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Bruchid Infestation in Pod and Seed in Exotic Collections of *Acacia senegal* (L.) Willd. in the Thar Desert

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Abstract: Exotic germplasm of *Acacia senegal* collected from the forests of Niger, Mali and Senegal were transplanted in 1988, and evaluated for tree morphology, pod and seed yield related traits for two years during 2005 and 2006. Mean values in 2006 were 7.33 cm for pod length, 4.71 kg for pod yield per tree, 3.87 for number of seeds per infested pod and 3.79 for number of seeds/healthy pod, which were significantly higher than those of 2005. On the other hand mean values were 24.9 for shelling percentage, 8.0% for pod infestation and 3.33 for percent of seeds infested in healthy pods, which were significantly lower than the values of 2005. Two species of bruchids, i.e. *Bruchus bilineatopygus* Pic. and *Caryedon serratus* Olivier were found to infest the seeds. EC87/7490, the highest pod and seed yielder with minimum seed infestation, was found to have more than 30% survival. Therefore the seeds of this accession can be used directly for large-scale plantation.

Key words: *Acacia senegal,* seed yield, bruchids, seed and pod infestation, exotic material

Acacia senegal (L.) Willd. locally known as 'Kumat', is one of the most commonly found tree species in the arid areas of Rajasthan, Gujarat, Punjab and Haryana. The plant thrives on rocky hills, dry sandy flats, or dunes where the annual rainfall is between 200 and 350 mm. It can yield well even where the soil is unable to support other crops including trees. Sheep and goats relish the pods of this species, as these are rich in proteins (22%), and fiber (39%) (Anonymous, 1979). In the Indian desert the seeds of this plant are consumed by local inhabitants in the form of vegetable as one of the constituents of the desert delicacy 'Panchkutta'. The processed seeds of this plant are reported to have 37.2% protein, the highest among the seeds of 12 species of *Acacia* (Banerji *et al.*, 1988). Under dry climate the trees yield gum, which is of medicinal value. Unlike other tree legumes of the desert region, the fully matured pods of this species do not fall on the ground till the arrival of monsoon.

Bruchids cause huge losses to pulses worldwide. In the desert region too, many species of bruchids have been reported to attack many tree legumes viz., *P. cineraria*, *A. tortilis*, and other acacias, resulting in loss of quality, quantity and germination of these seeds (Southgate, 1983). This study was conducted to estimate losses due to insects in exotic material of *A. senegal* and to identify the better genotypes for pod/seed yield with minimum infestation.

Materials and Methods

Seeds of five accessions collected from the forests of Niger, Mali and Senegal were procured from CIFT, France. Seventy-two seedlings of each accession (EC 87/7490, EC 87/7493, EC 87/7497, EC 87/7499 and

EC87/7500) were transplanted in the field during 1988 at Central Research Farm, CAZRI Jodhpur (26°18′N, 73°08′E). The climate of the area is typically arid, characterized by exceptionally hot dry summers, sub-humid monsoons and cold dry winters. The soil is sandy loam (Camborthid) with a pH of 8.1 and low in nutrients, with 0.23% organic carbon, 0.03% nitrogen and 0.02% phosphorus (Dhir, 1984). During 2005, four tall trees with more canopy diameter from each accession were selected. Data on these trees were recorded for height, collar diameter, dbh and canopy diameter. Fully matured pods were collected from the canopy of each tree during December of 2005 and 2006. Handful of pods taken randomly from each tree were grouped into infested and healthy pods on the basis of exit holes observed on the pods to record percentage of pods infested. Pods with no exit hole of bruchids, also had seeds harboring bruchid larvae. Therefore, seeds from both types of pods were further classified into infested and healthy and were counted and weighed for recording per cent seed infestation in infested and healthy pods, number of seeds/infested pod and healthy pod, weight of 100 healthy seeds of infested and healthy pods, 100 infested seeds of healthy and infested pods. In March, sieving of infested seeds was done to separate insects from the seeds. Insects were collected, identified and counted for dominance of species. The data were subjected to statistical analysis for mean, coefficient of variation and simple correlation coefficients for both the years. To see the difference in the values of the two years, Student's 't' test was applied (Gosset, 1908).

