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Influence of Different Concentrations of Bordeaux Mixture on the Management of Fruit Rot Disease of Arecanut Incited by *Phytophthora meadii* at Heavy Rainfall Areas of Malnad Region

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Abstract Arecanut (*Areca catechu* L.) is a most important profitable plantation crop cultivated in humid tropics of India. Fruit rot caused by *Phytophthora meadii* is a major constraint in arecanut production causing heavy economic yield loss or death of the arecanut palm itself. The fungi causes fruit rot in arecanut during the monsoon and subsequent cooler months. The fungus survives as oospores, chlamydospores, and mycelium in soil, on fallen nuts, dead nuts and inflorescence remaining on the palm. During 2015-16 to 2017-18 an investigation with Bordeaux mixture and stabilized Blue Bordo both at 1.0, 1.5, 2.0 and 2.5%, respectively along with control was conducted at Dinda, Megaravalli located in Malnad region of Karnataka. The average annual rainfall of this place during the experimental period was 3052.80 mm. The results revealed that the treatment Bordeaux mixture 1% recorded lowest number of infected bunches (1.24), lowest number of fallen nuts (13.41), lowest number of infected nuts, lowest weight of fallen nuts (86.17 g) and higher green nut yield (13.62 kg) perpalm. Highest number of fallen nuts (20.30), highest number of infected nuts (20.24), highest weight of fallen nuts (268.94 g) and lowest green nut weight (11.11 kg) per palm were recorded with the treatment control.

Keywords Arecanut, *Phytophthora meadii,* Fruit rot disease (koleroga), Bordeaux mixture, Heavy rainfall areas.

Introduction

The arecanut palm (*Areca catechu* L.) belonging to family Palmae is the source of arecanut commonly referred to as betelnut or supari in India. It is used in Indian and other South East Asian countries as a masticatory. In India it is mainly cultivated in the states of Karnataka, Kerala ande Tamil Nadu. Plantation level cultivation is also seen in parts of Andhra Pradesh, Telangana, Assam, Maharashtra, Meghalaya and West Bengal. Karnataka State ranks first in area and production of arecanut in India. Arecanut is cultivated in 15 districts of Karnataka State covering 2.70 lakh hectares with an annual production of 4.27 lakh tonnes. In Karnataka it is mainly cultivated in Dakshina Kannada, Uttar Kannada, Udupi, Shivamogga and Chikmagalur districts. Nowadays its cultivation is extended to Tumkur, Chitradurga, Davanagere, Hassan, Mysore, Madikeri, Bangalore and Mandya

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districts also. According to CFTRI Mysore, arecanut comprises of 46% of carbohydrates, 4.2% proteins, 8-12% fat, Iron, calcium along with certain vitamins. India is self sufficient in the production of arecanut.

Arecanut flourishes well in tracts of very heavy rainfall. However it is grown in areas with wide variations in rainfall such as Malnad of Karnataka where the annual rainfall may go upto or even more than 4500 mm as well as in low rainfall areas like maidan parts of Karnataka where the annual rainfall is about 750 mm.

Arecanut cultivation was predominant in gravelly laterite soils of red clay type of Southern Kerala and Coastal Karnataka during pre-independence period (Nambiar 1949). The productivity of the palm is affected by a number of diseases and disorders. Annual crop loss due to fruit rot ranged from 10-90% (Nambiar 1956, Koti Reddy and Anandaraj 1982). Fruit rot is an economically important disease causes damage to the product as well as the crop.

Fruit rot is caused by the fungus *Phytophthora meadii* resulting in partial or total loss The fungus *Phytophthora* affects the adult palms during Southwest monsoon causing fruit rot (Mahali or Koleroga). *Phytophthora* disease was first recorded by Butler (1906) in erstwhile Mysore State and later from the present Dakshina Kannada and Uttara Kannada districts of Karnataka and parts of Malabar and Cochin in Kerala. It is characterized by rotting and heavy shedding of immature nuts. A detailed account of the disease with its causal organism was documented by Coleman (1910) in his pioneering work on fruit rot.

Anandaraj and Balakrishnan (1987) developed a sampling technique to assess the yield loss due to fruit rot. Chowdappa et al. (2000) reported that the loss due to fruit rot vary according to locality and variety.

