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Current status and progress of research on the management of bean root rot complex in south western Uganda

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Abstract

Bean root rot is the most important disease affecting beans in South Western Uganda. The disease has resulted in complete loss of the crop in some areas. At the moment there is urgent need to look for means of reducing the disease and revitalizing bean production. The main objective of this study was to identify control measures that can reduce the disease on farmers fields. A rapid rural appraisal was carried out to determine the incidence of the disease and identify the disease causing organisms. Experiments set up included (i) integrated disease management, (ii) varietal resistance and (iii) combination of (i) and (ii). The experimental design in (i) and (iii) was a split plot while in (ii) the design was a randomized block design. The disease incidence in the district ranged between 80-100% on farmers fields. It was noted that 75% of the attacked crops were attached by *Pythium spp* alone. The other 25% was a combination of *Pythium spp* with one or both of the following: *Fusarium solani* and *Rhizoctonia spp*. The use of soil organic amendments such as farm yard manure, green manure and earthing up was only effective where the disease was not very severe when a snsceptible variety was used. Where the incidence was high, then these treatments were not effective. The most tolerant varieties identified were RWR 179, MLB 49/89A, G2333, Flora and Vuninkingi. A combination of farm yard manure, earthing up and tolerant varieties with seed dressing with fungicide and insecticide gave the highest yield of 2 tons per hactare as compared to tolerant varieties and green manure that gave a yield of 0.7 tons per ha only. It was therefore concluded that an integrated disease management strategy involving tolerant varieties, farm yard mannre and earthing up be adopted in order to reduce the disease in South Western Uganda.

Key words: Bean, root-rot, Uganda

Background

Common bean (*Phaseolus vulgaris L*) is the most important legume in Uganda (Sengooba 1987). It is a cheap source of protein and hence an important component in the diet of many Ugandans. It is also important as a source of cash both in the internal and export market.

In Uganda beans are grown throughout the country and can be grown throughout the year. South Western Uganda has been the greatest producer being responsible for 30% of the beans produced in the country (MAAIF, 1992). The production in this area dropped to 25% in 1994 and less than 20% in 1995 (MAAIF, 1997). This drop has been attributed to the effect of insect pests and diseases most specifically bean root rot.

Bean root rot is regarded as the most important disease affecting beans in South Western Uganda where it has resulted in complete loss of the crop in some areas. At the moment there is urgent need to search for control measures that are economical, environmentally safe and easy for the subsistence farmer so that bean production can be revitalized in this part of Uganda.

Objectives

The main objectives of this study were:

(a) To identify the organisms responsible for root rots in South Western Uganda
(b) To determine the incidence and severity of root rot in S.W. Uganda
(c) To evaluate different organic amendments, in controlling bean root rots
(d) To determine which cultural control measures can reduce root rot
(e) Identify resistant cultivars to root rots
(f) Tu determine a combination of organic amendments, cultural practices and resistant varieties that are effective in controlling the root rots

(g) At the end develop an integrated control strategy for controlling root rots in S.W. Uganda.

Materials and methods

Incidence and identification of the organisms responsible for root rot

To identify the organisms responsible for root rots and determine their incidence, a survey was carried out in all ten sub-counties of Kisoro district in 1996 and 1997. In each sub-county five farmers were randomly selected for the survey. In total fifty farmers were randomly selected for the survey. A structured questionnaire was used. In additioo a bean field belonging to the selected farmer was visited and a 1m^2 quadrat used for sampling and assessing the incidence and severity of the root rot. In each field a quadrat was used in five different areas of the field. A mean of the five quadrats gave the incidence. In each quadrat the total number of plants were counted and the number affected determined. Ten plants in each field were sampled to assess the severity. The organisms causing the root rots were identified after culturing in the laboratory and microscopic examination. Kochs postulates were performed to confirm the identity of the organisms.

Evaluation of organic amendments and cultural practices

Evaluation of organic amendments and other cultural practices in controlling root rot was carried out in 1997 for two seasons (1997A & B). The trial was set up on ten and twelve farmers fields in Kisoro district in 1997A and 1997B respectively.

In 1997A treatments included use of:

(a) *Calliandra/sesbania* as green manures (at a rate of 10 tons per hectare)
(b) *Acanthus* sp as green manure (10 tons per hactare)
(c) Inorganic fertilizer (NPK) (125 kg/hactare)
(d) Planting on ridges
(e) Earthing up
(f) Seed treatment with a combination of fungicide (Benlate) and insecticide (endosulfan) (Benlate at 28g per kg of seed)
(g) Application of farmyard manure (10 tons per ha)
(h) Control where no treatment was applied

In 1997B the treatments included those above (a-h) but in addition the following treatments were included:
(i) Treatment with fungicide (Benlate) alone
(ii) Treatment with insecticide (Endosulfan) alone

Data on root rot severity was assessed at 3 weeks after planting flowering and pod filling stage. The International Centre for Ttropical Agriculture based in Cali, Colombia (CIAT) 1-9 scale was used (where 1 indicates no visible symptoms and 9 represents 75% or more of the hypocotyl and root tissue with lesions and advanced decay). Five plants were used for assessment of severity. The incidence was taken as percentage number of plants affected using a quadrat as described above.

