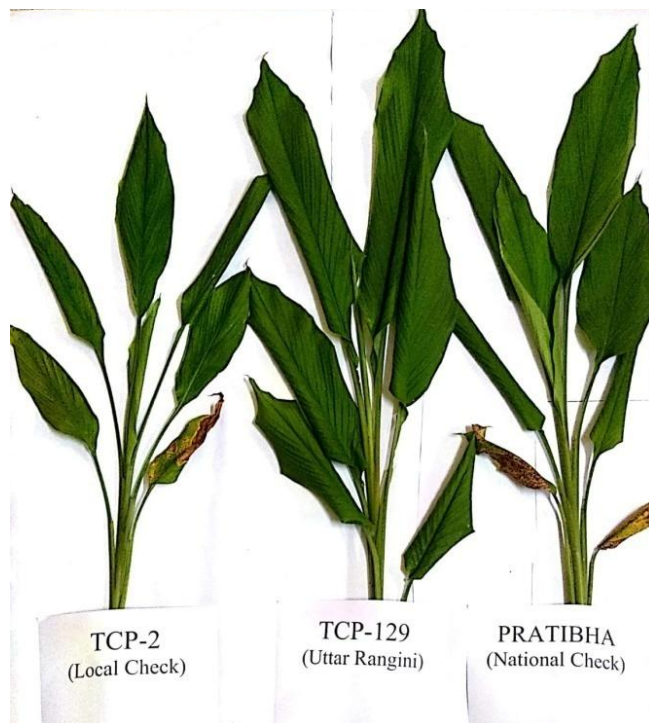


VARIETAL RELEASE PROPOSAL OF TURMERIC

UBKV TURMERIC-2 (TCP 129)

POPULAR NAME –UTTAR RANGINI



**SUBMITTED TO CENTRAL VARIETAL
RELEASE COMMITTEE**

BY

**UTTAR BANGA KRISHI
VISWAVIDYALAYA, COOCH BEHAR
WEST BENGAL 736165**

OBJECTIVES

Development of Turmeric genotype with

- 1. Resistant to leaf spot (*Colletotrichum capsici*) and leaf blotch (*Taphrina maculans*) disease**
- 2. Moderate curcumin (5.1%) content**
- 3. High yield potential (28.91 t/ha)**
- 4. High dry recovery (26.51 %)**



**UBKV TURMERIC-3 (TCP-129)
(UTTAR RANGINI)**

Proforma for Submission of Proposal for Release of Crop Variety to Central Sub-Committee on Crop Standards Notification and Release of Varieties

1.	Name of the crop and species	Turmeric (<i>Curcuma longa</i> L)
2.	(a) Name of the variety under which tested (b) Proposal name of variety.	(a) TCP-129 (IC-0615165); Registration Number: INGR -16033. (b)UBKV TURMERIC-3 (Popular Name : UTTAR RANGINI)
3.	Sponsored by	ICAR - All India Coordinated Research Project on Spices, Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal.
4.	(a) Institution or agency responsible for developing variety (with address). (b) Name of the persons who helped in the development of variety (Developers) (c) Name of Cooperators	Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, Pin 736165, West Bengal. Anamika Debnath, Suchand Datta, Sekhar Bandyopadhyay and Soumendra Chakraborty. Debanjan Chakraborty, Dr. Surajit Khalko, Prof. J. C. Jana, and Dr. Nandita Sahana, Murari Krishna Roy, UBKV; Dr. Sharon Aravind, Dr. T. E. Sheeja and Dr. D Prasath IISR, Kozhikode; Dr. C. Ushamalini, TNAU Coimbatore, Dr. A.K. Mishra, Dholi, V.P Pandey and Dr. R.S Mishra, NDUAT, Kumarganj, Dr. Happy Dev Sharma, YSPU H&F, Solan
5.	(a) Parentage with details of its pedigree	The variety has been developed through Clonal Selection from genotype TCP-129 (IC-0615165) from Gayerkata in the Jalpaiguri district of West Bengal in the year 2001.
	(b) Source of material in case of introduction IC/EC No./ Designation of parental lines should be clearly mentioned. In case the variety has been developed from local landrace/traditional variety its source (village, district, State, be given)	The variety TCP-129 (IC-0615165) UTTAR RANGINI has been developed from local landrace which was collected from Gayerkata (26.69 ⁰ N 89.02 ⁰ E; 75 m above sea level) in the district of Jalpaiguri of West Bengal in the year 2001.

	(c) Breeding method used.	(c) Clonal selection
	(d) Breeding objective.	(d) Identification of turmeric genotype for tolerance to leaf spot and leaf blotch diseases.
6.	State the varieties which most closely resemble proposed variety in general characteristics.	TCP-64 (Uttar Rupanjana)
7.	<p>a) Whether recommended by seminar/ conference/workshop/ SVRS</p> <p>b) If so, its recommendations with specific justification for the release of proposed variety.</p> <p>(c) Specific areas of its adoption.</p>	<p>Recommended by the variety release committee of 29th Annual workshop of ICAR AICRP on Spices held on 04.10.2018 to 06.10.2018 at Dr. YS Parmmar University of Horticulture and Forestry.</p> <p>NA</p> <p>(c) West Bengal, Tamil Nadu and Bihar</p>
8.	Recommended Ecology	Turmeric growing areas both under irrigated and rainfed conditions of the state West Bengal.
9.	<p>Description of variety/hybrid.</p> <p>(a) Plant height (Range)</p> <p>(b) Distinguishing morphological characteristics.</p> <p>(c) Maturity (range in number of days) Seeding/transplanting to flowering, seed to seed</p> <p>(d) Maturity group (early, medium and late- wherever such classification exists</p> <p>(e) Reaction of major diseases (under field and controlled conditions).</p>	<p>(a) 80-90 cm.(Table 1A, Page 10)</p> <p>(b) Bold size rhizome, Long primary and secondary finger, Rhizome shape straight, Rhizome habit intermediate, petiole length intermediate, lamina length long and width broad, pseudostem habit open, leaf deposition erect and leaf margin wavy,</p> <p>(c) Maturity – 210-220 days</p> <p>(d) Maturity group- medium</p> <p>(e) Tolerant to leaf spot and leaf blotch diseases (Table 3, page 15)</p>

