Original Research Article

Screening Taro germplasm against bacterial blight incited by *Xanthomonas axonopodis* pv. *Dieffenbachiae*

ABSTRACT

Sixty-four Taro germplasm accessions from north east India along with two national released varieties were evaluated in natural epiphytotic field condition against bacterial blight incited by *Xanthomonas axonopodis* pv. *dieffenbachia* for two consecutive seasons during 2018 and 2019 at an Experimental Farm for Horticultural crops, Assam Agricultural University, Jorhat. The results obtained for the two growing seasons were pooled together. Per cent disease incidence and disease severity ranged from 23.81 (Nepali-2) to 78.57 % (SC-1) and 14.17 (Nepali-2) to 67.50 % (SC-1) respectively. The area under the disease progress curve (AUDPC) which directly corresponds to the bacterial disease infection with time resulting in more susceptibility to the disease ranged from 1612.5 (Sreekiran) to 9812.5 (SC-1). AUDPC was calculated from the per cent disease severity obtained from the first day of disease observation till the last day *i.e.* from 60 to 240 days after transplanting (DAT). The disease reactions of different germplasm to bacterial blight of colocasia were evaluated based on the disease severity (%) and disease rating scale whereby no cultivars were immune and highly susceptible to the disease. Four accessions *viz*. Sreekiran, Naga-2, Chandil Pin, Nepali-2 were resistant, twenty-one were moderately resistant, twenty-six were moderately susceptible and fifteen were susceptible. Variety/ germplasm resistant to bacterial blight of Taro have not been reported till date. Proper selection of resistant varieties will be useful in breeding programmes and for further crop improvement to develop resistant varieties.

Keywords: *Taro; germplasm screening; disease severity; bacterial blight; Xanthomonas axonopodis* pv. *dieffenbachia*

1. INTRODUCTION

Taro (*Colocasia esculenta* L. Schott) also known by other names as old cocoyam, dasheen, eddoe, gabi, or arvi is a tropical and subtropical tuber crop that falls under the monocotyledonous family Araceae whose members are known as aroids (Yamaguchi, 1983). Taro ranks fifth amongst tuber and root crops after potato, cassava, sweet potato, and yams with a world total production of 17.72 million tonnes, cultivated in around 2.48 million ha (FAOSTAT, 2022). Almost all parts of edible aroids are utilized in different ways. Taro is rich in carbohydrates composing mainly starch, dietary fibre, protein, vitamin C, vitamin B-6, vitamin A, magnesium, calcium, iron, and phosphorous. In addition, aroids are

also known for their many medicinal properties (Babu *et al*., 2010). It is a versatile crop that can be grown in different climatic conditions and also in saline soils (Grubben and Denton, 2004) making it suitable to grow in varied locations.

Various abiotic and biotic stresses threaten the quality and yield of taro. In the recent decades, the bacterial leaf blight of taro caused by *Xanthomonas axonopodis* pv. *dieffenbachia* (Xad) (Asthana, 1946; Tomlinson, 1987; Opara *et al*., 2013) causes extensive damage and losses to the crop with 74-100 per cent incidence of Xad on cocoyam (Pohronezny *et al*., 1985). It is considered a quarantine pest because of its economic importance for the European Union (EPPO 2009) and it was first reported from India (Asthana, 1946). Early symptoms of the disease appear to be small star-shaped, water-soaked spots which eventually become V-shaped or irregular brown necrotic with a yellow margin under dry conditions where the systemic infections spread to other parts of the plant eventually killing the entire plant (Constantin *et al*., 2017). Cream to light yellow bacterial exudate can be seen on the undersides of young lesions, especially in the morning (Pohronezny *et al.*, 1985). The disease poses a serious threat in the tropical and subtropical region whereby heavy rainfall or dew with an average temperature of 20-30^{o}C favours the entry of the pathogen either directly or through the stomata spreading from cotyledon to young leaves where it can survive in the cormels until the next planting season (Brown and Asemota, 2009). The pathogen spreads mainly by running water, infected detached leaves, and contaminated materials (Paulraj, 1993). The control of bacterial blight is becoming difficult and is a challenging problem because of its systemic infection. However, the use of synthetic chemicals and pesticides are discouraged because of their hazardous nature to the environment and the living beings around. Integrated management of the disease by incorporating host resistance is one of the alternative ways. Screening of taro germplasm against bacterial blight of colocasia has not been conducted so far and no variety is found resistant to the disease.