Results and Discussion

After seventeen years of establishment, 26.1% of the 360 plants transplanted survived. Survival was 37.5% for EC 87/7493, 30.6% for EC87/7500 and EC 87/7490, 19.4% for EC 87/7499 and 12.5% for EC 87/7497. There was not much change in the morphological traits with one year of growth. Therefore, mean values of 2005 and 2006 were considered (Table 1). EC 87/7490 and EC 87/7493 were among the first two ranks for tree height, collar diameter, dbh and canopy diameter. Pod length in 2006 was more for all the accessions than in 2005 and ranged from 6.51 cm for EC 87/7497 to 7.92 cm for EC 87/7500.

Average pod length was 6.41 cm during 2005 and it was significantly more i.e., 7.33 cm during 2006. Mean pod yield was 2.45 kg tree^{-1} (ranging between 0.33 kg to 6.17 kg) during 2005, and it was almost double during the next year when the relative humidity was more. Similarly the seed yield per tree was more in the second year, but the difference in seed yield between the years was non-significant. Shelling percentage was 35.8% in 2005, which

Table 1. Mean values of 2005 and 2006 of tree morphological traits in different accessions of A. senegal

Character	EC87/7490	EC87/7493	EC87/7497	EC87/7499	EC87/7500	Grand mean
Height (cm)	7.10	7.90	6.30	5.96	6.93	6.80
Collar diam. (cm)	15.90	15.50	13.25	13.10	14.75	14.35
dbh (cm)	11.05	12.75	9.05	11.15	12.55	11.65
Canopy diam. (m)	6.35	5.98	5.78	5.45	5.86	5.84

Table 2. Mean, range and coefficient of variation of different tree characters, pod and seed infestation in A. senegal

Character	2005		2006		't' value
	Mean (range)	CV (%)	Mean (range)	CV (%)	
Tree height (m)	6.80 (5.00-8.60)	13.1	6.79 (5.0-8.3)	12.5	0.02
Collar diam. (cm)	14.1 (8.60-19.4)	17.5	14.6 (8.5-18.2)	15.1	0.58
dbh (cm)	11.5 (7.20-14.4)	16.5	11.8 (7.5-14.4)	15.9	0.38
Canopy diam. (m)	6.03 (5.05-7.25)	12.0	5.65 (3.65-7.35)	15.3	1.30
Pod length (cm)	6.41 (4.40-7.55)	11.1	7.33 (6.05-8.82)	10.2	3.45**
Pod yield/tree (kg)	2.45 (0.33-6.17)	70.2	4.71 (0.75-8.3)	45.2	3.20**
Seed yield/tree (g)	858 (111-2415)	70.6	1154 (245-2080)	47.5	1.40
Shelling (%)	35.8 (27.5-52.2)	16.6	24.9 (16.2-32.7)	18.5	5.64**
Pod inf. (%)	19.5 (5.13-28.4)	36.0	8.0 (2.6-17.5)	54.1	5.39**
SIIP (%)	22.8 (8.45-100)	94.9	18.1 (10-36.2)	36.6	0.80
SIHP (%)	5.59 (0.97-10.3)	46.5	3.33 (1.79-7.41)	47.3	2.88**
NSIP	3.21 (1.25-4.27)	22.0	3.87 (2.0-5.0)	20.5	2.43*
NSHP	3.26 (2.32-5.03)	22.2	3.79 (2.21-4.61)	18.1	2.07*
Wt. 100-HSIP (g)	4.91 (2.65-7.36)	21.7	5.19 (3.24-8.0)	27.7	0.61
Wt. 100-ISIP (g)	3.18 (1.73-4.96)	30.1	3.23 (0.75-5.22)	42.3	0.10
Wt.100-HSHP (g)	5.58 (3.05-8.06)	24.5	5.51 (3.41-8.64)	28.6	0.14
Wt. 100-ISHP (g)	3.17 (1.83-5.05)	27.6	3.18 (1.68-6.67)	46.1	0.02

* P<0.05, ** P<0.01

where, % SIIP=% seed infestation in infested pods, % SIHP = % seed infestation in healthy pods, NSIP=number of seeds/infested pod, NSHP=number of seeds/healthy pod, Wt. 100-HSIP=weight of 100 healthy seeds in infested pods, Wt. 100-ISIP=weight of 100 infested seeds in infested pods, Wt .100-HSHP=weight of 100 healthy seeds in healthy pods, Wt. 100-ISHP=weight of 100 infested seeds in healthy pods.

