# Registration of a High Rhizome and High Curcuminoid Yielding Variety of Turmeric (*Curcuma longa* L) CIM-Pitamber

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**ABSTRACT**

Curcuma longa *L. (Zingiberaceae), commonly known as turmeric, is not only one of the most popular spices for Indian cuisines, is also one of the most valuable medicinal plants of traditional systems of Indian medicine due to its numerous preventive and curative effects. The pharmaceutical importance of turmeric is due to the presence of linear diarylheptanoidal phenolic molecules that are collectively called as curcuminoids like curcumin, demethoxycurcumin and bisdemethoxycurcumin. These compounds are credited with anti-inflammatory, hypo-cholesterolemic, anti-oxidant, anti-parasitic, anti-spasmodic, anti-microbial, anti-rheumatic, anti-aging and anti-cancer properties. Extensive R&D efforts made during last eight years at CSIR-CIMAP have resulted in the identification of superior clones that can yield more than 50 tons of rhizomes/ha containing more than 10% content of curcuminoids. One such clone rechristened as CIM-Pitambar has been identified, that can produce 60-65 tons rhizomes/ha containing 12.5% curcuminoids in a relatively short span of 180-190 days. This variety has been developed using the method of cloline breeding approach. Among 130 germplasm accessions/ clones collected from different parts of India, single plants/clone selection was performed. This variety is also tolerant to leaf blotch disease of turmeric. This variety provides more than 54% higher rhizomes with 92% more curcuminoids, yielding around 165% more curcuminoids/ha than the cultivar IISR Pratibha, Which is the most commonly cultivated variety in North Indian plains. The introduction of CIM-Pitamber in cultivation will enable farmers to double their yield and profits per unit area, and thus will significantly improve the livelihood of poor farmers.*



## INTRODUCTION

India is the largest producer and exporter of turmeric in the world producing more than 80% of the global turmeric production. It is being cultivated

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in the country over an area of 150,000 ha [8] with Andhra Pradesh being the leader (70%) in turmeric production followed by Tamil Nadu, Odisha, Karanataka, West Bengal, Gujarat and Kerala. On an average, every Indian consumes about 100 mg turmeric powder extract every day amounting to 480,000 tons per year [2]. As the demand of turmeric is continuously increasing in both food and pharmaceutical industries in the back drop of limited and shrinking land resource, it is essential to develop varieties that can yield more rhizomes and curcuminoids from a unit area. Since curcumin is the main molecule for the increasing demand of turmeric, several varieties of turmeric were developed in India for increased curcumin content and rhizome biomass. It was discovered as a potential source of new drugs for variety of diseases [3]. The curcumin content in these varieties range from 3-9% with a 20-40 ton/ha rhizome yield potential. Some of the commercially grown high curcumin content varieties are Suroma, Roma, Rajendra Sonia, Suguna and IISR Pratibha. Because of high curcuminoids content the Indian turmeric is considered best in the world [7]. These cucuminoids largely contains curcumin, demethoxycurcumin and bisdemethoxycurcumin [9] that impart a vivid yellow natural colour to turmeric and are effective in the treatment of inûammatory disorder [11], anorexia, diabetic wounds and cough [5], hepatic disorders, cardiovascular diseases, tumors, rheumatism, sinusitis, multiple sclerosis [10], antimicrobial activity and health problems [6]. They have also been known to modulate lipid metabolism and therefore; it is used to treat obesity [1]. Besides these, curcumin is also being used in clinical trials against Alzheimer's disease [4].

Extensive R&D efforts made during last eight years at CSIR-CIMAP have resulted in the identification of several superior clones that can yield more than 50 tons of rhizomes/ha with more than 10% curcuminoids. One such clone of *Curcuma longa* (proposed to be rechristened as CIM-Pitambar) has been identified (from a set of land races collected from the villages inhabited by Tharu tribes from Dudhwa Tiger Reserve Forest of Uttar Pradesh), which can produce 60-65 tons rhizomes/ha containing 12.5% curcuminoids in a relatively short span of 180-190 days. This is the highest rhizome and curcuminoids yield reported so far in India. The proposed variety will be able to provide more than 54% higher rhizomes with 92% more curcuminoids, yielding around 165% more curcuminoids/ha than the cultivar IISR Pratibha, being the most popular variety in North Indian plains. This will enable farmers to double their yield and profits per unit area, and will contribute in significant improvement of the livelihood of poor farmers.

