indicated that Kt-Pl-19 variant – I, ICBD-6, ICBD-12, ICBD-13, ICBD-11 were promising for yield and yield attributing characters, while ICBD-12, ICBD-11, ICBD-2, ICBD-13, Kt-Pl-19 variant – I proved to be better for high seed numbers. With respect to total extractable colour, ICBD-5, ICBD-7, ICBD-4, ICBD-1, ICBD-18 were measured with high colour value, among the indigenous germplasm. Among the exotic collections, PBC-171, SSP-1999, EC-18, EC-45, EC-71 proved better for yield and yield attributing characters. The genotypes, Paprika King, EC-45, PBC-171, EC-43 produced maximum number and weight of seeds, whereas PBC-171, IMI-5, EC-71, EC-45 were found promising for high colour value. Based on these observations, the genotypes Kt-Pl-19 variant -I, ICBD-6, ICBD-12, PBC-171, SSP-1999 and EC-18 were found suitable for high yield, whereas ICBD-12, ICBD-11, Paprika King, EC-45 and PBC-171 for high seed numbers and ICBD-5, ICBD-7, ICBD-4, PBC-171, IMI-5, EC-71 for high colour value in Kerala. Among the various traits, wide range of variation was recorded for number of seeds per fruit and narrow range of variation for fruit length.

Keywords: *Capsicum annuum*, colour, paprika, paprika alike chillies, yield

Paprika (*Capsicum annuum* L.), is a form of chilli grown mainly for marketing as value added powder for colour and oleoresins. Paprika is the form used by International Spice Traders for non-pungent (sweet) red capsicum powder, which has great commercial importance world wide. The quality of paprika products is based on the visual and extractable colour, pungency level and to a lesser extent on the nutritional value (Verma 2003). There are two types of paprika *viz*., vegetable and spice paprika. Spice paprika refers to red high colour paprika suitable for paprika powder and oleoresins used for seasoning and other commercial purposes.

India is the leading producer, consumer and exporter of chillies, which is primarily used as an essential condiment in foods for imparting

*Present address: National Research Centre for Banana, Tiruchirappalli-620 102, Tamil Nadu, India.

pungency and red colour. In India, there are a few indigenous types of chillies, which are akin to paprika with fruits having high colour and low pungency such as 'Byadagi chilli' grown in Dharwad district of Karnataka state and Warangal Chappatta (Tomato chilli) grown in Warangal and Khammam districts of Andhra Pradesh (Shiva *et al*. 2008). These are much preferred by oleoresin manufacturers for extraction of paprika alike oleoresin (John 2000).

There is heavy demand for paprika in western countries and the export potential is also very high. Presently, the paprika cultivation and production is concentrated only to dry sub-tropical or temperate regions. Realizing the vast potential existing in the country for pepper (chilli) cultivation, a progamme to develop suitable paprika varieties was initiated in 1988, as there was no paprika variety available for cultivation on commercial scale (Korikanthimath *et al*. 2000; Verma & Joshi 2000). This has resulted in development of 'Arka Abir' (a selection from Byadagi chillies) from Indian Institute of Horticultural Research (IIHR), Bangalore and 'Kt-Pl-19' (having high colour and high oleoresin) from Indian Agricultural Research Institute (IARI), Regional Station, Katrain, Himachal Pradesh. Main traits required for paprika commercial varieties are high yield, high pigment content, colour retention and quality parameters like less or zero pungency level, etc. Performance of Kt-Pl-19 and 'Bydagai Chilli' were studied by Hosamani (2000) at Karnataka. However, the genotypes of paprika or paprika alike chillies adopted for one region may not be suitable for growing in other regions/areas. This has necessitated to evaluate and identify genotypes/lines suitable for the warm humid tropics of Kerala. In light of the above, the present investigation was undertaken to study the performance of different varieties in paprika (exotic) and paprika alike chillies (indigenous) in terms of vegetative, floral and quality characters, thereby identifying the suitable genotypes for yield coupled with quality parameters for warm humid tropical conditions of Kerala.