<p>(f) Reaction to major pests (under field and controlled conditions including store pests).</p> <p>(g) Agronomic features (e.g. Resistance to lodging, shattering, fertilizer responsiveness, suitability for early or late sown conditions, seed rate etc.).</p> <p>i) Sowing time</p> <p>ii) Seed rate and spacing</p> <p>iii) Irrigation</p> <p>iv) Fertilizers and manures</p>	<p>(f) CVT trial conducted from 2013-14 to 2015-16 in Dholi, Coimbatore and Kumarganj Centre and in Pundibari centre Continues up to 2017-18.</p> <p>3.33% of shoot borer incidence noticed in TCP 129 But no other pest incidence was observed during the trials. (Table 5, Page 17)</p> <p>(g) Detailed in Annexure –II (Package of Practices)</p> <p>i) April-May.</p> <p>ii) Whole or split mother and finger rhizomes are used for planting. A seed rate of 2,000 kg of rhizomes is required for planting one hectare. Spacing for raised bed system: 20 cm × 30 cm. (20 cm row to row ; 30 cm. plant to plant)</p> <p>iii) Crop is cultivated as rain fed crop.</p> <p>iv) a) FYM should be applied at the rate of 15 t/ha one to two month before planting the rhizomes in the field. N; P₂O₅: K₂O is applied at the rate of 60: 60: 90 Kg/ha. N is applied as urea, P₂O₅ as single super phosphate and K₂O is applied as Muriate of potash. Full of P₂O₅ and ½ of K₂O is applied as basal at the time of last ploughing of field.</p> <p>b) ½ of N and 1/4th of K₂O is applied 45-50 day after sowing and second dose consisting of ½ of N and 1/4th of K₂O is applied after 90 days after sowing.</p>
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	<p>v) Quality of produce</p> <p>(g) Quality of produce of grain, forage/fibre including nutritive value wherever relevant.</p>	<p>v) The primary constituent of turmeric is an important secondary metabolite which is curcumin, oleoresin and essential oils TCP-129 showed highest curcumin (5.10%), higher dry recovery percentage (26.51%) over other varieties including local check Suranjana. TCP 129 showed essential oil 6.53% and oleoresin 12.25%. (Table 6A, page 18)</p> <p>g) NA</p>
10.	Description of parents	Clonal selection of TCP-129 (IC-0915165) which was collected from Gayerkata in the district of Jalpaiguri of West Bengal in the year 2001.
11.	<p>a) Yield data in regional/inter-regional/district trails year wise (levels of fertilizer application, density of plant populations and superiority over local/standard varieties to be indicated.</p> <p>b) Yield data from National demonstration/ large scale demonstrations</p> <p>c) Average yield under normal conditions</p>	<p>a) Pooled yield data from 2013 -14 to 2017-18 was 28.98 t/ha which out yielded local variety Suranjana by 39.08% at Pundibari centre.</p> <p>b) Average yield data from National demonstration 27.17 t/ha (mean yield of Pundibari, Dholi and Coimbatore Centre) [Table 2, Page 14]</p> <p>c) Average yield 27.00 t/ha under normal conditions</p>
12.	<p>(a) Agency responsible for maintaining breeder seed</p> <p>(b) Quantity of breeder seed in stock</p>	<p>(a) Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal. Pin 736165.</p> <p>(b) 1,000 kg.</p>
13.	Information on acceptability of variety by farmers/consumers/industry	The germplasm Uttar Rangini is highly tolerant to Colletotrichum leaf spot and Taphirna leaf blotch disease. This germplasm also having high dry recovery content along with moderate curcumin content (5.10%) and it out yielded the local check Suranjana by the overall yield.
14.	Specific recommendations, if any for seed production	Nil

15.	Any other pertinent information.	DNA fingerprinting has been done (Annexure-III)
16.	Vivid presentation of the variety with the help of photographs of the variety is to be submitted by the breeder	Photographs of the variety enclosed
17.	National identity number	IC-0615165 and Registration Number : INGR - 16033.

15.	Any other pertinent information.	DNA fingerprinting has been done (Annexure-III)
16.	Vivid presentation of the variety with the help of photographs of the variety is to be submitted by the breeder	Photographs of the variety enclosed
17.	National identity number	IC-0615165 and Registration Number: INGR - 16033.

Anamika Debnath
28.09.2018

Signature of the Breeder

Dr. (Mrs) Anamika Debnath
Assistant Professor
Plant Pathology
AICRP on Spices
Uttar Banga Krishi Viswavidyalaya
Pundibari, Cooch Behar, West Bengal

Suchand Datta
28/9/2018

Signature of the In-charge, AICRP on Spices

In-Charge
ICAR-AICRP on Spices
Uttar Banga Krishi Viswavidyalaya
Pundibari, Cooch Behar-736165, W.B.