## MATERIALS AND METHODS

The variability provides the platform on which plant breeders exercises the selection and isolate the superior genotypes for commercial cultivation. Variety CIM-Pitamber has been developed using the cloline breeding method. 130 germplasm accessions/clones collected from different parts of India particularly Dudhwa Tiger Reserve Forest and Tharu farmer's fields single plant/clone selection was performed and on the basis of their initial performance, superior clones were identified within and between families (clones). Superior single plant progenies were multiplied and evaluated under IET followed by replicated multi row advanced yield trials for rhizome yield and total curcuminoids content.

The details of these evaluation trails are provided as below:

**Initial Evaluation Trial:** Total 20 clones along with two checks (var. Pratibha and Roma) were evaluated in single row plot of 3 m length (area 1.8 $m^2$) replicated thrice in RBD. Data were recorded on plant height (cm), fresh rhizome yield / plot (Kg) and days to maturity. Fresh rhizome yield / ha (t) and dry rhizome yield / plot (kg) were estimated based on respective plot yield (Table 1). 500gm of fresh rhizomes of all twenty entries were dried separately for estimating the dry rhizome yield (recovery %). Dried rhizomes were powdered for estimation of curcuminoid content and standardized protocols were followed for the same.

**Table 1: Result of Average performance of selected turmeric clones in IET (initial evaluation trial) of 1.8 m$^2$ plot, single row plot of 3 m length, replication 3**

| S. No. | Name | Plant height (cm) | Fresh rhizome yield / plot (Kg) | Estimated fresh rhizome yield / ha (t) | Estimated dry rhizome yield / plot (Kg) | Dry rhizome recovery (%) | Curcuminoid (%) | Days to leaf senescence | Days to digging of rhizome |
|---|---|---|---|---|---|---|---|---|---|
| 1 | **Bipul Saikia** | 55.00 | 7.09 | 39.38 | 1.70 | 24 | 11.47 | 217 | 267 |
| 2 | **Boraikhuwa** | 47.50 | 3.57 | 19.83 | 1.00 | 28 | 11.20 | 210 | 260 |
| 3 | **Captanchuk** | 49.00 | 5.79 | 32.17 | 1.50 | 26 | 11.80 | 238 | 288 |
| 4 | **CH32** | 47.50 | 14.27 | 79.27 | 2.85 | 20 | 8.94 | 209 | 259 |
| 5 | **CH4** | 50.17 | 14.09 | 78.27 | 2.67 | 19 | 7.97 | 200 | 250 |
| 6 | **CH-63** | 44.67 | 12.42 | 69.00 | 2.48 | 20 | 9.74 | 198 | 248 |
| 7 | **CH-76** | 55.00 | 12.06 | 67.00 | 2.53 | 21 | 5.98 | 200 | 250 |
| 8 | **CH-92** | 56.00 | 8.61 | 47.83 | 1.72 | 20 | 10.37 | 205 | 255 |
| 9 | **HOM-60** | 45.00 | 12.32 | 68.44 | 2.59 | 21 | 8.70 | 234 | 284 |
| 10 | **JL-55** | 51.17 | 13.17 | 73.17 | 2.50 | 19 | 7.90 | 224 | 274 |
| 11 | **Ledo Jagun** | 48.50 | 7.05 | 39.17 | 1.69 | 24 | 9.44 | 220 | 270 |
| 12 | **Muzaff-2** | 52.50 | 11.36 | 63.11 | 2.38 | 21 | 8.50 | 201 | 251 |
| 13 | **NDH-11** | 46.00 | 12.75 | 70.83 | 2.42 | 19 | 10.90 | 234 | 284 |
| 14 | **NDH-2** | 52.50 | 5.93 | 32.94 | 1.30 | 22 | 14.10 | 213 | 263 |
| 15 | **Neli** | 43.50 | 7.20 | 40.00 | 1.65 | 23 | 9.89 | 223 | 273 |
| 16 | **CIMAP Pitamber** | 45.50 | 14.33 | 79.61 | 3.15 | 22 | 12.50 | 189 | 239 |
| 17 | **Pratibha** | 51.83 | 7.59 | 42.16 | 1.45 | 19 | 4.60 | 208 | 258 |
| 18 | **Roma** | 52.50 | 5.85 | 32.50 | 1.70 | 29 | 9.30 | 240 | 290 |
| 19 | **Roma Pantnagar** | 51.67 | 13.41 | 74.50 | 2.41 | 18 | 10.27 | 220 | 270 |
| 20 | **TC11** | 54.17 | 12.12 | 67.33 | 2.30 | 19 | 6.67 | 218 | 268 |
| 21 | **TC19** | 46.50 | 13.17 | 73.17 | 2.63 | 20 | 10.57 | 226 | 276 |
| 22 | **TC4** | 44.00 | 12.47 | 69.27 | 2.62 | 21 | 8.95 | 212 | 262 |
| | **Mean** | 49.55 | 10.30 | 57.23 | 2.15 | 21.59 | 9.54 | 215.41 | |
| | **SD** | 3.91 | 3.41 | 18.96 | 0.58 | 2.99 | 2.17 | 13.86 | |
| | **SE** | 0.83 | 0.73 | 4.04 | 0.12 | 0.64 | 0.46 | 2.96 | |

