Annals of Arid Zone 53(2): 113-117, 2014

Popularization of Rodent and Dry Root Rot Control Technologies in an Adopted Village of Indian Arid Zone

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Received: December 2012

Abstract: Diseases and rodent pests are the main factors responsible for low yield of rainfed crops in arid regions. There is a considerable scope for increasing the production of pearl millet, mung bean, moth bean, clusterbean and sesame crops by adoption of technologies generated by the Central Arid Zone Research Institute. There is a need to disseminate technologies on disease and rodent management in the farming community. Therefore, a four year study (2006-2009) was taken up to popularize improved technologies in adopted village Dantiwada of Jodhpur District. Twenty nine demonstrations on clusterbean varieties (RGC-936 and RGM-112) and 15 demonstrations on moth bean varieties (CAZRI moth-1, CAZRI moth-2, CAZRI moth-3 and RMO-435) were conducted during 2006-2009 with seed treatment of Marusena-3, a bio-formulation of *Bacillus firmus* developed by CAZRI, Jodhpur, for controlling dry root rot disease. Plant mortality due to dry root rot in improved moth bean varieties was lower (17-23%) in treated plots as compared to 39 to 63% in untreated plots. The seed yield increased by 11-16% in improved clusterbean varieties and by 25-30% in local variety compared to control. On rodent management, 18 demonstrations on poison baiting with two rodenticide (zinc phosphide and bromadiolone as alone and also as follow up) were conducted in fields having pearl millet, mung bean, moth bean, clusterbean and sesame crops. Rodent control was successfully achieved with single treatment of zinc phosphide (2%) by 57 to 65% within 4 days of treatment. Single treatment with bromadiolone (0.005%) yielded 75 to 78% rodent control in these crops 15 days after treatment. Double baiting i.e. treatment of zinc phosphide followed by bromadiolone, the rodent control success 15 days after treatment was 82-84%. Adoption of rodenticidal treatments increased yield by 18 to 27% compared to control. Nine training programs were organized on dissemination of these technologies where 269 farmers/farm women were benefitted. Level of farmer's knowledge about management of disease and rodent pest increased significantly by 60-65% after training and demonstration.

Key words: Rodent, dry root rot, marusena, rodenticide.

In Indian arid regions, pearl millet, mung bean, moth bean, clusterbean and sesame are the major crops grown under rainfed conditions, which are subjected to moisture stress of short and long durations (Kar *et al.,* 2009), making them vulnerable to infection by *Macrophomina phaseolina* causing dry root rot (Lodha, 1986). Farmers grow local strains or improved varieties of these crops. However, varieties resistant to this disease are not available to farmers thus cultural and biological management strategies are the only available options. One of the bio-agent isolated from native soil of the region is a bacterium *Bacillus firmus,* which has shown antagonistic activities against *M. phaseolina* in laboratory and field tests (Singh *et al.,* 2012). CAZRI has developed a formulation of this bacteria named as Marusena-3.

Besides the dry root rot, rodents are another important factor responsible for low yield of these crops (Tripathi, 2004). There is a considerable scope for increasing the production of these crops by adoption of technologies like seed treatment with Marusena-3 and rodenticidal baiting generated by Central Arid Zone Research Institute, Jodhpur. Keeping this in view, a study was undertaken to popularize these two improved technologies among the farmers of Dantiwada village of Jodhpur District. Seed coating of clusterbean and moth bean with a bio-formulated product Marusena-3 of *B. firmus* and rodent management practices were popularized through various extension

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methods like demonstration, training, group discussion, etc., during 2006-2009.

Methodology

The study was conducted in Dantiwada village of Jodhpur District. The population of the village is 2037 with 400 families (2001). Total area of the village is over 2000 ha wherein more than 1500 ha is cultivable and 89 ha is under pasture. Effectiveness of *B. firmus* (Marusena-3) as seed coating against dry root rot was ascertained at farmer's field on improved and local varieties through 29 demonstrations on clusterbean and 15 demonstration on moth bean.

Rodent surveys and 18 demonstrations on rodent management technologies along with rodenticidal evaluations were conducted at farmer's fields. The treatments comprised (i) zinc phosphide (2%) (ii) bromadiolone (0.005%) (iii) zinc phosphide (2%) followed by bromadiolone (0.005%) and (iv) untreated control and were laid in different crops. For preparing the baits, pearl millet grain and groundnut oil was used. For one kg poison bait, 960 g pearl millet, 20 g of oil and 20 g of rodenticide was used. Control success was calculated based on live burrow count before and after the treatment.

