Vol.11 No. 1, Page No. 39 – 45 (2022)
Received: February, 2022; Accepted: May, 2022

Assessment of Integrated Management of Phytophthora Leaf Blight Disease in Colocasia (*Colocasia esulenta* (L.) Schott) under Climatic Change Situation of Bundelkhand Regions

R. K. Prajapati[1], B.S. Kirar[2] and S.R. Singh[3] and Neha Singh Kirar[4]
Krishi Vigyan Kendra, Tikamgarh [1], Panna[2] (M.P.), Hathras (U.P)[3]
and R. A. K. Agriculture Collage,Sehore (M.P.)[4]
Corresponding author: rkiipr@yahoo.com

Abstract

Tikamgarh district related to Agro-Climatic Zone of Madhya Pradesh (MP) was studied during 2017-18 considering district as its agricultural zones as unit of investigation because of a marked variation prevails in soil, climate, cropping pattern, area and productivity which divide in several blocks. In technology-3 with IPU 94-1 resistant variety with an average mean yield (14.3 q/ha) as against a yield with a mean of 8.0 q/ha recorded under farmer's practices. The incidence of MYMV was recorded 1% in technology-3 but the disease incidence was highest 23% in farmers practice. The results were found highly significant increase in yield and growth attributes of black gram on resistant variety of MYMV disease with integrated disease management technologies and reduced disease incidence as comparison to farmer practices. The technology index was 26.6%, while 30 % maximum technology index was in technology-3. The high yield and disease resistant varieties with disease management technologies were found the main factors to give the high achievement on black gram production while farmers were unaware about these resistant varieties and disease management practices. Farmers were convinced due to performance of technologies and accepted the ones but farmers want availability of new technologies inputs timely at local market. These technologies further could be taken under front line demonstration programme for large scale adoption horizontal and vertical spread among tomato grower of the district.

***Key words**: Phythopthora blight, Colocasia, Integrated Disease Management*

Introduction

Colocasia (*Colocasia esculanta* L. Scott) is an important tuber crop with high nutritious value and widely accepted in the whole world. Total area under colocasia in the world is about 10.8 million ha of which Asia's share is about 1.5 million ha. Cultivation of colocasia is widespread in India, Burma, China, Japan, Hawaii, Egypt, Africa and the Caribbean. Colocasia (Arvi) is an important tuber crops of India. In India, it is cultivated in an area of around 1.30 m ha with an annual production of 9.98 MT and average yield of 7.68 t/ha and the major colocasia growing states are Madhya Pradesh, Chhattisgarh, Assam, Nagaland, Manipur, Orissa, Maharashtra, Kerala, Andhra Pradesh, Meghalaya, West Bengal, Uttar Pradesh Gujarat, Tamil Nadu and Bihar. It is believed to have been one of the earliest cultivated plants and was in cultivation in wet tropical India before 5000 B.C., presumably coming from Malaysia, and from India further transported westward to ancient Egypt, where it was described by Greek and Roman historians as an important crop. It is an important vegetable grown throughout India and is sometimes called the "potato" of the humid tropics. In Tikamgarh district of Madhya Pradesh it is being cultivated because of storage capacity as off-season vegetables with an intercropping in summer and rainy season. In India, two colocasia types *viz*., *C. esculenta* var. *esculenta* and *C. esculenta* var. *antiquorum* are commonly cultivated throughout the country. During a survey of major colocasia growing areas, it was observed tuber yield of 30-50 t/ha, especially in *C. esculenta* var. *antiquorum*. Colocasia tubers are rich in starch and used almost everywhere as a vegetable[4]. Besides, this crop is of great medicinal value and is included in many Ayurvedic preparations. The corms and cormels are consumed as staple or subsistence food in developing countries.