28/9/18

Signature of Director of Research

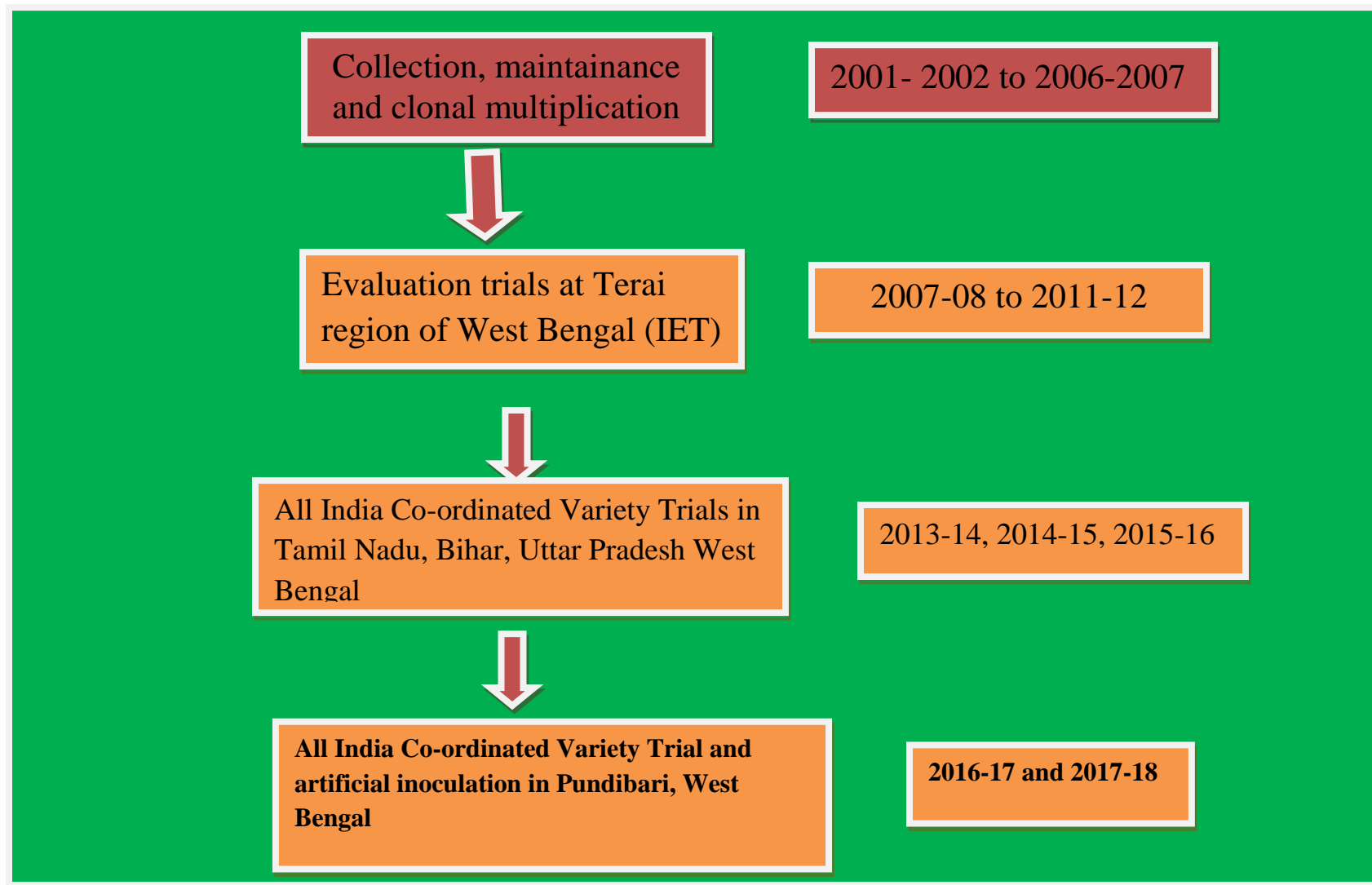
Director of Research
Uttar Banga Krishi Viswavidyalaya
Pundibari, Cooch Behar

28 Sep 18

Signature of the Head of the Institution

Vice-Chancellor
Uttar Banga Krishi Viswavidyalaya
Pundibari, Cooch Behar-736165 (W.B.)

Testing of the entry, TCP 129 under different Trials



Evaluation of TCP-129 at Terai Region of West Bengal



**Initial Evaluation Trials- 2007-08, 2008-09, 2009-10, 2010-11 and 2011-12 at
Terai Region of West Bengal**

No. of treatments / genotypes with details: 17 + 1 (Check)

Local check : TCP-2 (Suranjana)

Design: Randomized Block Design

Genotypes: TCP-11, TCP-54, TCP-57, TCP-64, TCP-70, TCP-72, TCP-84, TCP-97, TCP-104, TCP-107, TCP-119, TCP-128-1, **TCP-129**, TCP-139, TCP-140, TCP-160, ABN-1, TCP-02 (Check)

Replications: Three

Plot Size/spacing: Planting was done in raised beds of 3 m × 1 m plot size with a spacing of 30 cm row to row and 20 cm plant to plant.

Date of sowing: April- May

Season: Kharif

Date of Harvesting: March

Recommended package of practices were followed and observations were recorded on various morphological, yield and yield contributing characters. The data were subjected to statistical analysis (Panse and Sukhatme, 1978).

Table 1A: Growth and yield parameters of Turmeric Initial Evaluation Trial (pooled value of 2007-08, 2008-09, 2009-10, 2010-11 and 2011-12)