Impact of training was assessed through structured schedule by interviewing 30 farmers before and after the training program. Likewise feedback received from 21 farmers on Marusena treatment and 13 farmers on rodent control technology was analyzed for various parameters as given in Table 7.

Results and Discussion

Effect of Marusena-3 (B. firmus) seed coating

Fourteen demonstrations were conducted (2007–2008) on variety RGC-936. Pooled data for 2 years revealed that seed yield in untreated plots ranged from 185-400 kg ha^{-1} (mean: 321.50 kg ha^{-1}) compared to 245-620 kg ha^{-1} (mean: 372 kg ha^{-1}) in the plots sown with *B. firmus* coated seeds. The overall seed yield increased by 15.70% due to use of bio-control agent (Table 1). Similar treatments on RGM-112, recorded seed yield ranging between 140-530 kg ha^{-1} compared to 90-290 kg ha^{-1} yield in untreated plots. The overall mean seed yield increased by 11.40% due to bio agent coating. The effect was more discernible on local cultivar, where the yield in treated plots ranged from 140-360 kg ha^{-1} compared to 90-305 kg ha^{-1} in untreated plots, with an overall 26.43% increase in 15 demonstrations. Increased seed yield due to seed coating with Marusena-3 may be due to reduced incidence of dry root rot disease. Moreover, there was an early flowering in plants raised with *B. firmus* coated seeds.

Table 1. Effect of Marusena seed coating on seed yield of clusterbean during 2007 and 2008

Varieties	Yield (kg ha^{-1}) (Mean of two years)		Yield increase (%)
	Treated	Untreated	
RGC-936	372.00	321.50	15.70
RGM-112	420.00	377.00	11.40
Local	232.00	183.50	26.43

Field demonstrations on seed coating with Marusena-3 on moth bean (CAZRI-Moth-3) were conducted during 2007-2008. Seed yield of variety CAZRI-Moth-2 in untreated plots ranged from 475-495 kg ha^{-1} compared to 530-570 kg ha^{-1} in treated plot, leading to 12-15% increase. Similarly, in CAZRI-Moth-3 seed yield increased from 12-14% (mean: 13.40%). On local cultivar, a pronounced effect of seed coating was recorded, where the seed yield increased by 16-21% (mean: 19.35%) compared to untreated control (Table 2).

Table 2. Effect of Marusena on seed yield of moth bean during 2007 and 2008

Varieties	Yield (kg ha^{-1}) (Mean of 2 years)		Yield increase (%)
	Treated	Untreated	
CAZRI-Moth-2	510	453	12.58
CAZRI-Moth-3	550	485	13.40
Local	370	310	19.35

Four year study (2006-09) revealed that disease incidence was higher with 39.30 to 63.23% mortality in different moth bean varieties in untreated plots (Table 3). However, Marusena-3 treated plots recorded 17.15 to 23.17% mortality. Marusena-3 resulted in least incidence of disease in CAZRI Moth-1 (17.15%), which was at par with that of RMO-435(19.46%), CAZRI Moth-3 (21.88%) and CAZRI Moth-2 (23.17%).

Table 3. Effect of Marusena seed coating on dry root rot incidence on moth bean (2006-2009)

Varieties	Mean of 4 years			
	Treated		Untreated	
	Plant stand	Mortality (%)	Plant stand	Mortality (%)
CAZRI Moth-1	42.25	17.15	36.25	39.30
CAZRI Moth-2	42.50	23.17	35.75	63.23
CAZRI Moth-3	46.00	21.88	37.00	49.06
RMO-435	43.50	19.46	36.25	49.57

Three year study (2007-09) revealed that disease incidence was higher with 10.81 and 22.22% mortality in RGC-936 and RGM-112 varieties of clusterbean, respectively, in untreated plots however, treated plots recorded 6.81 and 14.20% mortality in respective varieties (Table 4). The results therefore indicated that Marusena-3 treatment provides effective control of dry root rot disease in clusterbean.