Colocasia leaf blight caused by *Phytophthora colocasiae* Raciborski is the most destructive fungal disease responsible for heavy yield losses (25 to 50%) of colocasia in India[3,5]. In addition, this pathogen causes a serious post-harvest decay of colocasia corms. It was first reported from India[1]. The disease starts with the onset of monsoon and continues till the end of monsoon. The disease appears as small, water soaked spots that increase in area and eventually spread to healthy plants. The whole leaf area is destroyed within few days. Under cloudy weather conditions with intermittent rains and temperature around 28 ºC, the disease spreads at tremendous speed and the entire field gives a blighted appearance. Therefore, attempts for its integrated management technological intervention by use of tolerant cultivars, fungicides, and planting techniques their combination were made. Field demonstration trails were conducted among the farmer field in villages of Jatara and Tikamgarh blocks of the district Tikamgarh for the year 2018 and 2019 during rainy season in R.B.D. at 25-farmers field. Planting of colocasia was done in the first week of June at a spacing of 60 x 45 cm in each plot of 3.0 x 2.25 m with three replications. Three technologies viz., T1 – control (Farmer practices+ local variety- Ghunyian+ No rhizome treatment+ flatbed sowing), T2 – Improved variety Narendra Arbi-1 + rhizome treatment with Ridomile MZ (Mancozeb + Metalaxyl) @ 3g/liter of water + Ridge planting, T3 - T2 + Ridomile MZ (0.2%) spray 15 days after as per need were taken for this study. The tolerant cultivar "Narendra Arvi-1 and susceptible local variety-Ghunyian taken for this study. The colocasia were sown in 15-20 June, 2018 and 2019. Observations were taken on leaf area damage per plant at 4 days' interval starting from the first appearance of the disease symptoms at the end of August till the drying of the shoot in the field. Cultivars that were resistant to leaf blight have been the most important method of disease control. In Bangladesh, among 50 lines tested by artificial inoculation in the field, two were highly resistant to *P. colocasiae,* five-resistant, 12-moderately resistant and the rest moderately to highly susceptible (Goswami, 1993). Fungicidal control is largely practiced against *P. colocasiae* in taro cultivation. Currently widely used products are systemic (Metalaxyl) and non-systemic fungicides (copper oxychloride, Mancozeb, zineb) applied as foliar sprays. In India spraying Metalaxyl at intervals of 15 days was effective in controlling the disease under field conditions and gave maximum net financial return[9]. Good control was obtained with Metalaxyl and fair control with copper oxychloride[6, 7] report that four sprays of zineb at 15-day intervals reduced the incidence of *P. colocasiae* and increased the yield. In Papua New Guinea five applications of Metalaxyl at 3-week intervals resulted in an increase of almost 50% corm yields.

Method and Materials

Tikamgarh district related to Agro-Climatic Zone of Madhya Pradesh (MP) was studied considering district as its agricultural zones as unit of investigation because of a marked variation prevails in soil, climate, cropping pattern, area and productivity which divide in several blocks. The district information on area, productivity and climatic vulnerability of colocasia was collected from directorate of agricultural land records and contingent plan of MP. The present study was carried out by the Krishi Vigyan Kendra, Tikamgarh (M.P.) during rainy seasons of two consecutive years 2018 and 2019 in the farmers' fields of 05-villages of Tikamgarh and Jatara block of the district in agro-climatic zone in rainfed condition on medium soils with low to medium fertility. Each demonstration was conducted in an area of 0.2 ha and 0.2 ha area adjacent to the demonstration plot as farmer's practices *i.e.* prevailing cultivation practices served as local check. All 25-on-farm testing trails demonstrations in 2.5 ha area with randomized block design (RBD) and each treatment replicated in -5 replications, farmer practice as local check replication. The technologies modules were T1–control (Farmer practices + local variety-Ghunyian+ No rhizome treatment+ flatbed sowing), T2–Improved variety Narendra Arbi-1 + rhizome treatment with Ridomile MZ (Mancozeb + Metalaxyl) @ 3g/liter of water + Ridge planting, T3-2 + Ridomile MZ (0.2%) spray 15-days after as per need when appear Phytophthora leaf spot disease in a few plants to minimize their spread were taken for this study. The tolerant cultivar Narendra Arvi-1 and susceptible local variety- Ghunyian taken for this study. Observations were taken on leaf area damage per plant at 4-days interval starting from the first appearance of the disease symptoms at the end of August till the drying of the shoot in the field.