Germplasm	Plant height (cm)	Tiller No.	Leaf No	Leaf length (cm)	Leaf breadth (cm)	Pseudo stem girth (cm)	Yield Kg/3m²	Wt of clump (g)	Wt of mother clump (g)
TCP-11	83.20	2.10	7.21	39.53	9.46	6.60	6.33	239.11	42.87
TCP-54	84.51	2.26	7.78	42.30	9.94	6.82	5.95	163.24	38.50
TCP-57	108.23	1.71	7.64	53.05	10.94	8.97	6.84	208.90	49.46
TCP-64	92.93	2.49	7.49	43.95	10.67	7.52	12.72	286.37	65.84
TCP-70	83.23	2.29	7.85	42.58	9.84	7.93	7.45	169.17	37.49
TCP-72	77.62	2.30	7.67	38.47	9.44	6.29	6.35	181.02	38.99
TCP-84	81.32	2.21	7.82	40.46	10.08	7.75	6.33	166.33	39.00
TCP-97	80.79	2.12	7.59	41.32	10.27	6.90	5.77	141.49	35.63
TCP-104	86.33	1.99	7.70	39.15	9.14	6.79	5.37	172.53	46.28
TCP-107	97.24	2.24	7.46	46.28	10.55	8.25	6.84	218.10	46.64
TCP-119	80.43	2.28	7.35	41.63	10.07	6.60	4.90	149.29	31.94
TCP-129	86.40	2.25	7.80	43.87	10.64	7.25	7.62	194.60	40.74
TCP-139	81.51	2.44	7.22	41.82	10.07	6.46	5.69	180.43	48.11
TCP-140	80.94	2.12	7.77	40.69	9.71	6.61	4.86	156.75	36.16
TCP-160	86.60	2.34	7.43	42.82	10.02	6.35	6.32	183.56	31.27
ABN-01	77.15	2.42	7.57	35.85	8.78	5.87	6.09	222.20	42.04
TCP-128-1	100.73	2.00	7.52	51.50	10.34	8.99	4.99	170.27	38.00
TCP-02	72.37	2.41	7.31	34.84	8.55	5.97	7.09	174.77	26.47
S.Em (±)	6.55	0.21	0.31	3.71	0.61	0.82	1.20	34.96	10.03
CD (at 5%)	13.07	0.43	0.61	7.41	1.22	1.64	3.39	69.75	20.02
C.V.%	21.32	4.32	1.21	15.61	2.86	3.58	7.80	26.32	16.80

Table 1B: Growth and yield parameters of Turmeric Initial Evaluation Trial (pooled value of 2007-08, 2008-09, 2009-10, 2010-11 and 2011-12)

Germplasm	Length of mother finger (cm)	No. of mother finger / clump	No. of Primary fingers	Wt of Primary fingers (g)	Length of Primary fingers (cm)	No. of secondary fingers	Wt of secondary fingers (g)	Length of secondary fingers (cm)	Net area rhizome yield (t/ha)
TCP-11	18.14	1.17	4.64	8.33	8.33	10.01	6.01	12.70	21.1
TCP-54	16.01	1.10	4.17	8.93	7.79	6.25	6.25	11.94	19.83
TCP-57	18.56	0.95	4.84	8.67	5.89	11.45	5.45	11.42	22.80
TCP-64	20.28	2.23	8.14	9.36	12.27	17.88	7.80	13.34	42.40
TCP-70	16.83	0.99	4.43	8.80	9.06	8.22	7.22	15.35	24.83
TCP-72	17.37	1.22	3.83	9.00	10.38	6.61	6.61	9.94	21.16
TCP-84	15.83	1.15	4.31	8.27	5.62	7.07	7.07	13.25	21.10
TCP-97	15.74	1.01	3.92	8.33	6.27	7.38	7.38	10.01	19.23
TCP-104	16.19	1.09	4.73	8.80	7.62	9.44	5.44	13.47	17.90
TCP-107	16.77	1.04	5.28	8.67	8.80	11.72	6.72	15.37	22.80
TCP-119	14.42	0.93	4.17	8.07	5.84	7.47	7.47	13.02	16.33
TCP-129	17.82	1.08	4.94	9.27	6.42	8.38	7.38	12.08	25.40
TCP-139	19.10	1.26	4.14	8.93	5.58	8.04	5.04	11.64	18.96
TCP-140	17.35	0.91	3.78	8.27	5.61	7.55	7.55	13.21	16.20
TCP-160	14.72	1.09	3.73	8.27	5.14	7.21	7.21	9.88	21.06
ABN-01	18.35	1.41	4.57	9.13	5.11	9.98	6.98	13.70	20.30
TCP-128-1	16.31	0.96	4.75	7.8	5.80	10.46	7.46	14.47	16.63
TCP-02	15.45	1.26	4.02	9.2	4.56	8.48	6.48	13.41	21.10
S.Em (±)	2.19	0.18	0.68	0.35	22.89	2.02	2.02	3.09	3.24
CD (at 5%)	4.37	0.35	1.36	0.99	5.77	4.03	4.03	6.17	7.96
C.V.%	9.32	4.10	3.68	5.63	11.42	10.43	13.65	20.45	25.80

Table 1C: Evaluation of foliar diseases of Turmeric germplasm (average value of -2011-12 and 2012-13)

Genotypes	Leaf blotch (PDI)	Leaf spot disease (PDI)	Genotypes	Leaf blotch (PDI)	Leaf spot disease (PDI)
TCP-11	53.33	50.62	TCP-107	14.82	22.23
TCP-54	12.35	9.26	TCP-119	64.20	32.72
TCP-57	35.80	49.39	TCP-129	6.79	6.18
TCP-64	22.22	16.67	TCP-139	53.12	50.62
TCP-70	28.40	51.86	TCP-140	40.35	51.86
TCP-72	41.98	79.02	TCP-160	50.00	39.51
TCP-84	44.45	50.62	ABN-01	37.86	42.73
TCP-97	48.15	48.77	TCP-128-1	41.42	37.79
TCP-104	19.75	37.04	TCP-02	23.46	22.22

Results and discussion: Analysis of pooled data showed that TCP-129 was recorded second highest yield (Plot yield of 7.62 kg/3m² and Projected yield of 25.40 t/ha) over all the other genotypes. In 2011-12 and 2012-13 leaf blotch and leaf spot disease incidence was recorded which was PDI 6.79, PDI 6.18, respectively. So, TCP 129 was found as a germplasm which has second highest yield and tolerant to leaf spot and leaf blotch diseases and was selected as a line to include in the CVT trial.

