Adaptability and production of hottest chilli variety under Gwalior agro-climatic conditions

Chilli or cayenne is one of the valuable crops of India and is cultivated in almost all parts of the country, especially Andhra Pradesh, Tamil Nadu and Karnataka. It belongs to the family Solanaceae. Chilli is not a native crop of India; it was brought from Portugalies in the 15th Century. Due to its taste and unlimited utility, chilli is used all over India and today we are the biggest producer. There is a good demand for Indian chillies abroad. We export about 35,000 tonnes chillies and earn about Rs 80 crores foreign exchange every year. Different varieties are grown for vegetables, spices, condiments, sauces and pickles. It is also used raw and ripened, both for colouring properties and pungency. Chillies also find uses in pharmaceuticals, cosmetics and beverages. Chillies are rich[1,2] in vitamins A, B and C, i.e. vitamin B (thiamin) 0.19 mg, vitamin A 292 IU and vitamin C 111 mg per 100 g.

Some varieties of chilli are hot, while others are less hot. The main reason for this variation is the content of capsaicin, its analogues and derivatives (collectively known as capsaicinoids). The pungency, hotness and irritating properties of chilli are due to the presence of seven compounds known as 'hot principles' (Table 1).

Due to hotness or irritating properties of capsaicinoids, chillies grown in India and abroad (especially Mexico) are sought to control riots[3,4]. The general concept is that irritating compounds from the natural product will be most acceptable from the human rights point of view and environment-friendly than synthetically produced compounds CN (1-chloroacetaphenon), CS (O-chlorobazyladene malononitrile and CR (Dibenz (b, f)-1, 4-oxozepine.

Defence Research and Development Establishment, Gwalior is progressing well in finding suitable alternatives to CN, CS and CR through oleoresin (mixture of capsaicinoids and carotenoids). Synthesis of these compounds is not economically viable and extraction of 100% pure capsaicinoids is difficult.

A special variety of chilli–Nagahari grown in Tezpur (Assam) has been identified as the hottest variety (pungency 855,000 SHU) in the world[5]. Analysis showed that this chilli surpassed the best known Mexican variety, Red Savina Habanero (Pungency 577,000 SHU and capsaicinoids vary from 0.2 to 3%) by about two times in capsaicin content[5]. Since the development of new irritants needs oleoresin with different percentages of capsaicin, it was thought worthwhile to exploit Nagahari chilli for this purpose, which has 5% capsaicinoids and pungency 855,000 SHU.

The main impediment for cultivation of Nagahari chilli under Gwalior agro-climatic conditions is that the cost of chilli procured from Assam worked out to be extremely high (given that charges of transportation are also included in final