The experimental plots sowing was made on commencement of monsoon 25th June to 1st July week of July during both the years. The individual plot size was 0.2 ha per treatment. Ridge and furrow bed. Side tubers each of 25-35 g were used for planting. About 37,000 side tubers weighing about 1200 kg were required to plant one hectare. The experimental plots were interspaced at 1.0 m. Each cultivar was given the same management treatments *i.e.* fertilization, irrigation, weeding and different technologies modules against Phytophthora leaf spot disease and vulnerable climatic conditions. Compost @ 12 t/ha is applied as basal dressing, while preparing the ridges for planting. A fertilizer dose of 80:25: 100 kg of N: P: K /ha were applied. Full dose of P and 1/2 of N and K applied within a week after sprouting and the remaining 1/2 of N and K one month after the first application. For uniform sprouting, irrigation was given just after planting and one week later. Subsequent irrigation was given at 12-15 days' intervals, depending on the soil type. The irrigation was stopped 3-4 weeks before harvest. In the case of rainfed condition, if there was prolonged drought, supplementary irrigation was required. Weeding, light hoeing and earthing up were required at 30-45 days and 60-75 days after planting. The leafy parts smothered about one month before harvest so as to enhance tuber development. Colocasia becomes were ready for harvest 5-6 months after planting. The mother corms and side tubers were separated after harvest.

Normal cultural practices were adopted to raise the crops successfully. The observations in each plot every year to record the disease incidence/leaf area and number of spot, and size of spots. the yield was recorded on plot basis. The Phytophthora leaf spot disease incidence and severity were recorded at 4-days interval. Disease rating scale of

Phytophthora leaf blight 1 (small spot), 2-moderate symptoms (medium spot) and 3-severe symptoms (large spot). The mean data for all observations over two years were pooled and statistically analyzed following standard procedure. Evaluate response of technologies for escaping biotic stresses of climatic abnormalities.

In OFT demonstration plots, critical inputs in the form of quality seed and treatment, farm manure, balanced fertilizers and agro-chemicals were provided by KVK. For the study, assessment and refinement of different IDM+ CPM technologies for suitability at local or micro-climatic situation so that these technologies would be further accepted or rejected or refined as per feedback of technological and farmers. The suitable modules were assessed for large scale demonstrated among more farmers for diffusion and adoption of technology for management of Phytophthora leaf spot disease of colocasia. The technological gap, extension gap and technology index were calculated under.

Technology gap = Potential Yield- Demonstration yield

Extension gap = Demonstration Yield-Farmers yield

Technology index (%) = $\frac{\text{Technology gap}}{\text{Potential yield}} \times 100$

Leaf area damage per plant was calculated using the following equation (Melinda *et al*., 1991). L= [(D/2) 2- (d/2) 2] Where L – leaf area damaged; D – final average diameter of necrotic leaf area (cm); d – initial average diameter of necrotic leaf area.

Result and Discussion

The results mean of both the year 201-2019 obtained of tolerant cultivar NA-1 and highly susceptible local farmer cultivar as technological intervention T1–control (Farmer practices local variety- Ghunyian+ No rhizome treatment+ flatbed planting, T2–Improved variety Narendra Arbi-1 + rhizome treatment with Ridomile MZ (Mancozeb + Metalaxyl) @ 3g/liter of water + Ridge planting, T3-2 + Ridomile MZ (0.2%) spray 15-days after as per need presented in Table 1, respectively. In untreated, control plants of farmer technology with local cultivar as susceptible variety Ghunyian, the mean leaf area damage per plant was 50.68 cm2 but in technological intervention T-2 with highly tolerant variety NA-1 it was 18.51 cm2 and in T-3 with the NA-1. It was 9.17 cm2. Among all the treatments, the use of NA-1 with technological intervention and preventive rhizome treatment with Ridomil MZ (0.2%) in T-2 and (T3) T-2 + spray at standing crop was the most effective against the disease with minimum leaf area damage per plant. This treatment resulted in 81.18 and 63.47 % reduction in leaf area damage per plant in T-3 and T-2 respectively as compared to untreated, control plants T-1. Mancozeb applied in protective spray along with one spray of Ridomil MZ at a critical stage of disease appearance followed by an another spray of Mancozeb provided excellent control of late blight of tomato. Spraying with Metalaxyl (0.3%) exhibited maximum disease control of Phytophthora leaf blight of colocasia and Metalaxyl mixed with Mancozeb or zineb was also found effective against this disease reported the best control of Phytophthora leaf blight of colocasia by application of Ridomil MZ (0.2%) with corresponding increase in rhizome yield. On the basis of above findings, it is concluded that Phytophthora leaf blight of colocasia could be effectively managed by the use of tolerant variety NA-1 with Mancozeb (0.25%) spray after the first appearance of the disease symptom and an another Ridomil MZ (0.2%) spray 15 days after the spraying of Mancozeb.