The occurrence of disease could be identified by the unusual shedding of fruits during Southwest monsoon season. The symptoms appear as dark green water soaked lesions on the nut surface usually near the perianth. Fungus makes entry to the host tissue through the stomata or epidermis. The entry is aided by the mycelium or germ tube of the germinating sporangia. Under the laboratory conditions the infection intiates within 18-19 h on the wounded tissues or occur 4-5 days after inoculation on uninjured fruit surface (Saraswathy 1994). Fruits loose their clear natural green color due toinfection. On the infected nuts the lesion spread gradually covering the fruit surface before or after shedding and on incubation under humid conditions develop white mycelia mat over the infected area and envelops entire surface of the fruit (Saraswathy 2004). In severe cases of infection fruit stalka and the axis of inflorescence are also infected (Marudarajan 1050, Sundararaman and Ramakrishnan 1028). Waterhouse (1974) described symptoms of fruitrot as development of chlorotic area with loose mycelium and luxuriant sporangia. The infected nuts showed discoloration of kernel, reduction in weight and large vacuole. The infection occurring towards the end of Southwest monsoon may not develop the typical symptoms of fruit rot and dry up without shedding of nuts and remain mummified. Fruit rot leads to quantitative and qualitative loss to the crop and the infected nuts are not suitable for chewing.

Fruit rot is effectively managed by prophylactic spray of 1.0% Bordeaux mixture with any sticker or spreader (Anandaraj 1085, Thomas and Marudarajan 1938) and Bordeaux mixture spray do not cause any adverse effect on areca palms. However, farmers in this region use higher concentrations of Bordeaux mixture (more than 1.0%) indiscriminately owing to heavy rainfall that occur in this region. Hence an experiment was conducted in the farmers field at Dinda (70-80 years old plantation), Agumbe hobli, Thirthahalli Taluk to know the influence of different concentrations of Bordeaux mixture on the management of fruit rot at heavy rainfall areas of malnad region.

Materials and Methods

The experiment was conducted during 2015-16 to 2017-18 in a 70-80 year old arecanut plantation spaced at 2.7 m × 2.7 m at Dinda, Megaravalli, Agumbe Hobli, Thirthahalli Taluk, Shivamogga district. Average annual rainfall of this place during the experimental period was 3052.80 mm. The experiment was laid out in randomized complete block design (RCBD) with 9 treatments including

Table 1. Number of healthy bunches and infected bunches per palm as influenced by different concentrations of Bordeaux mixture.

Tretments	No. of healthy bunches/palm				No. of infected bunches/palm			
	2015-16	2016-17	2017-18	Pooled	2015-16	2016-17	2017-18	Pooled
T_1 - Control	2.53	2.73	2.48	2.58	1.89	1.11	1.50	1.50
T_2 - Bordeaux mixture 1%	2.30	2.77	3.30	2.79	1.21	1.52	1.00	1.24
T_3 - Bordeaux mixture 1.5%	2.34	2.63	2.80	2.59	1.13	1.37	1.33	1.28
T_4 - Bordeaux mixture 2.0%	2.37	2.73	3.00	2.70	1.27	1.69	1.61	1.52
T_5 - Bordeaux mixture 2.5%	2.07	2.73	2.87	2.56	1.22	1.72	1.17	1.37
T_6 - Blue Bordo 1.0%	2.15	2.40	4.17	2.91	1.25	1.36	1.22	1.28
T_7 - Blue Bordo 1.5%	2.43	2.53	3.20	2.72	1.13	1.69	1.33	1.38
T_8 - Blue Bordo 2.0%	2.23	2.50	3.03	2.59	1.10	1.39	1.44	1.31
T_9 - Blue Bordo 2.5%	1.90	2.50	3.33	2.58	1.23	2.04	1.22	1.50
F test	*	*	NS	NS	*	*	*	*
SEm ±	0.23	0.17	0.37	0.16	0.14	0.10	0.14	0.06
CD @ 5%	0.70	0.51	-	-	0.41	0.29	0.43	0.19
CV%	17.84	11.26	19.89	10.36	18.64	10.79	18.97	7.98

control, which were replicated thrice. Each treatment comparised of 10 plants. The treatments were Bordeaux mixture (1.0, 1.5, 2.0 and 2.5%, Blue Bordo (1.0, 1.5, 2.0 and 2.5%) and control. The spraying of bunches was done at 30 to 45 days interval starting from last week of May (Before the onset of monsoon) based on the interval or gap provided by the rainfall during the season. During the last spray the crown part of the palm was also sprayed with respective treatments in order to protect them from crown rot and bud rot. Observations were recorded on number of healthy bunches, number of infected bunches, number of fallen nuts, number of infected nuts, weight of fallen nuts and green nut weight (kg) per palm. The observations were recorded after imposing the treatments. The data were subjected to Fischer's method of analysis of variance (ANOVA) as attained by Sundararaj et al. (1972)

Results and Discussion

The results revealed that spraying the bunches with Bordeaux mixture 1.0% (T_2) significantly recorded lowest number of infected bunches per palm (1.24) while the treatments Bordeaux mixture 1.5 and 2.5%, Blue bordo 1.0, 1.5 and 2.0% (T_3, T_5, T_6, T_7 and T_8, respectively) were at par with it (Table 1). The treatment T_2 has recorded lowest number of fallen nuts (13.41) and lowest number of infected nuts (12.33) per palm (Table 2). The treatment T_2 has recorded

Table 2. Number of fallen nuts and number of infected nuts per palm as influenced by different concentrations of Bordeaux mixture.

