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Integration of physical approach and chemical approach for the control of banana rhizome rot in first and ratoon crop of banana cv. KovvurBontha (ABB)

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ABSTRACT

India is the major producer of the banana crop in the world. Banana is divided into two types. First one is desert type and the second one is the cooking type of banana. Cooking banana is the stapple food in many parts of the India especially in Kerala. Major problem in cooking variety is that these varieties are highly susceptible to rhizome rot disease. To control this integration of physical method (collection and destruction) and chemical method (application of fungicide and bactericide) was used at an interval of 7 days and 14 days. The results showed that combination of physical method and application of MetalaxylMz (4 mgL-1) + streptomycin (1.5 mg/10L) at 7 days interval had resulted in survival percentage (96.03%), average number of the fingers/hand (12.67), average number of the hands/bunch (9.27), average weight of the bunch (29.67 kg) and yield per hectare (61.58 t/ha) in first crop. on the other hand, ratoon crop had recorded maximum survival percentage (99.83%), maximum average number of the fingers/hand (13.00), maximum average number of the hands/bunch (8.53), maximum average weight of the bunch (28.41kg) and maximum yield per hectare (59.45t/ha). This experiment concluded that rhizome rot can be completely control by the integrated physical and chemical method of disease management.

Keywords: Cooking banana, integrated physical and chemical, disease management

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INTRODUCTION:

Plantains contain more starch and less sugar than dessert bananas, therefore they are usually cooked or otherwise processed before eaten. They are typically boiled or fried when eaten green, and when processed, they can be made into flour and turned into baked products such as cakes, bread and pancakes. Green plantains can also be boiled and pureed and then used as thickeners for soups. The pulp of green plantain is typically hard with the peel often so stiff that it has to be cut with a knife to be removed (Scot *et al.,* 2006). Africa is considered a second center of diversity for *Musa* cultivars: West Africa for some plantains and the central highlands for East African Highland bananas (*Musa* AAA-EAHB; known as *matoke* in Uganda), most of which are cooked, although some are primarily used to make beer.

The banana plant is the largest herbaceous flowering plant. All the above-ground parts of a banana plant grow from a structure usually called a "corm" (Akaike, 1974).Plants are normally tall and fairly sturdy, and are often mistaken for trees, but what appears to be a trunk is actually a "false stem" or pseudo-stem. Bananas grow in a wide variety of soils, as long as the soil is at least 60 cm (2.0 ft) deep, has good drainage and is not compacted. The leaves of banana plants are composed of a "stalk" (petiole) and a blade (lamina). The base of the petiole widens to form a sheath; the tightly packed sheaths make up the pseudo-stem, which is all that supports the plant (Karamura*et al.* 2008). The edges of the sheath meet when it is first produced, making it tubular. As new growth occurs in the center of the pseudo-stem the edges are forced apart. Cultivated banana plants vary in height depending on the variety and growing conditions (Karamura et al. 2012).

Banana faces many biotic like bacterial, fungal, and viral diseases and abiotic stresses like drought, frost, etc. These biotic stresses were generally controlled in two methods. First one is preventive method. In this method, the pathogens were not allowed to attack the plant species. This is generally done by using pathogen free planting material, soil solarization, soil fumigation, etc. The second method is curative method. In the method, the diseased plants are tried to rectify after attack of the pathogen by using chemical agents, physical methods, physiological methods, etc (Nkuba et al. 2015).

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Among all the biotic stresses fusarium wilt (*Fusariumoxysporumf.sp. musae*) and bacterial wilts (*Xanthomonascampestris* pv. *Musacearum)* were turned into the lethal factor for the commercial cultivation of banana. It causes a major blow to the farmers by causing the severe economic losses in major banana growing parts of the India. There were no effective control measures exists for the control of these diseases. In this research, we observed the best method to control these diseases and reduce the economic losses by following the integrated approach of physical method and chemical methods.

MATERIAL AND METHOD

The study was conducted for new crop and following ratoon crop. Physical method and chemical methods were used one followed by another. Primarily, physicalmethod should be done between planting date to seven months after planting depending on the banana variety and duration of the crop. Principle of physical approach is that it should be done before emergence of the shooting at the corm base. The shoot emerge at corm base varies from 17 leaf stage to 24 leaf stage based on variety in banana. If the same practice conducted after emergence of the shoot at corm base will also control the disease but leads to loss of the yield. Irrigation to the disease affected plants should be stopped for fifteen days to control the rapid spreading. Affected leaves are removed completely along with the leaf sheath up to the corm. This method was repeated in ratoon crop also whenever it was required.

