DEVELOPMENT OF CULTURAL COMPONENTS IN INTEGRATED MANAGEMENT OF ROOT ROTS OF BEANS.

Robin Buruchara and Urs Scheidegger

SUMMARY

Root rots of beans can better be controlled using an integrated management approach whereby different components which are complementary and effective against the diseases are applied in an integrated manner. These studies were therefore meant to evaluate the effects of some of the potentially useful cultural (components) practices in the management of root rots. On-farm and on-station trials were conducted during seasons A and B of 1991 and 1992, to evaluate the effects of raised beds, ridges and different types of organic amendments.
Results obtained showed that incorporation of leucaena leaves and twigs as green manure two weeks before planting can result in reduction in plant mortality, severity of root rots and increase in yield. The effects were however, more pronounced in seasons when severity of root rots was high (1992 A). Besides, green manures of leucaena, calliandra and sesbania, appear to contribute towards the nutrition of the plants thus enhancing their tolerance to root rots. Raised beds nd ridges were effective in reducing plant mortality and increasing yields only uring a season when root rots were severe largely due to high soil moisture.

ITRODUCTION.

Root rot diseases of beans in the Great Lakes Region have been associated with about five or more fungal pathogens which occur singly or in a complex (Rusuku, 1990). Given the nature and complexities of root rot diseases, use of a single control measure against all of them is usually not effective or even practical. It is therefore recommended to use a combination of effective and practical methods in an integrated approach.
Certain cultural practices influence the severity of root rots and can be used as short term measures and as complementary components in the integrated management of these diseases. Some of the practices create unfavourable condition for pathogen development and survival, leading to reduction in inoculum levels, or in promoting plant growth and vigour such that the plant becomes tolerant to infection despite the presence of the pathogens. Growing of beans on raised beds or ridges for example, have been shown to reduce the severity of root rots caused by *Pythium* spp (Abawi and Pastor-Corrales 1990). In some parts of northern Rwanda and in valley bottoms, growing of some crops including beans on raised beds is commonly practiced, partly to avoid high soil humidity. Similarly, use of leucaena green manure has been shown in screenhouse trials to reduce severity of root rots and promote plant growth and vigour (Buruchara, 1990). The objectives of these studies were thus to evaluate (both in on-station and on-farm the effectiveness of certain cultural practices (options) which may be used in the management of root rots. Concurrent on-farm and on-station evaluation was meant

to identify both technical and socio-economic constraints associated with certain practices and allow incorporation of farmers views during technology development.

MATERIALS AND METHODS.

Prior to installation of trials, a meeting was held with farmers in the secteur Kibingo (9 km west of Butare) of the commune Runyinya, where root rots have been a problem and where soil fertility is also low. The meeting was meant to evaluate farmers' perception of the problem and agree on management options to be tested with their participation.

During the A and B seasons of 1991 and 1992, both on-farm and on-station trials to were conducted to evaluate the effects of raised beds, ridges and different types of organic amendments applied as green manures, on the severity of root rots. In 1992 A and B, effects of planting on narrow ridges were evaluated. On-station trials were conducted at the experimental farm of the Universite National du Rwanda (UNR), Butare, which has a history of root rot problems. The factors evaluated in on-farm trials were also evaluated in on-station trials but with more complex experimental designs.

Organic Amendments.

Leaves and twigs of Leucaena (*Leucaena leucocephala*) were incorporated in the soil as green manure about 10 to 14 days before planting following the beginning of rains. During the 1991 A and B season, the green manure was applied at a rate of 20 ton/ha, fresh weight. In on station trials, other sources of organic amendments such as Calliandra, Sesbania, wattle bark, grass weeds, and decomposing coffee pulp were evaluated, in addition to Leucaena. Following results obtained in the two seasons, adjustment were made in the rates of green manure later applied. Rates of 5 and 10 tons/ha of Leucaena were used in subsequent seasons (1992 A and B) both in on-station and on-farm trials.

Raised beds and Ridges.