2. MATERIAL AND METHODS

Sixty-four cultivated germplasms of Taro representing different genetic stocks from the North-East region of India along with two national released varieties *viz*. 'Muktakeshi' and 'SreeKiran' (**Table 1 & Figure 1**) were transplanted to the Experimental Farm for Horticultural crops, AAU, Jorhat during two growing seasons *viz*. 2018 and 2019 by maintaining a plant spacing of 1 m^2 in a randomized block design (RBD) with three replications following all the agronomic practices (**Figure 2)**. Screening of different germplasms against Xad were carried out under natural epiphytotic conditions by exposing the plants to natural infection by *Xanthomonas axonopodis* pv. *dieffenbachia.* The disease reaction was scored using a standard scale based on the presence and area covered by the disease lesion on leaves. Per cent disease incidence (PDI) was calculated following the formula:

$$\text{PDI} = \frac{\text{Number of plants infected}}{\text{Total number of plants sampled}} \text{x } 100$$

For per cent disease severity (PDS), 5 plants were randomly selected for each replication where the selected plants were tagged and disease severity was recorded using a disease rating scale (**Fig. 3**) as proposed by Opara et al. 2013 with few modifications:

0 = no disease symptom visible on the plant

1 = less than 15% of leaves area infected

2 = 15.01 - 30 % of leaves area infected

3 = 30.05 - 50% of leaves area infected

4 = 50.01 - 70% of leaves area infected

5 = above (>) 70% of leaves area infected

Per cent Disease Severity (PDS) was evaluated using the formula given by wheeler 1969 as

$$\text{PDS} = \frac{\text{Sum of individual disease scores}}{\text{Total number of leaves observed x maximum disease score}} \times 100$$

PDI and PDS obtained at 240 days after transplanting (DAT) for the two consecutive years were pooled together**.**

Cultivar/ germplasm reaction to bacterial leaf blight of colocasia was classified as follows:

Table 1: Cultivar/ germplasm reaction to bacterial leaf blight of Colocasia classification

Disease Rating Scale	Terminal disease severity (%)	Reaction
0	0	Immune (I)
1	1-15	Resistant (R)
2	15.01-30	Moderately resistant (MR)
3	30.01-50	Moderately susceptible (MS)
4	50.01-70	Susceptible (S)
5	Above 70.01	Highly susceptible (HS)

The area under the disease progress curve (AUDPC) was calculated from the pooled mean of the disease severity for the two consecutive years, i.e, 2018 and 2019 obtained from the first day of disease

observation till the last day *i.e.* from 60 to 240 DAT, where the disease severity was calculated at an interval of 30 days. AUDPC was used as a measure to quantify the amount of disease that occurred with time and also to compare the disease reaction for a particular cultivar/ germplasm. It was calculated according to the formula given by Shaner and Finney 1977.

$$AUDPC = \sum_{i=1}^{n-1} [\{(Y_i + Y_{i+1}) /2\} \times (t_{(i+1)} - t_i)]$$

Where, Y_i= mean disease severity on the i^{th} day, t_i = time (days after planting) on which Y_i was recorded and n = total number of observations.

For statistical analysis, the experiment data were subjected to the statistical analysis (Snedecor and Cochran 1967) using simple RBD. To compare the different treatments among themselves, critical differences (CD) and standard error of differences (S.Ed.) were calculated using the formula:

$CD = S.Ed. \times t_{0.05}$ for error degrees of freedom

$$S.Ed. = \sqrt{\frac{2 \times \text{Error mean square}}{\text{No. of replication}}}$$

Where,

S.Ed. = Standard error of difference

$t_{0.05}$ = Table value of "t" at 5 per cent probability level

Table 2. Taro cultivar/ germplasms collected from different locations of N.E. Indian states