Pooled data of turmeric CVT AICRPS in all centers

TUR/CP/7.4: Evaluation of turmeric for tolerance to foliar diseases

i) Crop: Turmeric

ii) Discipline: Crop protection

iii) Project code, title and year of start: TUR/CP/7.4, Evaluation of Turmeric for tolerance to foliar diseases, 2013 – 2014

iv) Technical Programme (experiment) details:

a) Year of start: 2013 – 2014 and continue upto 2015-16

b) Design: Randomized Block Design

c) No. of treatments / genotypes with details: 11

CL 32, CL 34, CL 52, CL 54 (from Coimbatore), RH 406, RH 407, RH 410 (from Dholi), TCP 14, TCP 129, TCP 161 (from Pundibari) and TCP 2 (Local check)

d) Centers involved: Pundibari, Coimbatore, Dholi, Kumarganj

e) Replications: Three

f) Plot size / spacing : 3 m × 1 m & 30 cm × 20 cm

g) Recommended package of practices were given.

Table-2A: Rhizome yield (t/ha) as influenced by different Genotypes of turmeric grown under All India Coordinated Trials across location throughout India (Pooled over three years; 2013-14, 2014-15 and 2015-16)

Turmeric Genotypes	Fresh Rhizome yield (t/ha)				% reduction over local check
	Pundibari	Coimbatore	Dholi	Cumulative Mean	
CL 32	18.61	31.92	20.91	23.81	---
CL 34	18.75	32.91	24.23	25.30	5.02
CL 52	16.55	30.26	23.98	23.60	---
CL 54	17.22	31.01	22.03	23.42	---
RH 406	16.71	29.17	40.95	28.94	20.13
RH 407	16.33	25.19	40.70	27.41	13.78
RH 410	15.79	27.21	39.76	27.59	14.53
TCP 14	23.37	29.02	22.89	25.09	4.15
TCP 129	28.91	30.58	22.02	27.17	12.79
TCP 161	18.29	27.72	27.33	24.45	1.49
(Local check)	14.84	32.25	25.17	24.09	---
Pratibha (National check)	21.27	---	---	---	
SEm (\pm)	0.48	---	2.06	---	
CD (0.05)	1.36	---	5.99	---	

Local check: Pundibari- TCP 2, Dholi-Morangia, Coimbatore –BSR-2

Results and Discussion: The results (Table-2) showed that the test entry, TCP-129 recorded higher yield of 27.17 /ha over most of the other genotypes including local check Suranjana (14.84 t/ha) and national check Pratibha (18.82 t/ha).

Table 2B: Pooled ANOVA for Stability analysis for yield (Eberhart and Russell model, 1966)

Source of variation	DF	Sum of squares	Mean squares
Variety	11	527.75	47.98
Environment	3	1,112.94	370.98
Var.x Environment	33	494.25	14.98
Env x Var. x Env	36	1,607.19	44..64
Env (Linear)	1	1,112.94	1,112.94
Env x Var (Lin)	11	222.48	20.23
Pooled Deviation	24	271.77	11.32
Pooled Error	88	1,181.22	13.42
Total	47	2,134.94	

Table 2C: Stability analysis for different parameters all the accessions based on four years replicated data

Variety	Mean yield (t/ha)	Regression coefficient (b_i)	Deviation from regression coefficient ($S^2 d_i$)
CL 32	23.41	1.36	5.08
CL 34	20.01	1.17	7.66
CL 52	24.26	0.97	6.43
CL 54	18.73	1.37	29.25
RH 406	21.67	1.24	18.24
RH 407	21.01	1.27	23.01
RH 410	18.25	1.00	0.67
TCP 14	23.64	1.18	-1.92
TCP 129	29.48	1.01	-0.87
TCP 161	21.70	1.27	-3.14
(Local check)	15.87	0.13	-1.90
Pratibha (National check)	21.27	-0.06	-0.32

Table:-3 Evaluation of leaf spot and leaf blotch diseases of all the turmeric genotypes**(Pooled value of 2013-14, 2014-15 and 2015-16)**

Turmeric Genotypes	Leaf blotch and leaf spot (PDI)								% reduction of disease over local check	
	Pundibari		Coimbatore		Dholi		Cumulative Mean			
	Leaf blotch	leaf spot	Leaf blotch	leaf spot	Leaf blotch	leaf spot	Leaf blotch	leaf spot	Leaf blotch	leaf spot
CL 32	24.91	20.84	15.27	7.21	48.33	15.56	29.50	14.54	23.42	44.034
CL 34	21.73	16.81	3.50	5.40	48.33	12.22	24.52	11.48	36.34	55.812
CL 52	14.32	8.76	12.88	7.22	45.00	16.67	24.07	10.88	37.51	58.122
CL 54	26.21	22.56	13.83	7.57	17.78	14.63	19.27	14.92	49.97	42.571
RH 406	37.39	30.37	11.42	7.84	19.81	0.00	22.87	12.74	40.63	50.962
RH 407	37.16	31.80	11.37	6.72	15.18	0.00	21.24	12.84	44.86	50.577
RH 410	31.48	36.38	6.06	5.53	17.96	0.00	18.50	13.97	51.97	46.228
TCP 14	13.47	8.93	9.67	5.92	21.11	10.00	14.75	8.28	61.71	68.129
TCP 129	12.78	7.26	3.96	5.68	7.40	4.82	8.05	5.92	79.10	77.213
TCP 161	24.26	27.22	8.00	9.11	37.77	7.22	23.34	14.52	39.41	44.111
Local check	23.88	24.23	30.58	19.26	56.11	34.44	38.52	25.98	---	---
Pratibha (National check)	28.04	13.22	---	---	---	---	---	---	---	---
SEm (±)	1.00	1.18	2.06	0.98	1.07	1.40	---	---	---	---
CD (0.05)	2.84	3.33	4.21	2.00	3.11	4.07	---	---	---	---

Local check: Pundibari- TCP 2, Dholi-Morangia, Coimbatore –BSR-2

Results and discussion: The results (Table-3) revealed that the test entry, TCP-129 showed the lowest PDI of 8.05 against leaf blotch disease. The said entry showed PDI of 5.92 against leaf spot disease. The results indicate that the entry, TCP-129 is highly tolerant to leaf spot and leaf blotch diseases of turmeric.