Treatments	Fallen nuts/palm (No's)				Infected nuts/palm (No's)			
	2015-16	2016-17	2017-18	Pooled	2015-16	2016-17	2017-18	Pooled
T_1 - Control	21.17	25.00	14.73	20.30	21.00	25.00	14.73	20.24
T_2 - Bordeaux mixture 1%	13.67	19.00	7.55	13.41	13.00	18.00	6.00	12.33
T_3 - Bordeaux mixture 1.5%	17.00	21.83	11.00	16.61	16.67	21.75	9.08	15.83
T_4 - Bordeaux mixture 2.0%	18.00	19.50	13.50	17.00	17.67	19.33	9.87	15.62
T_5 - Bordeaus mixture 2.5%	16.33	23.00	12.67	17.33	16.00	23.00	11.38	16.79
T_6 - Blue Bordo 1.0%	18.00	22.13	9.99	16.71	18.00	22.00	7.33	15.78
T_7 - Blue Bordo 1.5%	16.33	22.00	10.72	16.35	16.33	22.00	10.00	16.11
T_8 - Blue Bordo 2.0%	19.00	22.67	12.05	17.91	19.00	22.67	11.19	18.28
T_9 - Blue Bordo 2.5%	15.33	22.50	11.33	16.39	15.33	22.33	10.33	16.00
F test	*	NS	*	*	*	*	*	*
SEm ±	1.45	2.42	0.84	1.03	1.4	2.28	0.73	0.88
CD @ 5%	4.35	-	2.51	3.07	4.21	6.84	2.17	2.64
CV %	14.62	7.25	12.58	10.51	14.29	17.94	12.57	9.35

Table 3. Weight of fallen nuts (g) and green nut weight (kg) per palm as influenced by different concentrations of Bordeaux mixture.

Treatments	Weight of fallen nuts/palm (g)			Green nut weight/palm (kg)			
	2016-17	2017-18	Ppooled	2015-16	2016-17	2017-18	Pooled
T_1 - Control	408.37	129.50	268.94	8.32	12.75	12.27	11.11
T_2 - Boedeaux mixture 1%	111.46	60.88	86.17	13.77	12.75	14.36	13.62
T_3 - Bordeaux mixture 1.5%	281.59	84.42	183.00	12.81	11.78	13.88	12.82
T_4 - Bordeaux mixture 2.0%	132.50	76.58	104.54	11.17	11.55	13.17	11.96
T_5 - Bordeaux mixture 2.5%	170.78	104.98	137.88	11.93	11.19	15.09	12.74
T_6 - Blue Bordo 1.0%	305.06	85.26	195.16	10.32	11.38	15.41	12.37
T_7 - Blue Bordo 1.5%	217.93	88.05	152.99	9.38	11.80	12.87	11.35
T_8 - Blue Bordo 2.0%	204.04	94.50	149.27	10.32	11.59	15.00	12.31
T_9 - Blue Bordo 2.5%	138.25	109.30	123.78	9.80	11.28	14.47	11.85
F test	*	*	*	*	*	NS	*
SEm ±	21.96	10.15	11.28	0.74	0.52	0.77	0.42
CD @ 5%	65.84	30.42	33.81	2.22	1.56	-	1.19
CV %	17.38	18.98	12.54	11.82	9.09	9.51	5.64

lowest weight of fallen nuts (86.17 g) and higher green nut yield (13.62 kg) per palm (Table 3). Highest number of infected bunches per palm (1.52) were recorded with the treatment Bordeaux mixture 2.0%. Highest number of fallen nuts (20.30), highest number of infected nuts (20.24), highest weight of fallen nuts (268.94 g) and lowest green nut weight (11.11 kg) per palm were recorded with the treatment control. The results are in line with the findings of Coleman (1910).

Conclusion

Thus, indicating that prophylactic spraying of arecanut bunches and palms with Bordeaux mixture 1.0% is very effective in the management of fruit rot of arecanut.

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