S. No.	Name of cultivar/ germplasm	State	District/ Place	GPS coordinates
1	Muktakeshi	Kerala	CTCRI	8.540928,76.912979
2	SreeKiran	Kerala	CTCRI	8.540928,76.912979
3	AR-1	Arunachal Pradesh	Anjaw	28.111430,96.826999
4	AR -2	Arunachal Pradesh	Pasighat	28.065013,95.336343
5	AR -3	Arunachal Pradesh	Namsai	27.708248,96.009915
6	AR -4	Arunachal Pradesh	Namsai	27.708248,96.009915
7	AR -5	Arunachal Pradesh	Pasighat	28.065013,95.33634
8	AR -6	Arunachal Pradesh	Anjaw	28.111430,96.826999
9	AR -7	Arunachal Pradesh	Namphai	27.444969,96.124275
10	AR -8	Arunachal Pradesh	Pasighat	28.065013,95.336343
11	Namphai	Arunachal Pradesh	Namphai	27.444969,96.124275
12	AAU Col-32	Assam	KarbiAnglong	25.860200, 92.589638
13	AAU Col-46	Assam	KarbiAnglong	25.860200, 92.589638
14	AAU-39	Assam	KarbiAnglong	25.860200, 92.589638
15	AAU-5	Assam	KarbiAnglong	25.860200, 92.589638
16	Ahina	Assam	Jorhat	26.757792,94.207964
17	BogaAhina	Assam	Jorhat	26.757792,94.207964
18	Bogalassu	Assam	Merapani	26.31953,94.092661
19	Bormuwa	Assam	Jorhat	26.757792,94.207964
20	Domordima	Assam	Goalpara	26.073393,90.565948
21	GhotiKachu	Assam	Jorhat	26.757792,94.207964
22	HatiPanja	Assam	Jorhat	26.757792,94.207964
23	JCC-31	Assam	KarbiAnglong	26.072055, 93.454099
24	JCC-38	Assam	KarbiAnglong	26.072055, 93.454099
25	KakoKachu	Assam	Jorhat	26.757792,94.207964
26	Kokrajhar	Assam	Kokrajhar	26.509718,90.126725
27	Mohkhuti	Assam	Kokrajhar	26.509718,90.126725
28	MukiaKachu	Assam	Sivasagar	26.983600,94.6400393
29	Nepali-1	Assam	Kaliabor	26.538714,92.929206
30	Nepali-2	Assam	Kaliabor	26.538714,92.929206
31	Nepali-3	Assam	Kaliabor	26.538714,92.929206
32	Pamkha Rou	Assam	Sivasagar	26.983600,94.640039
33	PiyajiKachu	Assam	Goalpara	26.073393,90.565948

S. No.	Name of cultivar/ germplasm	State	District/ Place	GPS coordinates
34	RongaMuwa	Assam	Sivasagar	26.983600,94.640039
35	SawoniaKachu	Assam	Dibrugarh	27.484459,94.901944
36	SC-1	Assam	Tinsukia	27.487972,95.360185
37	SC-2	Assam	Tinsukia	27.487972,95.360185
38	TakaliKachu	Assam	Jorhat	26.757792,94.207964
39	Chandil Pin	Manipur	Ukhrul	25.311073,94.475377
40	Chang Pan	Manipur	Imphal- west	24.800612,93.936899
41	MC (Manipur churachand)	Manipur	Imphal- west	24.800612,93.936899
42	Muhkhi Pan	Manipur	Imphal-west	24.800612,93.936899
43	Pangong	Manipur	Ukhrul	25.311073,94.475377
44	Yerumipan	Manipur	Senapati	25.393369,94.150517
45	GC-1	Meghalaya	Songsak	25.659692,90.636597
46	GC-2	Meghalaya	Samanda	25.659692,90.636597
47	Garo Red	Meghalaya	Garobadha	25.573162,90.001751
48	MZ-1	Mizoram	Aizawl	23.855931,92.907450
49	MZ-2	Mizoram	Kolasib	24.226465,92.677348
50	MZ-3	Mizoram	Kolasib	24.226465,92.677348
51	Naga	Nagaland	Mokokchung	26.326826, 94.533382
52	Naga Black	Nagaland	Kohima	25.661875,94.101915
53	Naga-1	Nagaland	Dimapur	25.913591,93.728370
54	Naga-2	Nagaland	Dimapur	25.913591,93.728370
55	Naga-3	Nagaland	Dimapur	25.913591,93.728370
56	Naga-4	Nagaland	Kohima	25.661875,94.101915
57	Naga-5	Nagaland	Kohima	25.661875,94.1019156
58	Naga-6	Nagaland	Mokokchung	26.326826, 94.533382
59	Naga-7	Nagaland	Mon	26.725210,95.030399
60	Tung Nayak	Nagaland	Kohima	25.661875,94.101915
61	Wasumi	Nagaland	Wokha	26.097895,94.254844
62	Wokha-1	Nagaland	Zunheboto	26.015029,94.528873
63	Wokha-2	Nagaland	Wokha	26.097895,94.254844
64	Wokha-3	Nagaland	Wokha	26.097895,94.254844
65	TR-1	Tripura	Agartala	23.831237,91.282382
66	TR-2	Tripura	Jampui Hill	24.053817,92.278543