Genotype evaluation for resistance to root rots

In 1996B season one hundred locally grown bean cultivars in Uganda and twenty two introductions previsouly identified as resistant in Rwanda were evaluated on ten farmers fields in 1996. Single row plots, 3m in length were sown with one replicate per farm. K132, a well adapted but susceptible calima type variety was sown after every ten rows to account for variation in disease severity throughout the fields.

In 1997A and 1997B seasons only the twenty introductions were tested on eighteen farmers fields. All the 100 local cultivars were all severely affected in 1996 and were therefore not included in 1997. The varieties were planted in a completely randomized design with two replicates on each farm. Records were taken as described for organic amendments.

Determination of a combination of variety, organic amendments and cultural practices that can control root rots

In 1998A season the most resistant varieties, the organic amendments and cultural practices that gave the lowest incidence were combined to determine the best control for root rots.

Two separate experiments were set up for bush and climbing beans. The bush beans selected included RWR 719, MLB 49/89A and RWR 1092. The climbing genotypes included Vuninkingi, Umubano and Flora. The soil amendments included farm yard manure, Calliandra, Acanthus, Inorganic fertilizer (NPK), dressing with both fungicide and insecticide and control. The design was a split plot design with varieties in main plots and organic amendments in sub-plots. For all treatments earthing up was included.

Results and discussion

Incidence of root rot in Kisoro District

The results from the survey carried out in 1996 and 1997 indicated that over 90% of the plants sampled were affected by root rot alone; while 6-34% were affected by a combination of root rot and beanfly (Table 1).

Identification of the organisms responsible for root rot from the survey in 1996 and 1997

The results after culturing in the laboratory and identification showed that the major pathogen causing root rot in Kisoro was *Phythium sp* (Table 2). This organism was isolated from all samples collected. In addition *Fusarium sp* and *Rhizoctonia solani* were also prevalent. The three organisms were found to occur together. Where the other two occur without *Phythium sp* the root rot problem was not so severe.

Evaluation of soil amendments seed dressing and cultural practices

Root rot severity was high and similar for all treatments involving soil amendments when the disease inoculum was high and a susceptible variety was used. The incidence of the root rot was 100% for all the treatments except treatments that had fungicide (Benlate) applied. The root rot incidence for this treatment was 50-70% but the plants were not vigorous. However where inoculum was moderate, there were differences between treatments (Table 3).

Genotype evaluation for root rot resistance

There were significant differences between all the varieties (Table 4). The disease level was low in 1997A as compared to 1997B. The varieties with the least plant loss included

Table 1. Incidence of root rot and bean stem maggot in four countries of Kisoro district in 1996 and 1997 BSM + root rot

Country	Total No. No Sampled	No of plants affected by root rott (out of 40 plants)	%age with root rot alone root rot	No of plants with BSM and root rot	%age no of Plants with BSM and
Mutanda	360	356	98.9	34	9.5
Kigezi	480	443	92.2	38	6.25
Bufumbira	200	196	98.0	67	33.5
Kigezi	2000	193	96.5	68	34.0
LSD (0.05)		21.7		5.8	

Table 2. The importance of different root rot causing organisms in samples collected from Kisoro district in 1999b and 1997.

Country	Total no of samples	%age samples with Pythium	%age samples with *Fusarium sp.*	%age samples with *Rhizactonia solan*
Mutanda	30	100	50	66.7
Kigezi	25	100	40	48
Bufumbira	25	100	80	48
Kigezi	32	100	46.9	25
LSD			8.7	5.9

Table 3. The effect of different soil amendments and cultural practices on root rots in Kisoro district (mean of two seasons).

Management practice	Plant survival		Severity on roots	Grain yield
	3 weeks after planting	Pod filling		
FYM	68	62	7	785
NPK	64	57	7	744
Benlate/Endosulfan	52	50	6	415
Calliandra/green manure	51	46	7	520
Fungicide	51	48	6	400
Acanthus	44	33	8	425
Ridging	28	16	8	320
Earthing up	16	12	8	305
Insecticide	8	4	8	225
Control	4	0	9	110
LSD (0.05)	8.9	9.3		52.4

RWR 719, Vuninkingi, G 2333, RWR 1092, Flora, MLB 49-89A. These were combined with the soil amendments that gave the highest yield in 1998.