Table 4. Effect of Marusena seed coating on vegetative growth and dry root rot incidence on cluster bean (2007-2009)

Varieties	Mean of 3 years			
	Treated		Untreated	
	Plant stand	Mortality (%)	Plant stand	Mortality (%)
RGC-936	44	6.81	37	10.81
RGM-112	42	14.20	36	22.22

Rodent management

Field efficiency of rodenticides: The studies revealed infestation of Indian Desert gerbil, *Meriones hurrianae* and Indian gerbil, *Tateraindica* in the crop fields. The level of infestation was between 51-57 burrows ha^{-1} in pearl millet, mung bean, moth bean, sesame and clusterbean fields. The results indicated that on 4th day after single treatment of zinc phosphide mean reduction in rodent infestation was 57 to 65% (Table 5). On the other hand, single baiting with bromadiolone (0.005%) resulted in significantly lower mean control success of 25 to 27% on fourth day after treatment. In fact, bromadiolone, being an anticoagulant rodenticide, has chronic action on target species and therefore mortality of rodents with bromadiolone begins after 3-4 days of baiting and continues up to 10-12 days. That is why the control success with bromadiolone increased up to 75-78% within 2 weeks of treatment. Acute action of zinc phosphide, although yielded quicker success on 4th days after treatment but registered decreasing trends from 64.8 to 56.2% (pearl millet); 64.6 to 60% (mung bean); 62.2 to 59.1% (moth bean; 57.7 to 51.15 (clusterbean) and 57.2 to 50% (sesame) within 2 weeks. The double baiting i.e. zinc phosphide followed by bromadiolone baiting fetched highest mean rodent control success of 81.71% in pearl millet, 84% in moth bean and 82.69% in mung bean 15 days after treatment. Further analysis revealed that although the overall success with single treatment of bromadiolone and double treatment of zinc phosphide followed by bromadiolone was at par (75-84%), double baiting (integration of acute and chronic rodenticides) appeared to have an edge due to quick and sustained management of rodent pests. In the untreated control fields, the rodent population showed increasing trends during 2 weeklong observations due to immigration from surrounding areas. The above findings are in conformity with the findings reported by Tripathi *et al*. (2004). In the treated fields the immigrating pest populations were also managed due to sustained effects of anticoagulant rodenticides.

Effect of rodenticidal treatment on crop yield: Studies indicated that rodenticidal treatments had direct impact on yield of all the test crops due to management of rodents (Table 6). Two year (2007 and 2008) observations revealed that the mean seed yield increased by 26.80% in moth bean followed by pearl millet (22.40%), mung bean (19.50%), sesame (17.70%) and clusterbean (14.0%) over the control.

Farmers training

As part of capacity building and awareness creation, four on-farm farmers trainings on 'Rodent Management' and seed treatment of clusterbean and moth bean with Marusena were organized in the adopted village during 2006-09 in participatory and interactive mode. Around 269 farmers were exposed about, the rodent pest of the region; rodent problem in agriculture, storage and public health; diagnostics of the problem; rodent control techniques; rodenticides and bait preparation, applications and precautions in handling rodenticides and seed treatment with Marusena. Impact of training on rodent management

Table 5. Effect of rodenticidal treatment on rodent control success at Dantiwada village

Crop treatment	No. of burrows treated (ha^{-1}) 3 years mean	Control success (%)							
		2007		2008		2009		Mean	
		4 DAT	15 DAT	4 DAT	15 DAT	4 DAT	15 DAT	4 DAT	15 DAT
Pearl millet									
Zinc phosphide	49.3	62.20	60.00	65.40	53.80	66.66	54.90	64.75	56.23
Bromadiolone	55.0	23.10	71.20	28.60	78.60	29.82	75.43	27.17	75.07
Zinc phosphide + Bromadiolone	53.3	58.30	80.60	60.90	81.20	58.33	83.33	59.17	81.71
Control	44.3	-7.10	-14.20	-6.30	-22.20	-8.69	-19.60	-7.36	-18.68
Moth bean									
Zinc phosphide	63.5	-	-	62.50	61.10	61.90	57.14	62.20	59.12
Bromadiolone	55.0	-	-	23.70	78.20	-	-	23.70	78.20
Zinc phosphide + Bromadiolone	50.0	-	-	70.00	84.00	-	-	70.00	84.00
Control	53.0	-	-	0.00	-16.10	-4.20	-10.00	-2.20	-12.76
Mung bean									
Zinc phosphide	65.0	-	-	66.20	63.10	63.10	56.90	64.65	60.00
Bromadiolone	55.0	-	-	-	-	25.45	78.20	25.45	78.20
Zinc phosphide + Bromadiolone	52.0	-	-	-	-	71.15	82.69	71.15	82.69
Control	52.0	-	-	-4.20	-8.400	0.00	-16.10	-2.10	-12.25
Clusterbean									
Zinc phosphide	61.5	58.50	50.80	-	-	56.89	51.72	57.70	51.11
Control	53.5	-3.70	-11.10	-	-	0.00	-9.43	-1.85	-10.26
Sesame									
Zinc phosphide	56.0	-	-	57.20	50.00	-	-	57.20	50.00
Control	58.0	-	-	0.00	-4.90	-	-	0.00	-4.90