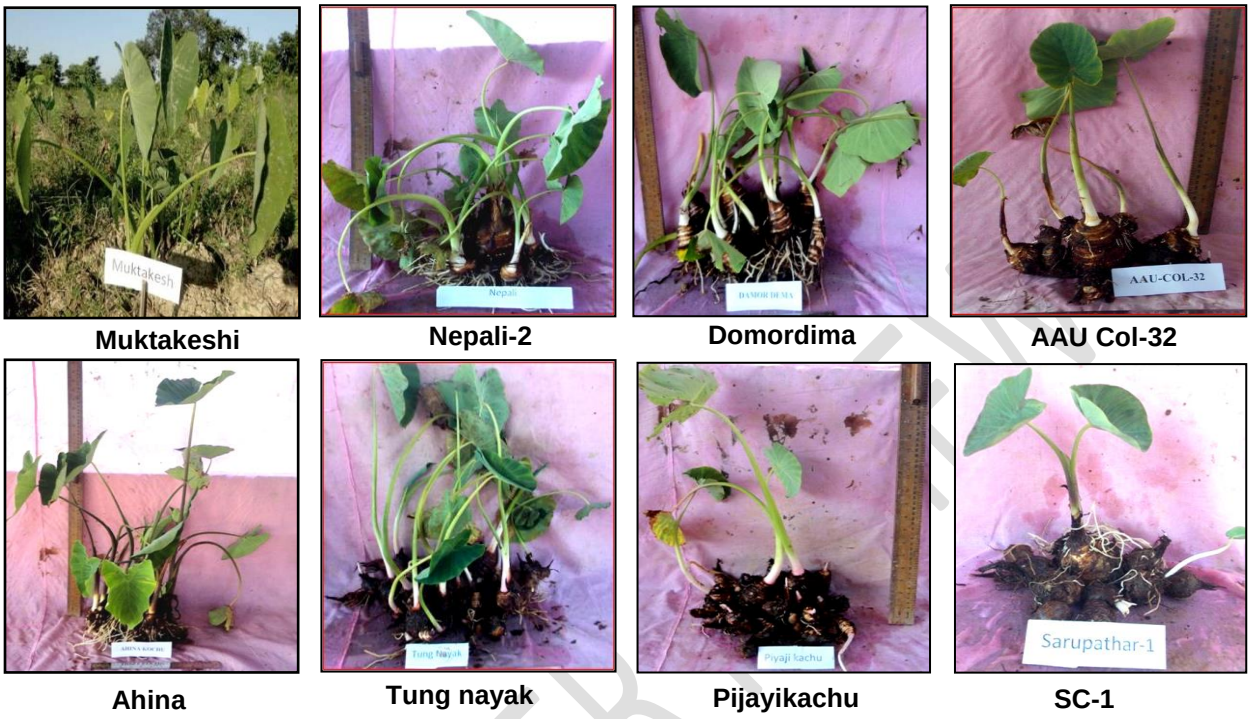

Figure 1. Some cultivars/ germplasms collected from different locations of Northeast India

Figure 2. Experimental field for screening taro cultivars/ germplasms against *Xanthomonas axonopodis* pv. *dieffenbachiae*

Figure 3. Bacterial blight symptoms of Taro observed in field

A. Less than 15 % of leaves area infected (Disease rating scale-1)

B. 16-30 % of leaves area infected (Disease rating scale-2)

C. 31-50 % of leaves area infected (Disease rating scale-3)

D. 51–70 % of leaves area infected (Disease rating scale-4)

3. RESULTS AND DISCUSSION

Screening of 66 taro cultivars against bacterial blight (BB) of colocasia during the growing season of 2018 and 2019 revealed different intensities of the disease symptoms where the disease severity was calculated from the disease rating scale obtained from the different symptoms shown by the respective germplasm (**Figure 3**). The results obtained at 240 days after transplanting (DAT) for the two seasons were pooled together in **Table 2.**

The per cent disease incidence ranged from 23.81% to 78.57%, in which cultivar SC-1 (78.57%) showed the highest incidence followed by PiyajiKachu (73.81%), KakoKachu, AR -6, TungNayak with a disease incidence of 69.05% each, while the least was for Nepali-2 (26.19%).

Per cent disease severity for the evaluated cultivars directly relates to the economic yield, and it was recorded between 14.17 to 67.5%. Likewise, the disease severity per cent was the highest for SC-1 (67.5%) preceded by PiyajiKachu, KakoKachu, AR-8, AR -6, Tung Nayak with per cent severity of 62.92%, 62.08%, 59.58%, 58.33% and 58.33% respectively. The lowest was obtained for Nepali-2 with per cent severity of 14.17%, followed by SreeKiran, Naga-2, Chandil Pin, Muktakeshi with per cent severity of 14.58%, 14.58%, 15%, 17.08% respectively.

The per cent disease incidence obtained in the recent study concurs with the study conducted by Opara *et al*., 2013 and Pohronezny *et al*., 1985 on Taro plants whereas the per cent disease severity obtained by them were less than the present investigation. This might be because they were experimenting in different Taro cultivars/ germplasm under different geographical locations and also the disease rating scale used for recording the disease severity might differ from the present investigations. Six commercial fields were surveyed for BB of cocoyam in Florida (Pohronezny *et al*., 1985) where 74-100% of disease incidence was reported with the foliar area damaged less than 10% in which the average disease severity scale was 2 or less. The disease severity obtained in the present investigation was in agreement with Phookan *et al*., 1996 where the disease damaged up to 50 per cent of colocasia leaves (cv. Nigetam) in Assam. Per cent bacterial leaf necrosis incidence of 36.4 to 62.1% was also reported by Safo- Kantanka and Adofo, 2007.