The effect of planting on raised beds was evaluated during the 1991 A and B seasons. Based on results obtained in the two seasons, modifications were made and planting on ridges was evaluated during the seasons 1992 A and B. Raised beds used were about 1 m wide and 30 cm high. Planting was done at random as commonly practiced by farmers, using a plant density of approximately 250000 plants per hectare. Ridges about 20 cm high and 50 cm apart were used in evaluating the effects of ridges. In the latter planting was done in rows.

RESULTS AND DISCUSSIONS.

Organic amendments;

During the 1991 A and B seasons, organic amendment and raised beds had no significant effects on seedling emergence, and the number of plants harvested in on-farm trial. High seedling emergence rates (80% season A and 78% season B) were observed implying little or no effect due to damping-off. Low rainfall received at the beginning of both seasons may have contributed to such a situation. On the other hand, organic amendments significantly reduced root rot severity and increased yields in both seasons (Table 1). Results obtained during the 1992 A season when root rots were severe showed that, 5 tons/ha of Leucaena significantly reduced plant mortality due to damping-off (both at V4 and R6 plant stages) and severity of root rots in local mixtures. An increase in yield of 21% was obtained but was not statistically significant. However, rates of 10 tons/ha significantly reduced plant mortality and disease severity, and resulted in yield increase of 128% (Table 3). Application of 5 ton/ha showed a better yield response on variety RWR 221 (364 kg/ha) than on the local mixture (99 kg/ha). On the other hand, increasing the rates from 5 to 10 ton/ha gave a better yield response on the local varietal mixture (503 kg/ha) than on RWR 221 (189 kg/ha). Given that variety RWR 221 is tolerant to root rots, the effect of organic amendment may have mainly been in improving soil fertility. However, a relatively better response by RWR 221 than the local varietal mixture at 5 ton/ha of organic amendment used, is probably due to its tolerance to low soil fertility. The local varietal mixture gave better and significant responses with 10 ton/ha of organic amendments.

A trend similar to that of on-farm trials was observed in on-station trials. In the seasons 1991 A and B organic amendments nearly doubled the dry matter production, significantly reduced severity of root rots and increased bean yields (Table 2). None of the treatments had any effects on plant emergence and number of plants at harvest. During season 1991 B, RWR 221 had lower disease scores than the local mixtures but yields were not significantly different. Use of organic amendment resulted in a yield increase of 43% in the first season (A) and 60% in the second season (B) over the control. However, overall yields were higher in the first than in the second season mainly due to higher pressure of foliar diseases during the latter. Trials conducted in 1992 A season to determine the effects of lower application rates (5, and 10 tons/ha) of leucaena organic amendments in controlling root rots and growth of local mixtures, also gave similar results as those in on-farm trials. Other types of organic amendments that were also evaluated are calliandra spp, *Sesbania magrantha* (10 ton/ha), grass weeds (varied constitution), and leaves of wattle bark, all as green manure. Decomposed coffee pulp and bananas leaves and stem were also evaluated. Results obtained over the two seasons show that calliandra and sesbania significantly reduced severity of root rots and increased yields compared to the control. The effects were similar to those of leucaena. Coffee pulp had some but insignificant effect on yield in only one but not in another season. Grass weeds gave varied response depending on their constituents. Wattle bark leaves and decomposing organic matter from banana leaves gave no positive effect over the control.

Table 1. The effects of principal paired treatments of organic amendment and raised beds on yield and root rot severity in on-farm trials (91 A and 91 B seasons)

Factor	Paired Treatment	Yield (kg/ha) 91A	Yield (kg/ha) 91B	Disease severity[z] 91A	Disease severity[z] 91B
Org. amendment[x]	-OA	1245	837	25.7**	21.3**
	+OA	1724**	1209**	14.2	13.5
Raised beds[y]	-RB	1462	972	19.9	18.6
	+RB	1507	1074	18.9	16.3
Mean		1485	1023	19.6	17.4
CV(%)		24.2	32.9	19.1	30.7

x -OA = no organic amendment added; +OA = leucaena green manure added 2 weeks before planting (20 t/ha).
y -RB = no raised bed; +RB = raised beds approximately 1 m wide and 30 cm high.
z = Disease severity as % hypocotyl and root tissues covered by lesions
* = Paired treatment means are significantly different (p=0.05) by ANOVA.
** = Paired treatment means are significantly different (p=0.01) by ANOVA.