Table 1 Effect of integrated disease management on leaf area damage due to Phytophthora leaf blight disease in tolerant variety NA-1+ technological interventions. Data represents mean of three replications with mean of two years.

Technologies	Leaf area damage (cm2) at 4 days interval after the first appearance of the disease symptom						
	0	4	8	12	16	20	Mean
T1	1.96	22.20	49.44	59.1	78.2	93.2	50.68
T2	2.95	8.14	12.04	24.33	31.20	32.40	18.51
T3	1.32	6.12	7.01	10.21	13.70	16.70	9.17
Mean	2.07	12.15	22.83	31.21	41.03	47.43	26.12

Note = T1= (Farmers, practice), T2= Technology-2, T3 =Technology-3

The significant data on highest decreased in Phytophthora leaf blight of colocasia were recorded 85.5% and 96.8% in both the years mean over farmers' practices, respectively in technology-2 and technology-3. The incidence of Phytophthora leaf blight was recorded least 8.5 % in technology-2 and while 1.9 % in technology-3 but the disease incidence was highest 59.5% in farmers practice on the mean basis of both the consecutive year (Table 2). The increased in yield was recorded highest in T-3 (51.1%) *i.e* 164 q/ha. Followed by T-2 (26.2%)/137 q/ha over T-1 farmer practices 10.5 q/ha. No. of rhizome of rhizome increased in T-3 highest 113.3% followed by T-2 (51.1%) over T-1. The rhizome weight was also recorded increased in 82.7% and 27.5% in T-3 and T-2, respectively over farmer practice T-1. In addition, this pathogen causes a serious post-harvest decay of colocasia corms. It was first reported from India[1,8]. At suitable climatic conditions, Phytophthora leaf blight of colocasia was widespread and destructive, can cause yield loss.

Table 2 Effect of integrated disease management on leaf area damage due to leaf blight in tolerant variety NA-1+ technological interventions. Data represents mean of three replications with mean of two years.

Years	Data on parameters of observations											
	Yield (q/ha)			Phytophthora leaf blight incidence (%)			No. of rhizome/plant			Weight of rhizome (g)		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
2018	107	135	161	62	10	2.3	21	32	47	28	36	51
2019	110	139	167	57	7	1.5	24	36	49	30	38	55
Total	217	274	328	119	17	3.8	45	68	96	58	74	106
Average	108.5	137	164	59.5	8.5	1.9	22.5	34	48	29	37	53

The economic viability of improved technologies over traditional farmer's practices was calculated depending on prevailing prices of inputs and outputs costs (Table-3). It was found that cost of production of colocasia from

Rs.40000 to 47000 in farmer practices (T1) to 45000 to 49000 (T2) and 50000 to 55000 /ha in (T3) with an average of Rs. 43500,47000 and 52500/ha of improved technologies T-1, T-2 andT-3, respectively in both the year as against the variation in cost of production in local check. The improved production technologies registered a grass return from Rs. 144150/ha, Rs. 172650/ha with a net return of Rs 97150/ha and Rs.120150/ha in T-2 and T-3, respectively over farmers T-1. The additional cost incurred in the improved technologies as compared to farmer's practices was mainly due to more costs involved in inputs of technologies. The highest B:C ratio were recorded 3.3 in T-3 and 3.1 in T-2 over T-1 (2.6). The increased highest in net return was 70 % in T-3 while followed by T-2 (34.6). Finding of in the support of Neha Lakra, 2019 who calculated the cost of cultivation of Chhattisgarh farmer including marginal to large farmers of colocasia growing.

Table 3 Economical analysis of cost of cultivation, gross cost, net return (Rs/ha) and cost benefit ratio of different technological modules for management of Phytophthora leaf blight in colocasia at farmers, fields during two consecutive years (2018-2019)

Years	Cost of cultivation (Rs/ha)			Gross return (Rs/ha)			Net return (Rs/ha)			B C ratio		
	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
2018	40000	45000	50000	96300	121500	144900	56300	76500	94900	2.4	2.7	2.9
2019	47000	49000	55000	132000	166800	200400	85000	117800	145400	2.8	3.4	3.6
Total	87000	94000	105000	228300	288300	345300	141300	194300	240300	5.2	6.1	6.5
Average	43500	47000	52500	114150	144150	172650	70650	97150	120150	2.6	3.1	3.3

*Sale rate of black gram @ Rs. 900/quintal (2018), Rs. 1200/quintal (2019)

The technology gap in the demonstration colocasia yield over potential yield were 49.5 q/ha in both the year mean on the same variety and its respective technologies for Phytophthora leaf blight management in colocasia (Table 4). The technological gap may be attributed to the dissimilarity in the soil fertility status and weather conditions.