The present investigation was carried out at Indian Institute of Spices Research, Kozhikode (Kerala) during 2002 to 2005. Paprika (exotic) and paprika alike chillies (indigenous) lines collected from various sources [ICBD denotes the indigenous collections of Byadagi Dabbi] through field survey were purified initially using insect-proof nylon cage, as suggested by Bosland (1993) and the seeds were collected from each accession separately in butter-paper cover and stored in desiccators. The seeds were raised in nursery and transplanted to pots after one-month under rain-shelter for three seasons (January to June). The potting media comprised of one part each of dried leaf mould, well-decomposed farm yard manure, river sand and garden soil. The trial was laid out in completely randomized design with 21 indigenous germplasm (paprika alike chillies) and nine exotic collections (paprika), replicated thrice. Ten plants were maintained in each replication for each genotype. Cultural practices were practiced uniformly for all the plants in pots. Observations on morphological parameters (days to 50% flowering, plant height, fruit length, fruit girth, weight of pericarp, number of seeds per fruit, weight of seeds per fruit, yield per plant) of these lines were recorded from ten pots/plants in each replication for each genotype for three seasons, according to IPGRI (1995). The total extractable colour of the fruit pericarp was analysed by ASTA method using a Shimadzu UV-Visible spectrophotometer at 450 nm and the colour value was expressed as ASTA units (ASTA 1995). The data thus collected were subjected to standard statistical analysis as per Gomez & Gomez (1986).

Analysis of variance revealed significant differences among the genotypes for all the traits studied (Table 1), which indicated the presence of significant variability in the germplasm belonging to paprika (exotic) (Kumari *et al*. 2011) and paprika alike chillies (indigenous) (Jagadeesha *et al*. 1999; Anu *et al*. 2002; Prasath *et al*. 2007; Prasath & Ponnuswami 2008a).

Quantitative characters were significantly influenced by the genotypes (Table 1). Among the indigenous germplasm, ICBD-17 took minimum number of days for flowering (54.33 days), followed by ICBD-16, ICBD-14, ICBD-18, ICBD-13 and ICBD-10 which were on par with each other. However, maximum number of days for flowering was recorded with Kt-Pl-19 variant –I (65.00 days). EC-18 flowered early (71.33 days) among the exotic collections, followed by EC-45, EC-71 and SSP-1999, which were statistically non-significant with each other. The early flowering of a plant is a desirable character indicating early fruiting and harvest. Similar variations in the flowering of paprika and chillies (paprika alike chillies) were reported by Anu *et al.* (1999; 2002).

Among the indigenous genotypes, the plant height ranged from 142.7 cm to 105.3 cm. The maximum plant height was shown in ICBD-16 (142.7 cm), followed by ICBD-11 and ICBD-9, which were at par with each other, while minimum plant height was observed in case of ICBD – 19 (105.3 cm). With respect to exotic types, PBC-171 had the tallest plant (183 cm), followed by EC-18 and EC-71, while Paprika King produced the shortest plant (80.00 cm). Plant height is highly genotype dependent. Being a genetically controlled factor, the plant height varied among the genotypes. These findings are in line with that of Anu *et al.* (2002) and Prasath *et al.* (2007) in chilli.

With respect to fruit length, ICBD-14 produced the longest fruit (11.87 cm) among the indigenous genotypes, followed by ICBD-17, which significantly differed from each other. However, ICBD-3, ICBD-13 and ICBD-18 had the longer fruits than others, whereas Kt-Pl-19 variant-1 produced the shortest fruit (3.72 cm). However, among the exotic germplasm, the fruit length varied from 3.201 cm to 17.33 cm, the maximum being with SSP-1999 and minimum with Cayenne. Other exotic genotypes with longer fruits were PBC-171, EC-71 and EC-45. Fruit length is an advantageous character contributing towards yield. Variability in fruit length was also reported by Anu *et al.* (2002) in paprika and paprika alike chillies under Kerala conditions.

Fruit girth was also significantly influenced by the genotypes, which varied from 4.76 cm to 6.90 cm. The maximum fruit girth was recorded in Kt-Pl-19, followed by ICBD-11, ICBD-12 and Kt-Pl-19 variant -1, which were on par with each other. The minimum fruit girth was observed with ICBD-3, among the indigenous germplasm. With respect to exotic genotypes, PBC-171 produced the maximum fruit girth, followed by EC-71, which did not differ significantly from each other. Likewise, Paprika King, EC-45 and EC-18 also produced higher fruit girth when compared to other genotypes; however, the least fruit girth was noticed with IMI-5. Fruit girth was positively associated with yield which is evident from the genotype response (Table 1). This is in agreement with the results of Verma & Joshi (2000), Kumari *et al.* (2011) in paprika and Anu *et al.* (2002) in paprika alike chillies.