After the physical approach (removing affected part from the plant), chemical approaches also followed to restrict further spread of the disease into the core. Following chemicals were directly poured into the basin of the plants along with the leaf spray.

The chemical combination were as follows 2 mgL^{-1}MetalaxylMz and 1.5 mg/10L streptomycin after 7 days (T_1), 3 mgL^{-1}MetalaxylMz and 1.5 mg/10L streptomycin after 7 days (T_2), 4 mgL^{-1}MetalaxylMz and 1.5 mg/10L streptomycin after 7 days (T_3), 2 mgL^{-1}MetalaxylMz and 2.0 mg/10L streptomycin after 7 days (T_4), 3 mgL^{-1}MetalaxylMz and 2.0 mg/10L streptomycin after 7 days (T_5), 4 mgL^{-1}MetalaxylMz and 2.0 mg/10L streptomycin after 7 days (T_6), 2 mgL^{-1}MetalaxylMz and 2.5 mg/10L streptomycin after 7 days (T_7), 3 mgL^{-1}MetalaxylMz and 2.5 mg/10L

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streptomycin after 7 days (T_8), 4 mgL^{-1}MetalaxylMz and 2.5 mg/10L streptomycin after 7 days (T_9), 2 mgL^{-1}MetalaxylMz and 1.5 mg/10L streptomycin after 14 days (T_{10}), 3 mgL^{-1}MetalaxylMz and 1.5 mg/10L streptomycin after 14 days (T_{11}), 4 mgL^{-1}MetalaxylMz and 1.5 mg/10L streptomycin after 14 days (T_{12}), 2 mgL^{-1}MetalaxylMz and 2.0 mg/10L streptomycin after 14 days (T_{13}), 3 mgL^{-1}MetalaxylMz and 2.0 mg/10L streptomycin after 14 days (T_{14}), 4 mgL^{-1}MetalaxylMz and 2.0 mg/10L streptomycin after 14 days (T_{15}), 2 mgL^{-1}MetalaxylMz and 2.5 mg/10L streptomycin after 14 days (T_{16}), 3 mgL^{-1}MetalaxylMzand 2.5 mg/10L streptomycin after 14 days (T_{17}), 4 mgL^{-1}MetalaxylMz and 2.5 mg/10L streptomycin after 14 days (T_{18}), Control (T_{19}) for three months. This method was also repeated in ratoon crop also whenever it was required. If the plants were completely recovered then only chemical application was done. If plants get reattacked by the pathogen, then the integrated approach was conducted before beginning of the shooting at the corm level which is twenty-one leaf stage.

The observations about parameters like percent survival of the plant, average number of the fingers/hand, average number of hands per bunch,average weight of the bunch and yield per hectare.

RESULTS AND DISCUSSION

Maximum percent survivability (96.03%) of the plants was observed when the plants were subjected to treatment T_3 (Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (1.5 mg/10L) at 7 days interval)followed by second highest percent survivability (93.03%) was observed in T_4 (Physical approach followed by MetalaxylMz (2 mgL^{-1}) + streptomycin (2.0 mg/10L) at 7 days interval) and the third highest percent survivability (92.23%) was observed in T_8 (Physical approach followed byMetalaxylMz (3 mgL^{-1}) + streptomycin (2.5 mg/10L) at 7 days interval) in the first crop. Lowest percent survivability (9.47%) was observed in control where the plants didn't apply with any treatment as showed in the table. 1 and figure 1.

When the same crops were continued in ratoon crop, the plants which were recovered were applied with only chemicals and the plants which got reattacked and revived had shown almost same results with higher recovery percentage which represented in table 1 and figure 1. In ratoon crop, Maximum percent survivability (99.83%) of the plants was observed when the plants were subjected to treatment T_4 (Physical approach followed by MetalaxylMz (2 mgL^{-1}) + streptomycin (2.0 mg/10L) at 7 days interval) followed by second highest percent survivability (98.03%) was observed in T_9(Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (2.5 mg/10L) at 7 days interval) and the third highest percent survivability (97.30%) was observed in T_3 (Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (1.5 mg/10L) at 7 days interval). Lowest percent survivability (4.33%) was observed in control where the plants didn't apply with any treatment.