Table 3. Reaction of different colocasia cultivars/ genotypes against bacterial blight of colocasia during 2018 and 2019

Sl. No.	Cultivars/ germplasms	Disease incidence (%)	Disease severity (%)	Disease rating scale	AUDPC	Host reaction
1	Muktakeshi	30.95(33.82)*	17.08(24.43)*	2	1837.50	MR
2	SreeKiran	26.19(30.81)	14.58(22.46)	1	1612.50	R
3	AR-1	38.10(38.12)	26.67(31.44)	2	3200.00	MR
4	AR -2	40.48(39.78)	26.67(31.44)	2	2850.00	MR
5	AR -3	59.52(50.50)	50.42(45.25)	4	6150.00	S
6	AR -4	50.00(45.00)	32.50(34.76)	3	3625.00	MS
7	AR -5	54.76(47.76)	35.00(36.27)	3	4150.00	MS
8	AR -6	69.05(56.22)	58.33(49.81)	4	7562.50	S
9	AR -7	59.52(50.50)	51.25(46.31)	4	5462.50	S
10	AR -8	64.29(53.34)	59.58(50.56)	4	8075.00	S
11	Namphai	45.24(42.29)	31.67(34.27)	3	3857.50	MS
12	AAU Col-32	30.95(33.82)	23.33(28.89)	2	2625.00	MR
13	AAU Col-46	45.24(42.29)	32.08(34.53)	3	3175.00	MS
14	AAU-39	35.72(36.71)	21.67(27.76)	2	2375.00	MR
15	AAU-5	40.48(39.55)	30.42(33.48)	3	3300.00	MS
16	Ahina	45.24(42.29)	30.83(33.74)	3	3512.50	MS
17	BogaAhina	42.86(40.92)	30.83(33.74)	3	3650.00	MS
18	Bogalassu	30.95(33.82)	20.42(26.87)	2	2350.00	MR
19	Bormuwa	45.24(42.29)	32.08(34.53)	3	3625.00	MS
20	Domordima	45.24(42.29)*	33.33(35.27)*	3	3862.50	MS
21	GhotiKachu	54.76(47.76)	42.50(40.45)	3	4975.00	MS
22	HatiPanja	42.86(40.92)	32.50(34.76)	3	3500.00	MS
23	JCC-31	35.72(36.71)	25.00(30.00)	2	2812.50	MR
24	JCC-38	45.24(49.34)	34.58(36.05)	3	4150.00	MS
25	KakoKachu	69.05(56.22)	62.08(52.02)	4	8312.50	S
26	Kokrajhar	40.48(39.55)	30.83(33.74)	3	3550.00	MS
27	Mohkhuti	59.52(50.5)	50.83(45.49)	4	6125.00	S
28	MukiaKachu	45.24(42.29)	32.92(35.02)	3	3962.50	MS
29	Nepali-1	33.34(3528)	20.42(26.87)	2	2250.00	MR
30	Nepali-2	23.81(29.21)	14.17(22.133)	1	1737.40	R
31	Nepali-3	47.62(43.64)	31.67(34.27)	3	3825.00	MS
32	Pamkha Rou	35.72(36.71)	22.08(28.05)	2	2475.00	MR
33	PiyajiKachu	73.81(59.22)	62.92(52.50)	4	8875.00	S
34	RongaMuwa	45.24(42.29)	31.67(34.34)	3	3825.00	MS
35	SawoniaKachu	40.48(39.55)	30.83(33.74)	3	3362.50	MS
36	SC-1	78.57(62.45)	67.50(55.24)	4	9812.50	S
37	SC-2	52.38(46.69)	44.17(41.68)	3	5637.50	MS
38	TakaliKachu	35.72(36.71)	21.25(27.67)	2	2375.00	MR
39	Chandil Pin	30.95(33.82)	15.00(22.79)	1	1799.60	R
40	Chang Pan	40.48(39.78)	30.42(33.48)	3	3587.50	MS
41	MC	54.76(46.76)	36.67(37.36)	3	4537.50	MS
42	Muhkhi Pan	64.29(53.34)	50.83(45.49)	4	5937.50	S
43	Pangong	40.48(39.78)	27.50(31.63)	2	3225.00	MR
44	Yerumipan	35.72(36.71)	26.25(30.84)	2	3062.50	MR