Table 2. Effects of principal paired treatments of organic amendment, raised beds and variety on yield, disease severity and dry matter production in on-station trials (91A and 91B seasons).

Factor	Paired treatment	Yield (kg/ha) 91A	Yield (kg/ha) 91B	Dis. Severity[z] 91A	Dis. Severity[z] 91B	Wt of 10 plants 91A	Wt of 10 plants 91B
Org.amendment[u]	-OA	2056	1663	21.7**	17.5**	59.7	75.4
	+OA	2756**	2079**	15.3	10.9	102.5**	105.4**
Raised beds[x]	-RB	2414	1756	20.0	14.8	70.5	79.3
	+RB	2373	1973	17.0	13.6	91.6*	101.5**
Variety[y]	LM	1600	1855	26.2**	17.1**	65.7	79.2
	RWR 221	3186**	1877	10.8	11.3	96.4**	101.6**
Mean		2398	1867	18.5	14.2	81.1	90.4
CV(%)		25.8	20.3	26.4	20.3	30.0	23.0

u -OA = no organic amendment; +OA = leucaena green manure added 2 weeks before planting (20 t/ha).
x -RB = no raised bed; +RB = raised beds approximately 1 m wide and 30 cm high.
y LM = local mixture ; RWR 221 (tolerant variety).
z Disease severity as % hypocotyl and root tissues covered with lesions.
* = Paired treatment means are significantly different (p=0.05) by ANOVA.
** = Paired treatment means are significantly different (p=0.01) by ANOVA.

Table 3: Effect of variety and different levels of organic amendment (Leucaena) on the severity of root rots and yield in on-farm trials at Runyinya; 1992A

Variety[x]	Organic Amendment Levels[y] t/ha	% Plant Loss		Disease severity[z]	Yield (kg/ha)	Yield advantage	
		V4	V6			% of LM-0	% of RW-0
Local Mixture	0	42.1 a[m]	47.5 a	38.2 a	467 a	-	-
	5	34.6 ab	37.1 b	28.2 b	566 a	21	-
	10	30.6 b	31.6 b	16.8 c	1069 b	128	-
RWR 221	0	13.4 c	14.4 c	17.5 c	1470 c	215	-
	5	12.9 c	13.3 c	11.5 cd	1835 cd	293	25
	10	9.3 c	10.9 c	6.6 d	2033 d	335	38
CV(%)		35.6	37.4	40.4	35.6		
LSD		7.6	8.6	8.1	381		

[u] = LM = local mixture; RW = RWR 221 (resistant to root rots).
[v] = Leucaena applied as green manure 10 days before planting.
[x] = Plant loss at V4 and R6 expressed as % of seed sown.
[y] = Disease severity as % hypocotyl and root tissue covered with lesions.
[z] = means followed by the same letter in a column are not statistically different (p=0.05) by Duncan's Multiple Range test.

Results obtained in these studies clearly show that soil amendment with leucaena (and sesbania and calliandra) green manure reduced severity of root rots and increased yields. This confirms previous observations made in greenhouse trials (Buruchara, 1990). However, these effects are influenced by season which in turn influence severity of the of root rots. The effects of organic amendments were more pronounced in 1992 A season when high rainfall during the early seedling stage resulted in high disease severity and plant mortality. During the other seasons, the effect of organic amendments were more pronounced on yield. This agrees with previous observation that, organic amendments with leucaena influences disease severity while at the same time improves the nutritional status of the soil thus exerting complementary effects. Well fertilized and vigorous plants tolerant to damage inflicted by root rot organisms. In 1991 B, the yield advantage in using organic amendment was not apparent due to the fact that the crop suffered from foliar diseases prevalent during the season. The rates of leucaena used (20 ton/ha) were apparently high and this resulted in increased plant foliage and a long growth cycle ideal for development of foliar diseases.