The difference in the survivability of the first crop and the ratoon crop may be due to adaptability of the plants to the cropping environment. The adaptability of the plants takes on whole cropping period to the development of immunity in the plants which results in the higher survival percentage in following ratoon crop.

Average number of fingers per hand in the bunches contribute majorly to the yield of the crop. There were no significant differences present among the different treatment in the first crop. Highest number of fingers per hands (12.33) in the first crop were observed in treatment T_3 (Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (1.5 mg/10L) at 7 days interval) followed by second highest number of fingers per hands (12.33) was observed in T_4 (Physical approach followed by MetalaxylMz (2 mgL^{-1}) + streptomycin (2.0 mg/10L) at 7 days interval) and the third highest fingers per hand (12.00) was observed in T_8 (Physical approach followed byMetalaxylMz (3 mgL^{-1}) + streptomycin (2.5 mg/10L) at 7 days interval). Lowest number of fingers per hand (9.33) was observed in control where the plants didn't apply with any treatment as showed in the table. 1 and figure 2.

In ratoon crop also no significant differences were among the number of fingers per hand. Highest fingers per hand (13.00) was observed when the plants were subjected to treatment T_4 (Physical approach followed by MetalaxylMz (2 mgL^{-1}) + streptomycin (2.0 mg/10L) at 7 days interval) followed by second highest number of fingers per hand (12.67) was observed in T_9 (Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (2.5 mg/10L) at 7 days interval) and the third highest number of fingers per hand (12.33) was observed in T_3 (Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (1.5 mg/10L) at 7 days interval). Lowest numbers of fingers per hand (9.67) was observed in control where the plants didn't apply with any treatment as represented in table 1 and figure 2.

In general, the healthy cooking banana varieties yields six to eight hands per bunch. More hands increase the yield of the first crop. Maximum number of hands per bunch (9.27) was observed when the plants were subjected to treatment T_3 (Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (1.5 mg/10L) at 7 days interval) followed by second highest number of hands per bunch (9.20) was observed in T_4 (Physical approach followed by MetalaxylMz (2 mgL^{-1}) + streptomycin (2.0 mg/10L) at 7 days interval) and the third highest number of hands per bunch (8.87) was observed in T_8 (Physical approach followed by MetalaxylMz (3 mgL^{-1}) + streptomycin (2.5 mg/10L) at 7 days interval). Lowest number of hands per bunch (5.60) was observed in control where the plants didn't apply with any treatment as showed in the table. 1 and figure 3.

In ratoon crop, there was a slight decrease in the number of hands per bunch may be due to the distribution of the nutrients to the different ratoon daughter plants. Maximum number of hands per bunch (8.53) per plants was observed when the plants were subjected to treatment T_4 (Physical approach followed by MetalaxylMz (2 mgL^{-1}) + streptomycin (2.0 mg/10L) at 7 days interval) followed by second highest hands per bunch (8.47) was observed in T_9(Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (2.5 mg/10L) at 7 days interval) and the third highest number of hands per bunch (8.13) was observed in T_3 (Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (1.5 mg/10L) at 7 days interval). Lowest hands per bunch (4.87) was observed in control where the plants didn't apply with any treatment in table 1 and figure 3.

Weight of the bunch plays a vital role in the yield per hectare. More yield helps in more economical benefits to the farmers. Highest average weight of the bunch (29.67 kg) in the first crop were observed in treatment T_3 (Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (1.5 mg/10L) at 7 days interval)

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followed by second highest average weight of the bunch (28.51 kg) was observed in T_4 (Physical approach followed by MetalaxylMz (2 mgL^{-1}) + streptomycin (2.0 mg/10L) at 7 days interval) and the third average weight of the bunch (28.47 kg) was observed in T_8 (Physical approach followed byMetalaxylMz (3 mgL^{-1}) + streptomycin (2.5 mg/10L) at 7 days interval). Lowest average weight of the bunch (15.17 kg) was observed in control where the plants didn't apply with any treatment as showed in the table. 1 and figure 4.