Combination of varieties, organic amendments and cultural practices

The disease level in 1998A was low for all treatments. For both bush and climbing beans, a combination of farm yard manure and any of the varieties gave the best control of the disease. Table 5 and 6 summarizes the results. The highest yield for climbing bean was with Vuninkingi (2.4 tons/ha) followed by G 2333 (2.0 tons/ha) and Flora (1.8 tons/ha) when combined with farm yard manure. This was followed by inorganic fertilizer. For bush beans RWR 719 gave the highest yield followed by MLB 49/89 and RWR 1092 respectively. There was no significant difference between FYM and inorganic fertilizer in yield. However these two were significantly different from Calliandra, Acanthus and control.

Table 4. The incidence of root rot and stem maggot in 1997 B at V_4

Variety	% no of plants dead	Mean root rot/5 plants sampled	Mean no of larvae per plant sampled
G 2333 (Umubano)	15.4	2.81	5.22
RWV 163	32.0	3.75	6.82
Flora	25.3	3.50	8.22
G 23331	41.8	3.30	4.25
Ihumure	45.4	3.92	7.21
Gisenyi	62.7	4.20	5.32
K132	94.9	5.00	5.16
RWV 167	78.2	3.67	5.45
Ngwinorare	61.5	3.98	6.33
Scam 80-cm/5	29.8	2.89	5.18
RWR 719	8.7	2.42	4.27
Scam 80-cm/1	26.7	2.92	7.80
Mixture (loc)	89.3	4.87	6.38
MCM 221	55.8	3.98	4.92
Vuninkingi	11.6	2.92	5.11
RWR 1092	22.2	3.33	3.82
MLB 40-89A	27.1	3.21	4.42
RWR 221	33.5	4.2	4.87
MLB 49-89A	25.6	3.52	5.27
Kiruli	54.8	3.86	6.88
LSD	16.7	1.3	1.43

Table 5. Reaction of 3 climbing bean varieties (Vuninkingi, G 2333 and Flora when combined with different organic amendments.

Variety	Management practice practice	Plant survival (%)		Severity at 3 WAP	Yield
		3 WAP	Harvest		
Vuninkingi	Calliandra	82.7	77.6	4.2	2275
	FYM	94.3	87.2	3.9	2400
	NPK	92.0	85.5	3.8	2380
	Seed dressing	85.0	84.0	3.17	1438
	Acanthus	75.2	63.2	4.7	1700
	Control	68.4	55.4	5.2	925
G 2333	Calliandra	74.4	72.8	5.1	1900
	FYM	83.7	81.3	4.2	2010
	NPK	82.4	80.4	4.2	1970
	Seed dressing	70.2	65.2	4.0	1560
	Acanthus	63.7	59.7	5.2	1420
	Control	58.2	53.7	5.8	730
Flora	Calliandra	72.3	70.3	5.7	1750
	FYM	81.8	81.0	4.5	1800
	NPK	81.2	78.4	4.4	1700
	Seed dressing	68.3	53.8	4.2	1200
	Acanthus	62.4	52.1	5.3	925
	Control	59.3	50.0	6.2	600
LSD (0.05)		5.8	6.7	1.02	105.7

Table 6. Reaction of 3 bush beans varieties when combined with different organic amendments.

Variety	Management practice	Plant survival %	Severity at 3 WAP	Yield
RWV 719	FYM	95.8	83.4	1234
	NPK	91.7	80.2	1116
	Calliandra	88.2	77.6	1025
	eed dressing	90.7	81.2	823
	Acanthus	80.0	74.1	740
	Control	75.2	63.7	425
MLB 49/89A	FYM	85.6	79.8	978
	NPK	83.4	77.6	825
	Calliandra	77.2	63.8	700
	Seed dressing	72.3	64.5	530
	Acanthus	71.8	62.4	470
	Control	62.4	57.3	400
RWR 1092	FYM	81.2	72.7	823
	NPK	80.8	71.6	700
	Calliandra	65.7	60.2	623
	Seed dressing	68.4	60.0	450
	Acanthus	62.7	57.7	430
	Control	60.0	55.5	400
LSD (0.05)		4.2	5.8	163.4

There was significant genotype by soil amendment interaction (Table 7) indicating that given tolerant varieties and improved soils, the root rot severity can be reduced. In addition where earthing up was applied there was increased adventious root development and better yield.

Table 7. Analysis of variance to determine the effect of soil amendment and genotype on severity of root rots in 1997

Source	Degree of Freedom	Mean square
Replication	12	2.57
Genotype	1	0.59
Error	12	0.99
Soil amendment	6	0.99*
AB	6	0.63*
Error	144	
CV		17.74

N.B: Mean separation by LSD at level 0.05 = 0.525

Conclusion

The organisms causing root rot in South Western Uganda were identified as *Pythiun sp, Fusarium sp* and *Rhizoctonia solani*. It was found that the root rot problem is complicated by the presence of beanfly and poor soil. The most effective control strategy was the use of a combination of tolerant varieties, soil fertility amendment and earthing up. Future work will include the effect of different nutrients on the root rot and use of other cultural control measures such as intercropping and crop rotation.

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