DAT=Days after treatment.

Table 6. Effect of rodenticidal treatment on yield of kharif crops at Dantiwada village (2007 and 2008)

Crop treatment	No of burrows treated ha^{-1}	Mean yield kg ha^{-1} (2 years)	% yield increase
Pearl millet			
Zinc phosphide	48.5		
Bromadiolone	54.0	800	22.14
Zinc phosphide + Bromadiolone	50.0		
Control	43.5	655	
Moth bean			
Zinc phosphide	64.0		
Bromadiolone	55.0	520	26.80
Zinc phosphide +Bromadiolone	50.0		
Control	56.0	410	
Mung bean			
Zinc phosphide	65.0	550	19.50
Control	48.0	460	
Clusterbean			
Zinc phosphide	65.0	320	14.00
Control	54.0	280	
Sesame			
Zinc phosphide	56.0	530	17.70
Control	58.0	450	

Zinc phosphide (2%) and Bromadiolone (0.005%) in bajra baits.

and seed treatment with Marusena was also assessed. Level of farmer's knowledge about management of pest and disease was 20-30% before our intervention, while it increased significantly to 60-65% after training and field demonstrations.

Group discussion

Ten group discussions were organized on seed treatment of clusterbean and moth bean with Marusena, and rodent control strategies in a group of 5-8 farmers. Under this program, the farmers were given practical exposures on seed treatment with Marusena; diagnosis of rodent damage to crops and identification of live burrows. Importance of community action for sustainable rodent management was explained to the farmers. Farmers were motivated to prepare the poison baits themselves and apply in the burrows of selected field under our supervision. In all 125 farmers were benefited through this exercise.

Feedback of technologies

Feedback of technologies i.e. seed treatment of clusterbean and moth bean with Marusena-3 and rodent management were collected from the farmers (Table 7). Data indicated that most of the farmers reported significant improvement in seedling emergence, early plant growth, early flowering (76.19%), increase in seed yield (90.47%) and low incidence of disease due to treatment of Marusena-3 (66.66%). Treated plots were harvested 3-4 days before untreated plots. In case of rodent control, majority of the farmers (69.23%) reported that rodents were successfully controlled in the crop fields.

Table 7. Feedback of technologies

Item	Number	%
Marusena-clusterbean and moth bean (N-21)		
Significant improvement in seedling emergence, early plant growth and early flowering	16	76.19
Low incidence of disease in treated compared to untreated plots	14	66.66
Treated plots were harvested 3-4 days before untreated plots.	17	80.95
Increase in seed yield	19	90.47
Rodent control (N-13)		
Successful control of rodents	8	69.23
Increased yield	11	84.61

Conclusions

Coating of moth bean and clusterbean seed with Marusena-3 reduced the incidence of dry root rot disease to the tune of 17-23% (moth bean) and 7-14%(clusterbean) in plant mortality in different varieties. The seed yield was also increased 12-13% (moth bean) and 11-16% (clusterbean).

Use of zinc phosphide (2%) baiting resulted into 57 to 65% control of rodents in pearl millet, mung bean, moth bean, clusterbean and sesame crops at 4 days after treatment, bromadiolone (0.005%) gave 75 to 78% rodent control success at 15 days after treatment. In case of double baiting treatment of zinc phosphide followed by bromadiolone, the rodent control success was 82 to 84% on 15 days after treatment.

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Printed in June 2015