In ratoon crop, there was a slight decrease in the yield per hectare may be due to the distribution of the nutrients to the different ratoon daughter plants. Maximum yield per hectare (59.45 t/ha) per plants was observed when the plants were subjected to treatment T_4 (Physical approach followed by MetalaxylMz (2 mgL^{-1}) + streptomycin (2.0 mg/10L) at 7 days interval) followed by second yield per hectare (58.39 t/ha) was observed in T_9(Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (2.5 mg/10L) at 7 days interval) and the third highest yield per hectare (58.13 t/ha) was observed in T_3 (Physical approach followed by MetalaxylMz (4 mgL^{-1}) + streptomycin (1.5 mg/10L) at 7 days interval). Lowest yield per hectare (22.03 t/ha) was observed in control where the plants didn't apply with any treatment (table 1 and figure 5).

Treatment	Survival Percentage (%)		Average number of the fingers/hand		Average number of the hands/bunch		Average weight of the bunch (Kg)		Yield per hectare (t/ha)	
	First Crop	Ratoon Crop	First Crop	Ratoon Crop	First Crop	Ratoon Crop	First Crop	Ratoon Crop	First Crop	Ratoon Crop
*MetalaxylMz (2 mgL-1) + streptomycin (1.5 mg/10L) at 7 days interval (T1)	87.20	94.00	11.33	11.00	6.00	5.27	24.17	22.90	57.53	55.41
*MetalaxylMz (3 mgL-1) + streptomycin (1.5 mg/10L) at 7 days interval (T2)	86.47	93.27	11.67	10.67	7.33	6.60	26.25	24.98	57.53	55.43
*MetalaxylMz (4 mgL-1) + streptomycin (1.5 mg/10L) at 7 days interval (T3)	**96.03**	**97.30**	**12.67**	**12.33**	**9.27**	**8.13**	**29.67**	**27.21**	**61.58**	**58.13**
*MetalaxylMz (2 mgL-1) + streptomycin (2.0 mg/10L) at 7 days interval (T4)	**93.03**	**99.83**	**12.33**	**13.00**	**9.20**	**8.53**	**28.51**	**28.41**	**60.26**	**59.45**
*MetalaxylMz (3 mgL-1) + streptomycin (2.0 mg/10L) at 7 days interval (T5)	87.80	94.60	11.00	11.00	5.53	4.80	18.92	17.65	47.77	45.64
*MetalaxylMz (4 mgL-1) + streptomycin (2.0 mg/10L) at 7 days interval (T6)	84.50	91.30	9.67	10.67	6.20	5.47	20.35	19.08	51.17	49.06
*MetalaxylMz (2 mgL-1) + streptomycin (2.5 mg/10L) at 7 days interval (T7)	84.57	91.37	11.00	10.33	8.27	7.53	27.31	26.04	60.10	57.95
*MetalaxylMz (3 mgL-1) + streptomycin (2.5 mg/10L) at 7 days interval (T8)	**92.23**	96.93	**12.00**	11.00	**8.87**	7.47	**28.47**	19.37	**60.52**	56.63
*MetalaxylMz (4 mgL-1) + streptomycin (2.5 mg/10L) at 7 days interval (T9)	90.13	**98.03**	10.00	**12.67**	7.87	**8.47**	25.97	**27.24**	59.00	**58.39**
*MetalaxylMz (2 mgL-1) + streptomycin (1.5 mg/10L) at 14 days interval (T10)	73.00	79.80	10.33	11.67	7.00	6.27	25.37	24.10	59.04	56.91
*MetalaxylMz (3 mgL-1) + streptomycin (1.5 mg/10L) at 14 days interval (T11)	75.70	82.50	11.00	10.00	8.33	7.60	27.45	26.18	59.06	56.93
*MetalaxylMz (4 mgL-1) + streptomycin (1.5 mg/10L) at 14 days interval (T12)	78.73	85.53	10.67	11.33	7.13	6.40	21.84	20.57	52.64	50.50
*MetalaxylMz (2 mgL-1) + streptomycin (2.0 mg/10L) at 14 days interval (T13)	81.87	88.67	10.67	11.00	6.27	5.53	19.73	18.46	50.44	48.30
*MetalaxylMz (3 mgL-1) + streptomycin (2.0 mg/10L) at 14 days interval (T14)	83.77	90.57	10.00	10.33	6.53	5.80	20.12	18.85	49.27	47.14
*MetalaxylMz (4 mgL-1) + streptomycin (2.0 mg/10L) at 14 days interval (T15)	74.53	81.33	11.00	11.00	7.20	6.47	21.55	20.28	52.70	50.56
*MetalaxylMz (2 mgL-1) + streptomycin (2.5 mg/10L) at 14 days interval (T16)	71.07	77.87	10.67	10.67	6.13	4.53	18.53	24.70	48.93	46.80
*MetalaxylMz (3 mgL-1) + streptomycin (2.5 mg/10L) at 14 days interval (T17)	78.63	85.43	10.33	10.00	5.27	7.13	20.64	17.26	58.73	49.00
*MetalaxylMz (4 mgL-1) + streptomycin (2.5 mg/10L) at 14 days interval (T18)	70.57	77.37	11.00	10.33	8.20	5.40	27.17	25.90	51.10	56.89
Devoid of both physical and chemical approach (T19)	9.47	4.33	9.33	9.67	5.60	4.87	15.17	13.90	28.17	22.03
SE(m)±	6.53	1.44	0.67	0.66	0.15	0.15	0.41	0.41	0.56	0.56
C.D. at 5%	18.82	4.15	N/A	N/A	0.42	0.42	1.19	1.19	1.62	1.61