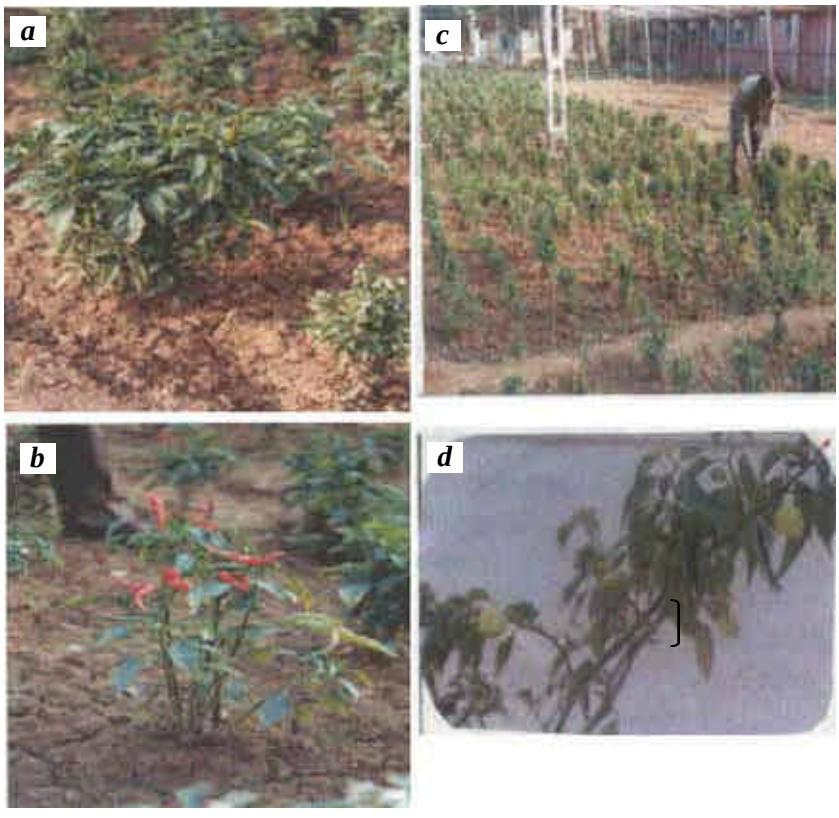

Figure 1. Growth and maturity of chilli varieties Pusa Sadabahar (***a*** and ***b***) and Nagahari (***c*** and ***d***).

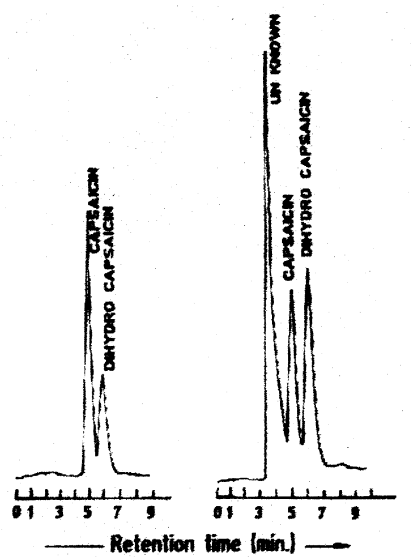

Figure 2. HPLC of (***a***) standard capsaicin showing capsaicin and dihydracapsaicin and (***b***) Gwalior-grown chilli showing aleoresin.

Table 1. 'Hot principles' in chilli

Capsaicin (E)–isomer–64.5%	
Nor-capsaicin	
Nor-Nor-capsaicin	a
Homo-capsaicin	
Dihydro capsaicin – 32.6%	
Homo dihydro capsaicin	
Nor-dihydro capsaicin	b
(a + b) = 2.9%	

Table 2. Oleoresin, capsaicin and dihydrocapsaicin contents in different varieties of Indian chillies

Chilli variety	Grown at	Oleoresin (% w/w)	Capsaicin (% w/w)	Dihydrocapsaicin (% w/w)
Nagahari	Tezpur	15.0	4.28	1.42
Nagahari	Gwalior	9.7	0.45	0.39
Nagajolokia	Gwalior	13.0	1.5	2.50
Pusa Sadabahar	Gwalior	6.15	2.0	3.0

cost estimation). Moreover, it is inconvenient to collect the material from a remote place like Tezpur and there is also the difficulty in handling due to its pungency.

The altitude of Gwalior (Madhya Pradesh) is 205 m msl; lat 26°14′N and long 78°15′E. The annual rainfall for the year 2002 was 537.7 mm and average relative humidity recorded was 54% at 830 IST and 39% at 1730 IST. Similarly, average maximum temperature was 32.5°C and minimum was 18.8°C.

Likewise, the monthly average temperature of Tezpur for the year 2002 was 27°C. The maximum temperature was 33.5°C and minimum was 17.6°C. The annual rainfall recorded was 1320.4 mm and average monthly humidity was 71.15%.

The climatic conditions at Tezpur and Gwalior have significant effect on chilli production, particularly on its yield and capsaicin content.

The seeds of Nagahari variety obtained from Tezpur were first treated with Thirum @300 g/kg of seed before sowing. Seeds were sown in fibresheet trays on 20 July 2001 and 31 August 2001, and seedlings were raised. After about six weeks when the seedlings attained 2″ height and 4–6 leaves appeared, they were transplanted to 12″ earthen and plastic pots on 31 August 2001 and 8 September 2001 respectively.