In the indigenous germplasm, Kt-Pl-19 variant – 1 was found to have the highest pericarp weight per fruit (10.34 g), followed by ICBD-1 (6.30 g), which were significantly different. The genotypes namely, ICBD-6, ICBD-13 and ICBD-10 registered higher pericarp weight than others but were on par with each other. However, minimum weight of pericarp was observed with ICBD-18 (3.557 g). The weight of pericarp per fruit ranged from 2.410 g to 29.490 g, the highest being with SSP-1999 and the lowest being with IMI-5, among the exotic collections. Higher pericarp weight was recorded with PBC-171 and Paprika King. Weight of pericarp is an important quantitative character in determining the yield of paprika powder. Variation in the pericarp weight of the genotypes was also reported in paprika and paprika like chillies (Anu *et al.* 2002).

Number and weight of seeds was significantly affected by the genotypes. Wide variation for the number and weight of seeds was recorded in fruits, which ranged from 45.33 to 106.70 and from 0.414 g to 1.026 g, respectively among the indigenous germplasm. The maximum number and weight of seeds per fruit was

Table 1. Evaluation of paprika and paprika alike chillies for quantitative and qualitative characters (Mean of four years)

Genotypes	Days to 50% flowering	Plant height (cm)	Fruit length (cm)	Fruit girth (cm)	Weight of pericarp fruit^{-1} (g)	Number of seeds fruit^{-1}	Weight of seeds fruit^{-1} (g)	Yield plant^{-1} (g)	Total extractable colour (ASTA units)
				Indigenous					
ICBD – 1	60.67	113.0	9.083	5.767	6.300	76.00	0.7860	371.0	239.3
ICBD -2	57.00	115.7	7.027	6.000	5.577	96.67	0.9017	358.2	201.7
ICBD -3	59.67	112.0	11.030	4.767	5.237	62.33	0.7883	356.0	139.7
ICBD -4	57.33	113.3	5.957	5.000	5.370	72.33	0.6800	341.3	240.0
ICBD -5	61.33	105.7	10.230	6.033	4.890	66.00	0.7283	350.2	277.7
ICBD -6	57.67	130.0	8.457	6.000	5.783	57.00	0.7260	646.0	131.0
ICBD -7	58.00	110.0	6.680	5.067	4.120	58.33	0.5650	440.7	243.0
ICBD -8	56.67	130.0	9.703	5.500	5.373	69.33	0.7423	557.7	39.00
ICBD -9	60.00	134.7	9.033	5.667	5.073	84.00	0.8320	517.3	153.0
ICBD -10	56.33	122.7	8.620	5.700	5.693	48.67	0.5770	509.3	113.0
ICBD -11	59.00	142.0	9.197	6.867	5.413	87.67	0.8610	448.8	224.0
ICBD -12	60.67	121.7	9.037	6.667	5.257	106.70	1.026	574.5	231.0
ICBD -13	56.33	118.3	10.880	6.067	5.763	80.33	0.9127	583.4	201.3
ICBD -14	54.67	118.3	11.870	6.133	4.247	64.33	0.5953	321.6	235.0
ICBD -15	56.00	133.3	9.273	5.233	3.727	45.33	0.4140	332.7	217.0
ICBD -16	54.67	142.7	9.643	5.067	5.003	80.33	0.6610	446.8	208.7
ICBD -17	54.33	128.3	11.600	5.533	3.777	71.00	0.5450	327.2	226.0
ICBD -18	55.33	117.7	10.780	5.400	3.557	67.33	0.5213	228.8	238.3
ICBD -19	59.33	105.3	10.320	5.367	3.977	74.33	0.6620	349.4	217.0
Kt-Pl-19	60.00	112.7	9.207	6.900	5.203	68.33	0.5523	418.4	182.3
Kt-Pl-19 Variant - I	65.00	112.0	3.720	6.500	10.34	71.00	0.9837	720.9	136.7
				Exotic					
Paprika King	72.67	80.00	8.410	9.733	8.943	77.67	0.9287	373.5	153.0
EC – 45	72.00	124.3	7.103	9.733	4.980	77.00	0.7910	382.0	180.0
EC – 71	72.33	143.0	7.757	11.400	5.480	45.33	0.4577	253.7	208.0
EC – 43	74.33	135.0	3.520	5.067	4.827	79.00	0.7287	123.1	98.00
PBC – 171	76.33	183.0	8.150	11.770	10.29	65.33	0.7683	396.1	229.3
IMI – 5	73.67	113.3	4.027	4.367	2.410	34.00	0.3020	275.4	222.0
SSP – 1999	72.67	134.7	17.330	6.467	29.490	56.67	0.5520	592.3	92.00
Cayenne	75.00	114.3	3.201	6.133	4.333	111.70	0.6497	148.0	139.7
EC – 18	71.33	143.7	6.250	9.133	3.990	71.67	0.3787	746.6	111.0
SEm +	1.027	4.318	0.075	0.174	0.178	4.118	0.018	15.66	2.613
'F' test	**	**	**	**	**	**	**	**	**
CD (P<0.05)	2.907	12.22	0.213	0.493	2.907	12.22	0.213	0.493	7.393
CV (%)	2.84	6.05	1.50	4.64	5.01	10.07	5.29	6.51	2.46