The details of experimental design for initial evaluation are summarized below:

| | | |
|---|---|---|
| Sowing | : | First week of June |
| Digging | : | First fortnight of April |
| Plot size | : | Single row of 3m, (1.8$^2$ m) |
| Replications | : | Three |
| Row to row distance | : | 60cm |
| Plant to Plant distance | : | 20cm |

**Multi Row Evaluation Trial:** Six best performing clones along with two checks (var. Pratibha and Roma) were again planted in three row plots (area 5.4 m$^2$) with three replications in a Randomized Block Design (RBD). Normal agronomic practices were followed. The evaluation of the material was done for plant height (cm), fresh rhizome yield / plot (Kg) and days to maturity. Fresh rhizome yield / ha (t) were estimated based on respective plot yield. 500gm of fresh rhizomes of all entries were dried separately for estimating the dry rhizome yield (recovery %). Dried rhizomes were powdered for estimation of curcuminoid content and standardized protocols were followed for the same.

Details of Experimental design for second stage evaluation are provided below:

| | |
|---|---|
| Sowing | : Last week of June |
| Digging | : First fortnight of April |
| Plot size | : 3 rows of 3m length (5.4 $m^2$) |
| Replications | : Three |
| Row to row distance | : 60cm |
| Plant to Plant distance | : 20cm |

## RESULTS AND DISCUSSION

Turmeric germplasm screening and characterization work was started in 2008 with 70 germplasm / breeding clones available in CIMAP genebank. Another set of 20 clones was provided by CIMAP's breeders. Besides, fresh collection of 40 landraces was made from North East states of India and Tharu villages of Dudhwa Tiger Reserve Forest of UP. Looking in to the variable behaviour of landraces, single plant selection (within family) was performed for two years and purified clonal lines were developed. All the clones were characterized for minimum descriptors. Superior clones were identified based on rhizome yield and curcuminoids content for further evaluation. Twenty such clones were selected and carried forward to Initial Evaluation Trial (IET). Eight traits were analysed (Table 1). The plant height was found maximum in CH-92 (56cm) genotype followed by CH-76 (55cm) and Bipul saikia (55). Fresh rhizome yield/ plot was maximum in CIM Pitamber (14.33kg) followed by CH 32 (14.27kg), CH 4 (14.90kg), JL 55 (13.17kg) and TC 19 (13.17kg). Estimated fresh rhizome yield / ha was maximum in CIM Pitamber (79.61t) followed by CH 32 (79.27t), Roma