The pots for transplanting of seedlings were prepared by filling with a mixture of 2 : 1 sandy loam soil farmyard manure. Further, 2 kg nitrogen (N), 1 kg phosphorus (P_2O_5) and 750 g potash (K_2O) were added and mixed well with one quintal of soil and manure mixture. The pots were filled with mixture up to the top, leaving 1″ space for watering. The seedlings were transplanted and pots were moved to greenhouse and occasionally removed to direct sunlight. Half the quantity of nitrogen was mixed with soil mixture as a basal dose and half the quantity was applied as top dressing in two split doses after 40 and 60 days of transplanting.

As a plant protection measure to control the incidence of fruit rot, die-back, a mixture of diathane-M 45 0.25% + Bavistin 0.1% was spread on plants using a fine nozzle, twice at 12 days interval. To save the plants from attack of thrips, di-mathoate (0.025%) was spread twice at 15 days interval after 3 weeks of transplanting. Wettable sulphur was applied 4 weeks after transplanting to control mites.

Profuse flowering was observed from December 2001 to February 2002. Fruit setting started from January 2002 onwards and fruits matured by the end of March 2002. The mature yellowish-coloured fruits were plucked and dried in sunlight.

Crops of chilli varieties, Nagajolokia from Assam and Pusa Sadabahar from Indian Agricultural Research Institute, New Delhi were also grown in field conditions.

The dried chilli was powdered and oleoresin was obtained by solvent extraction in acetone, with subsequent removal of solvent by distillation. It consists of both volatile essential oil and non-volatile resin. After distillation, the extract was concentrated and subjected to high performance liquid chromatography (HPLC; Figure 2) using Shimadzu Model LC-6A liquid chromatography, μ Bondapak C-18 column, MeOH : water (60 : 40 v/v), 10% acetonitrile and 1% citric acid as mobile phase and a variable wavelength UV–VIS spectrophotometric detector set at 280 mm, to ascertain the presence of capsaicin and dihydrocapsaicin, which are the main constituents responsible for pungency (about 90%) among the seven compounds present in oleoresin. The comparative study of oleoresin, capsaicin and dihydrocapsaicin of different varieties grown at Gwalior is given in Table 2.

It is evident from the above data that the percentage of oleoresin is remarkably decreased with the change in climate. Similarly, there is a drastic change in the ratio as well as percentage availability of capsaicin and dihydrocapsaicin.

However, data for Pusa Sadabahar could not be compared due to non-availability of reported data. Thus it is evident that the hot chilli varieties grown under Gwalior agro-climatic conditions stand next-best to Nagahari and Nagajolokia chillies grown in Assam with regard to pungency.

1. Phal-Phool, July–September 2000, pp. 29–31.
2. *Indian Hortic.*, 2003, **47**, 10–12.
3. *The Hindu*, 31 August 2000.
4. *Hindustan Times*, 4 September 2000.
5. Ritesh Mathur, Dangi, R. S., Das, S. C. and Malhotra, R. C., *Curr. Sci*., 2000, **79**, 287–288.
6. Kosuge, S. and Furata, M., *Agric. Biol. Chem.*, 1970, **34**, 248–256.
7. Iwai, K., Susuki, T. and Fujiwaki, H., *Agric. Biol. Chem.*, 1970, **43**, 2493–2498.
8. Kawada, T., Watanare, T., Katsura, K., Takami, H. and Iwai, K., *J. Chromatogr.*, 1979, **329**, 99–105.
9. Scoville, W. L., *J. Am. Pharmacol. Assoc.*, 1912, **1**, 453.
10. Govindarajan, V. S., Narasimhan, S. and Dhanara, S. J., *J. Food Sci. Technol*., 1977, **14**, 28–34.
11. Yahai, E. M. and Padilla, M. C., *J. Agric. Food Chem*., 1998, **46**, 2075–2079.

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