** - Highly significant

produced by ICBD-12, ICBD-2, Kt-Pl-19 variant -1, ICBD-11, ICBD-13 and ICBD-9, while minimum number and weight of seeds was observed with ICBD-15. However, the number and weight of seeds per fruit varied from 34.00 to 111.70 and from 0.302 g to 0.9287 g, respectively in the exotic genotypes, the maximum being with Cayenne, Paprika King, EC-43, EC-45, PBC-171 and the minimum with IMI-5. Both the number and weight of seeds were positively associated with each other contributing towards yield (Kumari *et al*. 2011), which is also evident from the present study (Table 1).

The genotype, Kt-Pl-19 variant-1 produced the highest yield (720.9 g/plant), followed by ICBD-6, ICBD-12, ICBD-13 and ICBD-8, among the indigenous germplasm evaluated. However, the lowest yield was observed with ICBD-18. In the exotic paprika, the yield varied from 123 g/plant to 746 g/plant. Genotypes namely EC-18, SSP-1999, PBC-171, EC-45 and Paprika King produced higher yield when compared to others, while the minimum was produced by EC-43. Higher number of seeds and weight of fruit/pericarp and seeds could be mainly attributed to higher yield produced by these lines, which is supported by Kumari *et al*. (2011). Variability in chilli germplasm was also reported by Prasath *et al*. (2007).

Significant difference was found for the total extractable colour or colour value in the fruits among the lines, which ranged from 113 to 277.7 ASTA units in indigenous germplasm and from 92 to 229.3 ASTA units in the exotic lines. In the indigenous lines, the maximum colour value was measured with ICBD-5, followed by ICBD-7, ICBD-4, ICBD-1 and ICBD-18, while the minimum value with ICBD-10. Whereas in the exotic genotypes, PBC-171 gave maximum colour value, followed by IMI-5, EC-71 and EC-45 and the minimum value was registered by SSP-1999. Similar findings were reported by Leela *et al*. (2004), Prasath *et al*. (2007) and Prasath & Ponnuswami (2008b).

With respect to coefficient of variation (CV), wide to narrow variability was observed for all the traits studied. Among the various traits, maximum coefficient of variation was recorded for number of seeds per fruit (10.07%), followed by yield per plant (6.51%), plant height (6.05%) and weight of seeds per fruit (5.29%), while minimum variation was measured with fruit length (1.50%). Wide variation suggested the presence of high genetic variability, while narrow or minimal variation indicated the desirability of selection. Similar variations for various traits in paprika and paprika alike chillies were reported by Anu *et al*. (2002), Jagadeesha *et al*. (1999) in 'Byadagi chilli' and Prasath *et al*. (2007) in chilli.

The present study indicated highly significant variation among the genotypes for all the characters in paprika and paprika alike chillies. Among the various traits, wide variation was recorded for number of seeds per fruit and narrow variation for fruit length. Based on these observations, the genotypes Kt-Pl-19 variant -I, ICBD-6, ICBD-12, PBC-171, SSP-1999 and EC-18 were found suitable for high yield, whereas ICBD-12, ICBD-11, Paprika King, EC-45 and PBC-171 for high seed numbers and ICBD-5, ICBD-7, ICBD-4, PBC-171, IMI-5, EC-71 for high colour value.

Acknowledgments

The authors are thankful to the Heads, Division of Crop Improvement and Crop Production & Post Harvest Technology and the Director, Indian Institute of Spices Research, Kozhikode, Kerala for providing necessary facilities.