**Table 2: Result of Performance of selected turmeric clones in multi-row advance yield trial of 5.4 $m^2$ plot, three row plot of 3 m length, replication 3**

| S. No. | Treatments / Source | Plant height (cm) | Fresh rhizome yield / plot (Kg) | Estimated fresh rhizome yield / ha (t) | Dry rhizome recovery (%) | Curcuminoid (%) | Days to leaf senescence | Days to digging of rhizome |
|---|---|---|---|---|---|---|---|---|
| 1 | **CH32** | 46.33 | 35.67 | 66.04 | 20 | 8.94 | 207.67 | 258 |
| 2 | **CH4** | 48.67 | 35 | 64.81 | 19 | 7.97 | 198 | 248 |
| 3 | **NDH-2** | 51 | 22.33 | 41.36 | 22 | 14.10 | 213.67 | 264 |
| 4 | **CIMAP Pitamber** | 47 | 36.33 | 67.28 | 22 | 12.60 | 189.67 | 240 |
| 5 | **Pratibha** | 53.33 | 21.67 | 40.12 | 19 | 4.60 | 208.67 | 259 |
| 6 | **Roma** | 53.67 | 19.67 | 36.42 | 29 | 9.30 | 240.67 | 291 |
| 7 | **Roma Pantnagar** | 51.67 | 35.33 | 65.43 | 18 | 10.27 | 229 | 279 |
| 8 | **TC19** | 47.67 | 35.67 | 66.04 | 20 | 10.57 | 227.33 | 277 |
| | **Treatment M.S.S. (7)** | 24.83** | 168.19** | 576.63** | - | - | 869.92** | |
| | **Error M.S.S. (14)** | 1.42 | 1.02 | 3.52 | - | - | 1.13 | |
| | **Mean** | 49.92 | 30.21 | 55.94 | 21.13 | 9.79 | 214.34 | |
| | **SD** | 0.97 | 0.83 | 1.53 | 3.48 | 2.89 | 0.87 | |
| | **SE** | 0.69 | 0.58 | 1.08 | 1.23 | 1.02 | 0.61 | |
| | **CV** | 2.39 | 3.35 | 3.35 | - | - | 0.50 | |
| | **CD (5%)** | 2.08 | 1.77 | 3.28 | - | - | 1.86 | |
| | **CD (1%)** | 2.90 | 2.46 | 4.56 | - | - | 2.59 | |


**Figure 1: Photos of parent rhizome and close view of CIM Pitamber plant.**

**Figure 2: Photos of rhizomes of CIM Pitamber and their transverse section showing the colour**

Pantnagar (74.50t), CH 4 (78.27t), JL 55 (73.17t) and TC 19 (73.17t). The dry rhizome yield / plot was recorded maximum in CIM Pitamber (3.15kg) followed by CH 32 (2.85kg) and CH 4 (2.67kg). The Dry rhizome recovery was maximum in Boraikhuwa (28%) followed by Bipul saikia (24%) and Ledo jagun (24%). Curcuminoid content was maximum in NDH 2 (14.2%) followed by CIM Pitamber (12.5%), Captanchuk (11.80%), Bipul saikia (11.47%) and Boraikhuwa (11.20%). Days to leaf senescence was early in CIM Pitamber (189 days) followed by CH 63 (198 days). Days to digging of rhizome was early in CIM Pitamber (239 days) followed by CH 63 (248 days). Again 6 clones were selected from these 20 clones on the basis of high rhizome yield and curcuminoid content and analysed for eight traits (Table 2). The result shows that CIM Pitamber has fresh rhizome yield / plot of 36.33 kg, Estimated fresh rhizome yield / ha was (67.28t), Dry rhizome recovery (22%), curcuminoid content (12.60%) and has early days to leaf senescence (189.67days) and early days to digging of rhizome (240days).

It is hoped that the proposed new variety of turmeric CIM- Pitamber (Figure 1 and Figure 2) with higher rhizome yield/per mint and 12.5% of curcuminoid will make business more lucrative and sustainable to the pharma industries associated with curcuminoid based bioactive preparations. Besides, this variety will therefore benefit both farmers and industries involved in turmeric cultivation. Farmers can have double income from one hectare crop (more than 54% higher rhizomes with 92% more curcuminoids yielding around 165% more curcuminoids/ha than the cultivar IISR Pratibha).

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