Table 4 Extension gap (q/ha), Technology gap (q/ha) and technology index (%) on demonstration of IDM+ CPM intervention

Year	Technology	Yield (q/ha)					Ext. gap (q/ha)	Tech. gap (q/ha)	Tech. Index (%)
		Potential	Improved technology			Local Check			
			T2	T3	Av.				
2018	NA-1+IDM	200	135	161	148	107	41	52	20.5
2019	NA-1+IDM	200	139	167	153	110	43	47	23.5
Average		200	137	164	150.5	108.5	42	49.5	22.0

The highest extension gap of 41q/ha was recorded in lowest in colocasia NA-1 variety and highest 43 q/ha observed in the same variety with IDM technology. This emphasized the need to educate the farmers through various means for the adoption of improved colocasia production technologies to reverse this trend of wide extension gap. More and more use of latest production and IDM technologies with high yielding and resistant variety will subsequently change this alarming trend of galloping extension gap. The new technologies will eventually lead to the farmers to discontinue the old technology and to adopt new technology. The technology index shows the feasibility of the evolved technology at the farmer's fields and the lower the value of technology index more is the feasibility of the technology. The technology index was 23.5%, maximum while 20.55 % minimum with mean of both the year 22% technology index was in technology-3 and T-2 with the same variety during 2018-2019 (Table 4).

Conclusion

The results were found highly significant increase in yield and growth attributes of colocasia on tolerant variety of Phytophthora leaf blight disease with integrated disease management technologies and reduced disease incidence as comparison to farmer practices. The high yield and disease tolerant variety with disease management technologies were found the main factors to give the high achievement on colocasia production while farmers were unaware about the tolerant variety and disease management practices. Farmers were convinced due to performance of technologies and accepted the ones but farmers want availability of new technologies inputs timely at local market. These technologies further could be taken under front line demonstration programme for large scale adoption horizontal and vertical spread among colocasia grower of the district.

References

1. Butler, E.J. and Kulkarni, G.S. (1913). Colocasia blight caused by *Phytophthora colocasiae* Rac. *Memoirs of the Department of Agriculture in India*, 5, 233-259.
2. Goswami, B.K, Zahid, M.I, Haq, M.O. (1993). Screening of *Colocasia esculenta* germplasm to Phytophthora leaf blight. Bangaladesh, *Journal of Plant Pathology* 9 (12), 21-24.
3. Melinda, J. and Stevenson, W. R. (1991). A leaf disk assay for detecting resistance to early blight caused by *Alternaria solani* in juvenile potato plants. *Plant Disease*, 75: 385-389.
4. Misra, R.S. (1991). Prevalence of Phytophthora leaf blight of colocasia in Northern and Eastern India. *Phytophthora Newsletter* 17, 36 pp.
5. Misra, R.S. (1999). Management of Phytophthora leaf blight disease of taro. In: Balagopalan C., Nair T.V.R., Sunderesan S., Premkumar T., Lakshmi K.R. (Eds) *Tropical Tuber Crops in Food Security and Nutrition*, Oxford and IBH, New Delhi, 460-469.
6. Neha Lakra, Prishila Kujur and Urmila Bhagat (2019). Economic analysis of Colocasia production in Bastar plateau of Chhattisgarh state, *Journal of Pharmacognosy and Phytochemistry*, 8(5).
7. Sahu, M.P., Singh, K.P, Singh, J.R.P. (1989). Control of light blight of taro. *Indian Farming*, 39 (2), 22-23.
8. Samui, S.K, Maitra S., Roy, D.K, Mondal, A.K and Saha, D. (2000). Evaluation on front line demonstration on groundnut (*Arachis hypogea* L.). *Journal of Indian Society of Coastal Agriculture Research*, 18: 180-183.