References

American Spice Trade Association (ASTA) 1995 Official Analytical Methods. American Spice Trade Association, New York.

Anu A, Babu K N & Peter K V 2002 Evaluation of paprika genotypes in Kerala. Indian J. Plant Genet. Resour. 15: 93–99.

Anu A, Nirmal Babu K, Mathew P A & Peter K V 1999 Variability in paprika (*Capsicum annuum* L.) germplasm. In: Sasikumar B, Krishnamoorthy B, Rema J, Ravindran P N & Peter K V (Eds.) Proceedings Golden Jubilee National Symposium on Spices, Medicinal and Aromatic Plants – Biodiversity, Conservation and Utilization, 10-12 August 1998, Kozhikode (pp.88–89), Indian Society for Spices, Kozhikode, Kerala.

Bosland P W 1993 An effective plant field cage to increase the production of genetically pure chilly (*Capsicum* spp.) seed. Hort. Sci. 28: 1053.

Gomez K A & Gomez A A 1986 Statistical Procedure for Agricultural Research (2nd edition). John Willey and Sons, New York.

Hosamani R M 2000 Paprika in north Karnataka – Status, research and development. Indian J. Arec. Spices Med. Plants 2: 50–57.

IPGRI, AVRDC & CATIE 1995 Descriptors for capsicum (*Capsicum* spp.). International Plant Genetic Resources Institute, Rome, Italy; the Asian Vegetable Research and Development Center, Taipei, Taiwan and the Centro Agronómico Tropical de Investigación y Enseñanza, Turrialba, Costa Rica.

Jagadeesha R C, Prabhu S T & Basavaraja P K 1999 Variation in 'Byadagi' chilli (*Capsicum annuum* L.). In: Sasikumar B, Krishnamoorthy B, Rema J, Ravindran P N & Peter K V (Eds.), Proceedings of Golden Jubilee National Symposium on Spices, Medicinal and Aromatic Plants – Biodiversity, Conservation and Utilization, 10-12 August 1998, Kozhikode (pp.85–87), Indian Society for Spices, Kozhikode, Kerala.

John K 2000 Promotional activities of Spices Board on paprika. Indian J. Arec. Spices Med. Plants 2: 47–49.

Korikanthimath V S, Peter K V & Mathew P A 2000 Prospects of paprika types in Karnataka. Indian J. Arec. Spices Med. Plants 2: 45–46.

Kumari S S, Jyothi K U, Reddy V C, Srihari D, Siva Sankar A & Ravi Sankar C 2011 Character association in paprika (*Capsicum annuum* L.). J. Spices Arom. Crops 20: 43–47.

Leela N K, Shiva K N & Mathew P A 2004 Evaluation of paprika genotypes for colour. In: Korikanthimath V S, John Zachariah T, Nirmal Babu K, Suseela Bhai R & Kandiannan K (Eds.) Proceedings of the National Seminar on New Perspectives in Spices, Medicinal and Aromatic Plants, 27-29 November 2003, Kozhikode (pp.212–214), Indian Society for Spices, Kozhikode, Kerala.

Prasath D & Ponnuswami V 2008a Heterosis and combining ability for morphological, yield and quality characters in paprika type chilli hybrids. Indian J. Hort. 65: 441–445.

Prasath D & Ponnuswami V 2008b Breeding for extractable colour and pungency in *Capsicum* – a review. Veg. Sci. 35: 1–9.

Prasath D, Ponnuswami V & Muralidharan V 2007 Evaluation of chilli (*Capsicum* spp.) germplasm for extractable colour and pungency. Indian J. Genet. Plant Br. 67: 97–98.

Shiva K N, Prasath D & Parthasarathy V A 2008 Chilli and Paprika. In: Parthasarathy V A, Kandiannan K & Srinivasan V (Eds.) Organic Spices Production (pp.477–522), New India Publishing Agency, New Delhi.

Verma T S & Joshi S 2000 Status of paprika development in India. Indian J. Arec. Spices Med. Plants 2: 39–44.

Verma T S 2003 Breeding and development of paprika at Katrain (IARI). In: Singh H P, Sivaraman K & Tamil Selvan M (Eds.) Indian Spices – Production and utilization. Proceedings of National Consultative meeting for Accelerated Production and Export of Spices (pp.350–355), Kozhikode, Kerala.