Table 4: Evaluation of diseases on artificial inoculation (Pooled over 2016-17 and 2017-18)

Turmeric Genotypes	Disease incidence	
	Leaf blotch (PDI)	Leaf spot (PDI)
TCP 129	8.33	5.56
TCP 2	16.67	19.44
Pratibha	22.22	11.11

Results and discussion: The results (Table-4) revealed that the test entry, TCP-129 showed the lowest PDI of 8.33 against leaf blotch disease. The said entry showed PDI of 5.56 against leaf spot disease. The results indicate that the entry, TCP-129 is highly tolerant to leaf spot and leaf blotch diseases of turmeric.

Severity scale for calculating Percent Disease Index PDI

0: No disease on leaf and pods

1: Small brown spot covering <1% leaf area (pin point spots on pod)

3: Brown sunken spots 1-10% leaf area (< 1% pod area)

5: Brown spots 11-25% leaf area (1-10% pod areas)

7: Circular brown sunken spots 26-50% leaf area(11-25% pod area)

9: Circular to irregular >51% leaf area (>26% pod area)

Disease severity or Infection index

$$= \frac{\text{Sum of all disease rating} \times 100}{\text{Total no. of rating} \times \text{maximum disease grade}}$$

Table 5: Record on pest incidence of all the turmeric genotypes

Turmeric Genotypes	Pest incidence [% of Shoot borer (<i>Conogethes punctiferalis</i>) infected plants]			
	2015-16	2016-17	2017-18	Mean
CL 32	7.50	17.50	10.00	11.67
CL 34	5.00	2.50	12.50	6.67
CL 52	5.00	2.50	10.00	5.83
CL 54	2.50	5.00	7.50	5.00
RH 406	2.50	12.50	5.00	6.67
RH 407	0.00	10.00	10.00	6.67
RH 410	7.50	2.50	15.00	8.33
TCP 14	2.50	5.00	2.50	3.33
TCP 129	5.00	0.00	5.00	3.33
TCP 161	5.00	5.00	7.50	5.83
TCP 2 (Local check)	5.00	2.50	2.50	3.33
Pratibha (National check)	2.50	5.00	2.50	3.33

Results and discussion: The result (Table 5) revealed that only shoot borer incidence was noticed during the trial. Lowest incidence (3.33% plant affected) of shoot borer was recorded in TCP 129, TCP 14 as well as in Local and National check. No other pest incidence was found.

Table 6A: Quality analysis of different turmeric genotypes (2 centres)

Variety/ Genotype	Curcumin (%)		Essential Oil (%)		Oleoresin (%)		Dry recovery (%)	
	Pundibari	Dholi	Pundibari	Dholi	Pundibari	Dholi	Pundibari	Dholi
TCP-14	3.93	4.63	6.33	6.59	11.35	11.65	26.05	32.9
TCP-129	5.10	5.24	6.53	6.68	12.25	11.88	26.51	32.86
TCP-161	4.83	5.19	6.10	6.67	10.99	11.87	26.15	34.01
TCP 2 (Local check)	4.90	---	6.60	---	11.70	---	22.65	---
Pratibha (National check)	5.10	---	7.00	---	11.92	---	21.39	---

Table 6B: Quality analysis of different turmeric genotypes (Mean value of 2 centres)

Variety/ Genotype	Curcumin (%)	Essential Oil (%)	Oleoresin (%)	Dry recovery (%)
TCP-14	4.28	6.46	11.50	29.48
TCP-129	5.17	6.61	12.07	29.69
TCP-161	5.01	6.39	11.43	30.08
TCP 2 (Local check)*	4.90	6.60	11.70	22.65
Pratibha (National check)*	5.10	7.00	11.92	21.39

* Data from Pundibari Centre

Quality analysis of the Pundibari centre done by Solan Centre

Results and discussion: The results (Table-6A and 6B) revealed that the mean value of the test entry TCP-129 showed highest curcumin (5.17%), higher dry recovery percentage (29.69%) over other varieties including local check Suranjana. TCP 129 showed essential oil of 6.61% and oleoresin of 12.07%. The results indicated that the entry, TCP-129 has higher economic advantage.