Raised Beds and Ridges.

During the 1991 A and B season, raised beds had no effect in reducing disease severity or increasing yield both in on-station and on-farm trials (Table 1 and 2). In on-station trials, raised beds improved dry matter production significantly. Variety RWR 221 was significantly superior to the local mixture in dry matter production, number of plants harvested, yield per plant and per hectare. It also had a lower disease score than the local mixture. Ridging was however effective particularly

during the 1992 A season, when rainfall was high and root rots were severe. Plant mortality due to damping-off on the local varietal mixture was reduced by about 40% at both V4 and R6 stages, and yield increased by 139% (Table 4). The advantage of using ridges with the resistant variety RWR 221 was low (7%). During the 1992 B season, rains were relatively low and there was no advantage both in disease severity and yield by using ridges.

Table 4: Effect of variety and ridging on severity of root rots and yield in on-farm trials at Runyinya, 1992A season

Variety[w]	Paired Treat-ment[y]	% Plant loss				Disease seve-rity[z]		Yield (kg/ha)		Yield advantage (% LM without RD)	
		V4		V6							
		92A	92B	92A	92B	92A	92B	92A	92B	92A	92B
Local mix-ture	-RD	46.5*	11.4	51.0*	34.6	38.9*	-	390*	672	-	-
	+RD	28.0	10.4	30.2	28.2	16.0	-	935	737	139	9
RWR 221	-RD	12.8	10.4	13.7	19.6	18.0*	-	1670	1620	328	141
	+RD	7.1	8.3	7.8	19.1	9.7	-	1786	1562	358	132
CV(%)		33.5	27.9	32.3	37.6	32.9		35.9	35.4		

[w] = LM = local mixture; RW = RWR 221 (Resistant to root rots)
[x] = -RD = No ridging; +RD = Ridging
[y] = Plant loss at V4 and R6 expressed as % of seed sown.
[z] = Disease severity as % hypocotyl and root tissue covered with lesions.
* = Paired treatment means significantly different (p=0.05) by Duncan's Multiple Range test.

Growing beans on raised beds is beneficial during wet and cool wheather patterns as it increases aeration and soil temperature as well as decreases soil moisture. It also promotes deeper and greater root formation and thus allows more tolerance to root rots. Pythium rot severity is especially reduced on raised ridges. During seasons 1991 A and B and 1992 B, raised beds had some but not significant effect on disease severity and yield. This may imply that conditions during the early and critical stages for damping-off pathogens such as Pythium and Rhizoctonia were probably not ideal for their development. But during season 1992 A, the converse was true and ridging had a significant effect both on disease severity and yield. These studies show that ridging is useful in root rot infested soils associated with high moisture or during high rainfall seasons. Areas which receive regular and high rainfall during early stages of plant growth could benefit from using such practices.

Farmer Assessments

Organic amendment with leucaena was the most appreciated method by collaborating farmers during all the seasons tested. Desirable attributes cited are, 1. effect in reducing loss of plants due to root rots, 2. increase in yield, 3. increase in vegetative growth (for leaf consumption) and 4. positive residual effect on sorghum grown after beans. The main constraint cited was availability of sufficient quantities. As a response, farmers in the trial zone are interested in methods of producing green manure for themselves such as hedgerows or on contours.

Farmers did not appreciate the use of raised beds in the management of root rots since it had no observable effect. They consider its high labour demand an additional disadvantage. This was the basis for modification and subsequent testing of ridges. The effects of planting on ridges were however appreciated by all participating farmers during the 1992 A season. The method was similarly, considered laborious and its effects were not consistent in the two seasons. Due to seasonal variation in rainfall amounts, farmers considered ridges useful during periods and areas of high rainfall, or in plots and areas which tend to be water-logged.

LITERATURE CITED.

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