Sl. No.	Cultivars/ germplasms	Disease incidence (%)	Disease severity (%)	Disease rating scale	AUDPC	Host reaction
45	GC-1	35.72(36.71)	22.92(28.61)	2	2600.00	MR
46	GC-2	59.52(50.50)	51.25(45.74)	4	5862.50	S
47	Garo Red	64.29(53.46)	54.58(47.66)	4	6912.50	S
48	MZ-1	35.72(36.71)	23.33(28.89)	2	2725.00	MR
49	MZ-2	42.86(40.92)	31.25(34.01)	3	3425.00	MS
50	MZ-3	38.10(38.12)	24.17(39.47)	2	2650.00	MR
51	Naga	40.48(39.78)	26.25(30.84)	2	2957.50	MR
52	Naga Black	35.72(36.71)	23.75(29.18)	2	2575.00	MR
53	Naga-1	40.48(39.78)	30.83(33.74)	3	3475.00	MS
54	Naga-2	26.19(30.81)	14.58(22.46)	1	1650.00	R
55	Naga-3	26.19(30.81)	19.17(26.98)	2	2125.00	MR
56	Naga-4	40.48(39.55)	30.42(33.48)	3	3710.00	MS
57	Naga-5	30.95(33.82)*	19.17(25.98)*	2	2250.00	MR
58	Naga-6	45.24(42.29)	34.17(35.8)	3	4375.00	MS
59	Naga-7	50.00(45.00)	37.08(37.54)	3	4837.50	MS
60	Tung Nayak	69.05(56.22)	58.33(49.81)	4	7512.50	S
61	Wasumi	40.48(39.55)	31.25(34.01)	3	3450.00	MS
62	Wokha-1	64.29(53.340	52.50(46.43)	4	7025.00	S
63	Wokha-2	40.48(39.55)	25.83(30.56)	2	2987.50	MR
64	Wokha-3	45.24(42.29)	32.92(35.02)	3	4087.50	MS
65	TR-1	30.95(33.82)	22.92(28.610	2	2775.00	MR
66	TR-2	50.00(45.00)	34.17(35.80)	3	4550.00	MS
	S.Ed. (±)	**1.00**	**0.95**			
	CD ($_{P=0.05}$)	**1.99**	**1.89**			

Data are pooled mean of three replications for year 2018 and 2019.

** Figures in parentheses are angular transformed values or log values*

Table 4. Area under the disease progress curve (AUDPC) of bacterial blight in Taro under field conditions during 2018 and 2019

Sl. No.	Taro Germplasm	Pooled disease severity (%) from year 2018 and 2019				AUDPC
		Days after transplanting				
		60	120	180	240	
1	*Muktakeshi	4.17	7.92	12.08	17.08	1837.50
2	*Sree Kiran	3.33	7.08	10.83	14.58	1612.50
3	AR-1	7.50	14.58	21.67	26.67	3200.00
4	AR -2	6.67	11.67	19.17	26.67	2850.00
5	AR -3	19.58	29.58	37.92	50.42	6150.00
6	AR -4	9.17	15.00	24.58	32.50	3625.00
7	AR -5	10.83	18.75	27.50	35.00	4150.00
8	AR -6	22.92	36.67	48.75	58.33	7562.50
9	AR -7	15.00	21.67	36.25	51.25	5462.50
10	AR -8	27.08	39.17	52.08	59.58	8075.00
11	Namphai	11.25	16.25	26.58	31.67	3857.50
12	AAU Col-32	4.17	11.67	18.33	23.33	2625.00
13	AAU Col-46	5.42	11.67	22.50	32.08	3175.00
14	AAU-39	5.83	9.58	16.25	21.67	2375.00
15	AAU-5	7.08	14.17	22.08	30.42	3300.00
16	Ahina	7.92	15.83	23.33	30.83	3512.50
17	Boga Ahina	9.17	15.83	25.00	30.83	3650.00
18	Boga Lassu	5.42	10.00	16.25	20.42	2350.00
19	Bormuwa	8.75	14.58	25.42	32.08	3625.00
20	Domor Dima	10.42	17.08	25.42	33.33	3862.50
21	Ghoti Kachu	15.00	22.08	32.08	42.50	4975.00
22	Hati Panja	6.67	14.17	24.58	32.50	3500.00
23	JCC-31	5.42	11.67	20.00	25.00	2812.50
24	JCC-38	10.42	18.75	27.92	34.58	4150.00
25	Kako Kachu	28.33	39.58	53.75	62.08	8312.50
26	Kokrajhar	8.33	14.58	25.00	30.83	3550.00
27	Mohkhuti	16.67	26.67	41.67	50.83	6125.00
28	Mukia Kachu	10.00	17.08	27.50	32.92	3962.50
29	Nepali-1	5.42	8.75	15.83	20.42	2250.00
30	Nepali-2	4.58	8.33	11.25	14.17	1737.40
31	Nepali-3	10.00	16.25	26.67	31.67	3825.00
32	Pamkha Rou	5.42	10.42	17.08	22.08	2475.00
33	Piyaji Kachu	33.75	44.58	55.00	62.92	8875.00
34	Ronga Muwa	10.83	15.83	26.67	31.67	3825.00
35	Sawonia Kachu	8.75	12.92	23.33	30.83	3362.50
36	SC-1	40.42	49.58	60.00	67.50	9812.50
37	SC-2	17.08	25.42	37.92	44.17	5637.50
38	Takali Kachu	5.42	9.17	17.08	21.25	2375.00