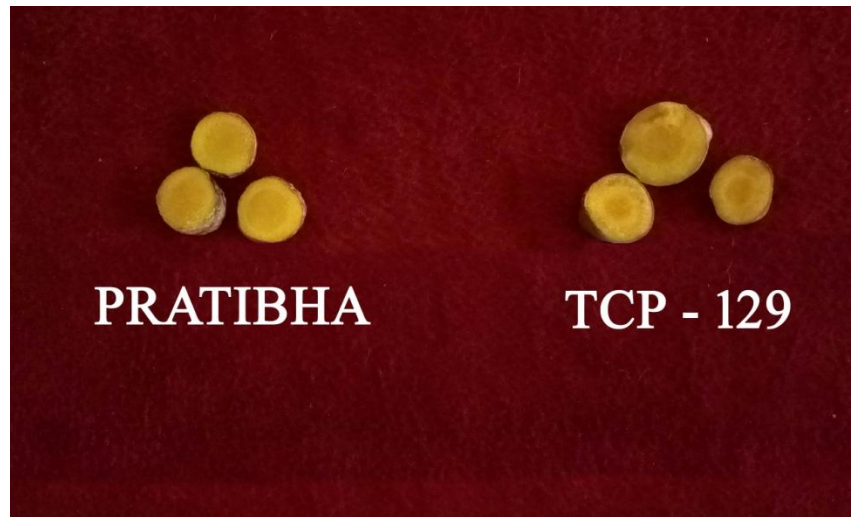
Salient Features of Uttar Rangini



1. Foliar disease (Leaf spot and leaf blotch) tolerant variety



2.Moderate curcumin%-5.1



3. High yield potential 14.34 kg/plot (28.91 t/ha)



Annexure -I
Distinguishable DUS Characters

S No.	Characteristics	States	TCP-64 (Uttar Rupanjana)	TCP-129 (Uttar Rangini)
1	Plant: Pseudo stem habit	Compact	Compact	Open
		Open		
2	Plant: Height (cm)	Short (<85)	Medium	Medium
		Medium (85-100)		
		Tall (>100)		
3	Plant: Number of shoots	Few(<3)	Few	Few
		Medium (3-5)		
		Many (>5)		
4	Plant: Number of leaves on main shoot	Few (<5)	Intermediate	Intermediate
		Inter mediate (5-10)		
5	Plant: Leaf disposition	Erect (<45°)	Erect	Erect
		Semi-erect (45-85°)		
		Horizontal (>85°)		
6	Leaf: Petiole length (cm)	Short (<15)	Long	Inter mediate
		Inter mediate (15-25)		
		Long (>25)		
7	Leaf: Lamina length (cm)	Short (<30)	Long	Long
		Medium (30-40)		
		Long (>40)		
8	Leaf: Lamina width (cm)	Narrow (<10)	Medium	Medium
		Medium (10-15)		
		Broad (>15)		
9	Leaf: Venation pattern	Close	Distant	Close
		Distant		

10	Leaf: Margin	Even	Wavy	Wavy
		Wavy		
11	Rhizome: Habit	Compact	Intermediate	Intermediate
		Intermediate		
		Loose		
12	Rhizome: Shape	Straight	Straight	Straight
		Curved		
13	Primary Rhizome Length (cm)	Short (< 5 cm)	Medium	Medium
		Medium (5 - 10 cm)		
		Long (> 10 cm)		
14	Rhizome: Internode pattern (cm)	Close (< 1)	Close	Close
		Distant (>1)		
15	Rhizome: Status of tertiary rhizome	Absent	Present	Present
		Present		
16	Rhizome: Inner core colour	Orange	Orange	Lemon Yellow
		Lemon Yellow		
		Radish Yellow		
17	Dry recovery (%)	Low (<15)	High	High (26.51%)
		Intermediate (15-20)		
		High (>20)		
		Intermediate (15-20)		
		High(>20)		

Annexure -II

Package of practices-Turmeric

One of the most important spices which is required and used in our day-to-day life is turmeric. Not only it is used as spices, but it is also used as beautification and perfumatory products for commercial uses. When high yielding and highly developed varieties are used scientifically, they can be very much economically useful for farmers very good return. Turmeric can be grown in the fields where coconut, arecanut and fruit trees are grown with sufficient shades in the field. Leaf spot and leaf blotch disease poses a serious threat to turmeric production. For commercial viability turmeric should have good quality. So a variety with good yield, tolerant to leaf spot and leaf blotch diseases and good quality parameter can help farmers to grow a commercially viable turmeric crop.

Climate: Turmeric is a crop which is mainly grown in tropical countries. They can be grown upto 1250 mt. above sea level. 20⁰-30⁰C temperature is ideal range of temperature in any region of West Bengal. At first higher temperatures are required but when rhizomes are formed in good shape, near about 20⁰C is required for proper development and growth.

Soil: High level, well drainage facility, fertile, sandy-clayey loam or clayey loam soil are required for cultivation of turmeric in any region. Water stagnation in the soil is very much detrimental for the growth of this plant. Due to this reason, rhizome rot disease is occurred in the rhizome. The soil pH should be maintained within 5-7 range for good production of turmeric in this region.

Variety: TCP-2 (Surnjana) and other local cultivars are mostly cultivated in most of the regions of West Bengal.

Preparation of field: Proper field should be identified and prepared by thorough ploughing up to the depth of 20-25 cm and leveling by a leveler. The field is freed from weed and previous crop residue and is cleaned enough for turmeric cultivation.

Planting: April-May months is highly suitable for planting in different parts of West Bengal. Mother and fingers are used for planting purpose. Usually 25-30 g of rhizome pieces are used for planting purpose. Minimum 2-3 buds should be present in the rhizome. In case of one hectare land, 2.0 tonnes of rhizomes are required for planting. Turmeric is planted as ridge and furrow method in plot or in continuous plot having 1 mt width and where there is predominance of

rainfall. It can also be planted in 3 m × 1 m plots with raised beds of about 15 cm height with 30 cm space between the lines and 20 cm between the rhizomes.

Rhizome Treatment: The rhizomes is soaked for 30 minutes with 2.5 g mancozeb and 1 g carbendazim for 30 minutes and then dried in shades.

Nutrient Management: FYM should be applied @ 15 t/ha one to two month before planting the rhizomes in the field. N; P₂O₅; K₂O is applied at the rate of 60 : 60: 90 Kg/ha. N is applied as urea, P₂O₅ as single super phosphate and K₂O is applied as Muriate of potash. Full of P₂O₅ and ½ of K₂O is applied as basal at the time of last ploughing of field. ½ of N and 1/4th of K₂O is applied at 45-50 days after sowing and second dose consisting of ½ of N and 1/4th of K₂O is applied at 90 days after sowing.

Intercultural operation: Mulching is done in all the plots after sowing. Generally 2-3 times mulching should be done. It is done with dried paddy straw or dried leaves. The soil is loosened up by applying khurpis and weeding is done at the time of sowing in this region.

Irrigation: In west Bengal it is mostly grown as rain fed crop.

Harvesting: Generally, rhizomes are taken out from the soil 7-9 months after sowing depending upon the varieties. When the leaves are dried in the field, then it is ideal for harvesting turmeric. Then the rhizomes are taken out from the field and roots and soils stuck to rhizomes are separated carefully.

Yield: Generally 20-25 t/ha of rhizomes are produced in this region. In high yielding varieties, upto 30 t/ha of yield is also recorded.

Diseases: Foliar disease like leaf spot and leaf blotch is a problem in terai region of West Bengal. Spray with propiconazole or hexaconazole @1 ml/liter of water or mancozeb @ 2.5 g/liter of water is found effective in management of foliar diseases. Rhizome rot is another disease found here in this region. If it is found, then metalaxyl + mancozeb 3 g/liter of water or Mancozeb @ 2.5-3 g per lit of water or copper oxychloride @ 4 g/liter of water or Carbendazim @ 1g/lit of water is used for curing of this disease.