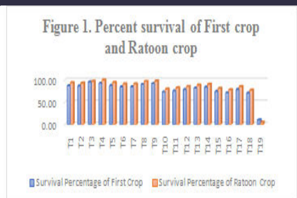

Figure 1. Percent survival of First crop and Ratoon crop

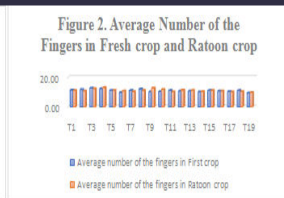

Figure 2. Average Number of the Fingers in Fresh crop and Ratoon crop

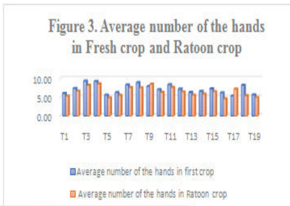

Figure 3. Average number of the hands in Fresh crop and Ratoon crop

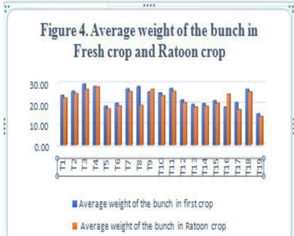

Figure 4. Average weight of the bunch in Fresh crop and Ratoon crop

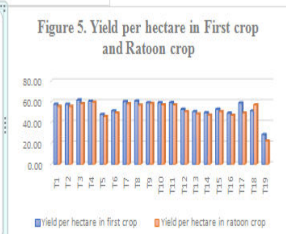

Figure 5. Yield per hectare in First crop and Ratoon crop

After the initiation of the shooting in the corm, the removal of leaves doesn't help much in the retaining the yield of the crop but plants had survived in this experiment. The reason for these results may be the removal of the affect parts will reduce the formation of microclimate between the layers of the leaf sheaths and the application of the chemical will restricts the further spreading of the fungal and bacterial spores to the deeper layers of the plants. Repeated application of the chemicals at regular leads to the recovery of the plant system using the applied recommended dose of fertilizers. But the removing the leaves after initiation of the shoot at corm affects the photosynthesis rate and reduces the photo assimilation and gradually decreases the yield. Similar results were obtained by Blommee*et al.* (2017); Carter *et al.* (2010); Everitt and Hothorn (2006); Jaworski and Hilszczański (2013); Karamura*et al.* (2008); Karamura*et al.* (2012); Tripathi L, *et al.* (2009); Uwamahoro*et al.* (2018).

Picture 1. Effect of different physical and chemical approach on the survival percentage and yield of the banana plants.

The name soft rot derived from the characteristic softdecay of the fleshy tissues of the rhizome of infected bananas.Banana, like most tuberous and bulbous plants,has higher carbohydrates in the rhizome tissues andthese storage organ tissues have cells in semi dormantcondition (Walker, 2004). These symptoms werealso noticed during the course of present investigation.The softening is mainly caused by the action of pecticenzymes on the storage tissues (Mehrotra & Aggarwal,2003).

Literature review suggests that this disease has notbeen recorded in Ney Poovan nor in NanjanagudRasabale,though rhizome rot has previously been reported indifferent banana cultivars: Gros Michel (Stover, 1959),Nendran (Singh, 1990), Dwarf Cavendish (Singh, 1990;Patel & Shukla, 2010) and Grande Naine (Patel &Shukla, 2010) from different banana growing regions.

Finally, this experiment concludes that the integrated approach of physical and chemical approach leads to the reduction of the disease intensity and damage to the crop.

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