Sl. No.	Taro Germplasm	Pooled disease severity (%) from year 2018 and 2019				AUDPC
		Days after transplanting				
		60	120	180	240	
39	Chandil Pin	4.17	8.33	12.08	15.00	1799.60
40	Chang Pan	9.17	15.83	24.17	30.42	3587.50
41	MC	12.92	20.42	30.42	36.67	4537.50
42	Muhkhi Pan	16.25	26.25	39.17	50.83	5937.50
43	Pangong	6.67	13.75	22.92	27.50	3225.00
44	Yerumipan	7.50	12.92	21.25	26.25	3062.50
45	GC-1	6.25	10.83	17.92	22.92	2600.00
46	GC-2	15.00	23.75	40.83	51.25	5862.50
47	Garo Red	20.83	31.25	46.25	54.58	6912.50
48	MZ-1	6.67	11.25	19.17	23.33	2725.00
49	MZ-2	7.92	13.33	24.17	31.25	3425.00
50	MZ-3	5.83	10.42	18.75	24.17	2650.00
51	Naga	5.83	12.42	20.83	26.25	2957.50
52	Naga Black	6.25	10.42	17.50	23.75	2575.00
53	Naga-1	10.00	14.17	23.33	30.83	3475.00
54	Naga-2	3.75	6.67	11.67	14.58	1650.00
55	Naga-3	4.17	10.00	13.75	19.17	2125.00
56	Naga-4	10.75	16.25	25.00	30.42	3710.00
57	Naga-5	5.00	10.00	15.42	19.17	2250.00
58	Naga-6	15.00	19.58	28.75	34.17	4375.00
59	Naga-7	14.17	22.08	32.92	37.08	4837.50
60	Tung Nayak	27.08	34.17	48.33	58.33	7512.50
61	Wasumi	7.92	14.17	23.75	31.25	3450.00
62	Wokha-1	23.33	33.33	45.83	52.50	7025.00
63	Wokha-2	7.92	12.08	20.83	25.83	2987.50
64	Wokha-3	11.67	17.50	28.33	32.92	4087.50
65	TR-1	7.08	12.50	18.75	22.92	2775.00
66	TR-2	15.00	21.25	30.00	34.17	4550.00
	S.Ed. (±)	1.06	0.97	0.96	0.95	
	CD ($_{P=0.05}$)	2.11	1.93	1.91	1.89	

Data are pooled mean of three replications for year 2018 and 2019.

Table 5. Screening of colocasia cultivars/ germplasms based on the disease severity and their reaction to bacterial blight

Disease severity (%)	Disease rating scale	Disease reaction	Name of cultivars/ germplasms	No. of cultivars
0	0	Immune (I)	Nil	Nil
1-15	1	Resistant (R)	SreeKiran, Naga-2, Chandil Pin, Nepali-2	4
15.01-30	2	Moderately resistant (MR)	Muktakeshi, AAU Col-32, AAU-39, AR-1, AR-2, BogaLassu , GC-1, JCC-31, MZ-1, MZ-3, Naga, Naga Black, Naga-3, Naga-5, Nepali-1, Pamkha Rou, Pangong, TR-1, TakaliKachu, Wokha-2, Yerumipan	21
30.01-50	3	Moderately susceptible (MS)	AAU Col-46, AAU-5, Ahina, AR-4, AR-5, BogaAhina, Bormuwa, Chang Pan, DomorDima, GhotiKachu, HatiPanja, JCC-38, MC, Kokrajhar, MZ-2, Naga-1, MukiaKachu, Naga-4, Naga-7, Naga-6, Namphai, Nepali-3, RongaMuwa, TR-2, SC-2, SawoniaKachu,,	26
50.01-70	4	Susceptible (S)	AR-3, AR-6, AR-7, AR-8, GC-2, Garo Red, Mohkhuti, KakoKachu, Muhkhi Pan, PiyajiKachu, SC-1, Tung Nayak, Wokha-1, Wokha-3, Wasumi	15
Above 70	5	Highly Susceptible (HS)	Nil	Nil