Pest: Stem borer is found which bores the stems inside, so the plant becomes dry and ultimately died. Application of Cartap hydrochloride @ 9 kg/ha can manage the pest. Indoxacarb at the rate of 1 ml or Flubendiamide @ 0.2 g per liter of water should be sprayed to avoid this infestation in this region.

ANNEXURE III

Summary of DNA Fingerprinting Report

1	Name of the firm/ institute/ person submitting the sample	Dr. Suchand Datta, Professor, Vegetable and Spice Crops & In-Charge, AICRP on Spices, Uttar Banga Krishi Viswa Vidyalaya, Regional Research Station, Terai Zone, Pundibari, West Bengal- 736165.
2	Crop	Turmeric
3	Name of the cultivar (s)	TCP 64 and TCP 129 compared with TCP 191 and TCP 161.
4	Technique (s) used	ISSR
5	Name of the primer	UBC 868
6	No. of alleles/ bands compared	13
7	Basis for selection of markers	Presence of a clearly distinguishable polymorphic band that distinguishes the closely resembling cultivars a) TCP 64 and TCP 191 b) TCP 129 and TCP 161
8	Report on the DNA fingerprinting	15 different ISSR primers were analysed in the study, and we could identify the primer UBC 868, which showed polymorphic alleles UBC 868 _{900,750,600,450} that distinguish the candidate TCP 129 from its closely resembling cultivar/variety TCP 161 and UBC 868 _{700,600,550,500,400} that distinguish the candidate TCP 64 from its closely resembling cultivar/variety TCP 191. The gel pic and scoring data are provided below.
9	Scientist who prepared the report	Dr. T.E Sheeja, Principal Scientist, Division of Crop Improvement and Biotechnology, ICAR-IISR.

Disclaimer : This report should not be treated as an evidence to settle legal dispute, if any

Report of DNA fingerprinting of turmeric sample

DNA extraction, purification, quantification

DNA extraction was carried out using genomic DNA isolation kit (Sigma –Aldrich) from leaf tissues of the candidate sample TCP 64 and its closely resembling variety TCP 191, TCP 129 and its closely resembling variety TCP 161. The quantity and quality of DNA was analysed using 0.8% agarose gel and eppendorf biophotometer readings. The DNA of good quality was further used for conducting ISSR analysis.

Analysis

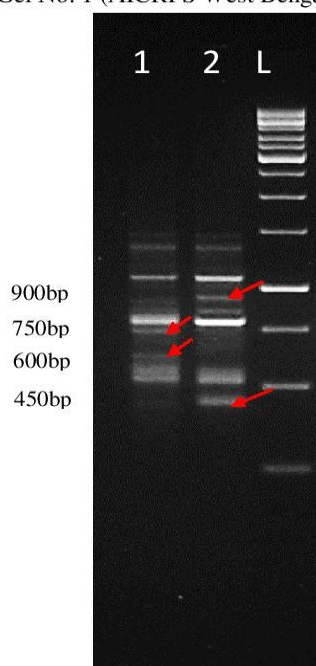
PCR reaction was carried out with 50 ng of DNA as template using Emerald green PCR mastermix (Takara) and the PCR products were analysed in 2% agarose gels. The gels were run at 80V for 2- 2½ hrs and the gels were visualized using uv trans illumination. Data was scored based on the presence (1) or absence of bands (0).

Conclusions

Table 1: Name and sequence of the primer used

S. No.	Primer Name	Sequence (5'-3')
1	UBC 868	GAAGAAGAAGAAGAAGAA

Gel No. 1 (AICRPS West Bengal Turmeric- WBT 01)

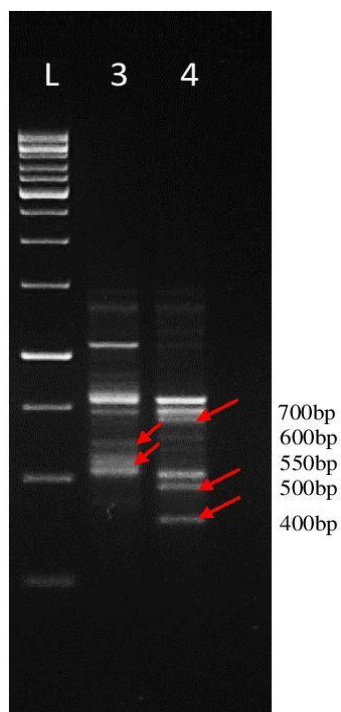


Lane 1- TCP 129
Lane 2- TCP 161
Lane L- 1kb ladder

Table 2: Allele size observed in samples

Primer Name	Size (bp)	Sample 1 TCP 129	Sample 2 TCP 161
UBC 868	1400	1	1
	1100	1	1
	900*	0	1
	850	1	1
	800	1	1
	750*	1	0
	600*	1	0
	550	1	1
	520	1	1
	450*	0	1

Note: allele size marked in red color with ‘*’ symbol denotes the polymorphic bands UBC 868_{900,750,600,450} which distinguishes the candidate variety TCP 129 from TCP 161 which is taken for comparison.



Lane L- 1kb ladder
Lane 3- TCP 64
Lane 4- TCP 191

Table 2: Allele size observed in samples

Primer Name	Size (bp)	Sample 3 TCP 64	Sample 4 TCP 191
	1400	1	1
	1100	1	1
	800	1	1
	750	1	1
	700*	0	1
	600*	1	0
	550*	1	0
	520	1	1
	500*	0	1
	400*	0	1

Note: allele size marked in red color with ‘*’ symbol denotes the polymorphic bands UBC 868_{700,600,550,500,400} that distinguish the candidate TCP 64 from its closely resembling cultivar/variety TCP 191 taken for comparison.