Area under the disease progress curve (AUDPC) for each cultivar/ germplasm was calculated from the per cent disease severity obtained from the first day of disease observation till the last day of observation i.e. from 60 to 240 DAT, where the disease severity was recorded at an interval of 30 days (**Table 3)**. AUDPC is a quantitative measure of disease resistance that does not need data transformation which directly corresponds to the bacterial disease infection with time where the cultivars/ germplasm having the highest value will correspond to the highest bacterial infection, leading to more susceptibility to the disease and vice versa. Evaluations must be initiated as soon as the disease incidence occurs and should stop when the susceptible genotypes are near total destruction. SC-1 recorded the highest AUDPC of 9812.5, followed by PiyajiKachu (8875), KakoKachu (8312.5),

AR-8 (8075), AR -6 (7562.5), Tung Nayak (7512.5) while the least was for SreeKiran (1612.5), followed by Naga-2 (1650), Nepali-2 (1737.4), Chandil Pin (1799.6), Muktakeshi (1837.5).

The disease reactions of different cultivars/ germplasm to bacterial blight of colocasia (**Table 4**) were evaluated based on the disease severity (%) and disease rating scale (Opara *et al*., 2013) with little modifications. No germplasm was immune and also highly susceptible to the disease. SreeKiran (national released variety) with disease severity of 14.58% and AUDPC of 1612.5 was resistant to the disease along with three others, namely Chandil pin, Naga-2 and Nepali-2. Muktakeshi (national released variety) with disease severity of 17.08% and AUDPC of 1837.5 was found to be moderately resistant to bacterial blight along with twenty other germplasm *viz*. AAU Col-32, AAU-39, AR-1, AR-2, BogaLassu, GC-1, JCC-31, MZ-1, MZ-3, Naga, Naga Black, Naga-3, Naga-5, Nepali-1, Pamkha Rou, Pangong, TR-1, TakaliKachu, Wokha-2, Yerumipan. Twenty-six germplasms were moderately susceptible namely AAU Col-46, AAU-5, Ahina, AR-4, AR-5, BogaAhina, Bormuwa, Chang Pan, DomorDima, GhotiKachu, HatiPanja, JCC-38, MC, Kokrajhar, MZ-2, Naga-1, MukiaKachu, Naga-4, Naga-7, Naga-6, Namphai, Nepali-3, RongaMuwa, TR-2, SC-2, SawoniaKachu while fifteen germplasms namely AR-3, AR-6, AR-7, AR-8, GC-2, Garo Red, Mohkhuti, KakoKachu, Muhkhi Pan, PiyajiKachu, SC-1, Tung Nayak, Wokha-1, Wokha-3, Wasumi were susceptible.

Screening of taro germplasm against BB of colocasia has not been conducted so far. However, screening of colocasia against Phytophthora leaf blight (PLB) was taken as a comparison of whether it cannot be concluded on this aspect. Eleven germplasms of Colocasia and Xanthosoma were screened against PLB (Lokesh *et al*., 2014) where AAU *Colocasia esculenta* Acc 35 and *Xanthosomas sagittifolium* Acc 7 were tolerant to the disease while AAU *Colocasia esculenta* Acc 5, AAU *Colocasia esculenta* Acc 46 and AAU *Colocasia esculenta* Acc 32 had the disease severity of around 11-25%, 26.50% and 40-60% respectively. Das and Chakraborty, 2007 screened 30 cultivars of colocasia against PLB, wherein five cultivars along with Muktakeshi showed a tolerant reaction, seven were moderately susceptible while others were susceptible including Ahina, Kanikachu, kakakachu and nagakachu. Fifteen genotypes were also screened for PLB (Kumar *et al*., 1996) where Kadma Local and Muktakeshi were immune. In the present study, Muktakeshi was moderately resistant; Ahina and kaka kachu were moderately susceptible and susceptible cultivars, respectively. AAU-32 was moderately resistant, while AAU col-46 and AAU-5 were moderately susceptible.

The higher the AUDPC value, the higher will be the susceptibility of the cultivars/ germplasm to the disease and *vice versa.* Cultivar SC-1 collected from Sarupathar, Assam is the most susceptible amongst all which had the highest AUDPC value of 9812 with a disease incidence of 78.57% and disease severity per cent of 67.5%. SreeKiran with the lowest AUDPC value of 1612.5, disease severity per cent of 14.58% and 26.19% disease incidence per cent was the most resistant variety amongst all.

4. CONCLUSIONS

The control of bacterial blight of Taro is a challenging problem because of its systemic infection and the use of synthetic chemicals for its management is hazardous to the environment and living beings around. So, integrated management of the disease by proper selection and incorporating host resistance cultivars like SreeKiran, Naga-2, Chandil Pin and Nepali-2 is one of the most important factors in increasing and sustaining Taro production.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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