significantly reduced to 24.9% in 2006. During the second year, though pod yield and seed yield were more but shelling per cent was less, which might be due to poor transfer of food from pod husk to the developing seeds. Weight of 100 healthy seeds of healthy pods was maximum in 2005 (5.58 g) and in 2006 (5.51 g) followed by healthy seeds of infested pods for both the years .It shows that insects in the pods eat away some of the seeds and check the development of other seeds. Weight of 100 infested seeds in both types of pods i.e., infested and healthy pods during both the years ranged from 3.17 g to 3.23 g showing that the pods which appeared to be non infested were not really healthy. The 't' values did not show significant difference in weight of 100 healthy and infested seeds of healthy and infested pods between the years. 100-seed weights were slightly more in second year except the weight of healthy seeds of healthy pods, which were maximum in 2005 (Table 2). Accessions EC87/7490 and EC87/7493 were better for pod yield per tree, seed yield per tree, shelling percentage and seed infestation.

Coefficient of variation, which facilitates comparison of variability about different sized means, for 100 seed weights ranged between 21.7% and 30.1% in the first year, and 27.7% to 46.1% in the second year. The values were more for second year for 100 healthy and 100 infested seeds for both infested and healthy pods showing that second year environment i.e., better humidity in later months may be due to late monsoon, was more favorable for expressing the genotypes for seed weight. The CV values for tree height, collar diameter, dbh, canopy diameter, pod length and shelling per cent were less than 20% showing that there was more uniformity for these traits among different trees. For pod yield and seed yield CV was about 70% in first year and it decreased to about 45% in the second year showing that the environment of first year was better for expressing the genotypes and selections done in first year for seed yield will be more effective. Mean pod infestation was 19.5% and ranged between 5.13 and 28.4% in the first year. Infestation in second year was only 8.05% and it varied from 2.6% to 17.5% with much variation. There were

Table 3. Correlation matrix of nine characters during 2005 and 2006 in A. senegal

Character	1	2	3	4	5	6	7	8	9
1 Tree height	-	0.58*	0.64**	0.37	0.40	0.16	0.16	-0.35	0.02
2 Collar diam.	0.67**	–	0.70**	0.71**	0.16	0.22	0.24	-0.32	0.14
3 dbh	0.70**	0.65**	–	0.57*	0.42	0.06	-0.02	-0.60*	0.28
4 Canopy diam.	0.44	0.72**	0.41	–	0.02	0.45	0.43	-0.33	-0.12
5 Pod length	0.25	0.25	0.21	-0.05	–	0.31	0.29	-0.17	0.25
6 Pod yield/tree	0.66**	0.70**	0.45	0.60*	0.09	–	0.98**	-0.19	-0.69**
7 Seed yield/tree	0.60*	0.66**	0.37	0.49	0.18	0.92**	–	-0.03	-0.66**
8 Shelling %	-0.24	-0.24	-0.31	-0.41	0.15	-0.18	0.17	–	0.12
9 Pod inf. %	-0.16	-0.14	0.08	-0.20	0.34	-0.39	-0.38	-0.06	–

Table 4. Correlation matrix of pod infestation and seed infestation characters during 2005 and 2006 in A. senegal

$	1	2	3	4	5	6	7	8	9	10	11	12
1	–	0.98**	-0.19	-0.69**	0.34	-0.36	-0.45	-0.32	0.08	0.07	0.61*	-0.05
2	0.92**	–	-0.03	-0.66**	0.28	-0.31	-0.33	-0.33	0.11	0.05	0.66**	-0.07
3	-0.18	0.17	–	0.12	-0.11	0.15	0.53*	0.15	0.21	0.09	0.22	0.10
4	-0.39	-0.38	-0.06	–	-0.36	0.22	0.55*	0.42	0.22	0.02	-0.39	0.11
5	-0.22	-0.22	0.01	0.19	–	0.18	-0.66**	-0.27	-0.19	0.50*	0.43	0.35
6	-0.61*	-0.59*	0.15	0.63**	0.24	–	0.18	-0.14	-0.05	0.28	0.12	0.14
7	0.19	0.28	0.24	0.30	0.20	0.26	–	0.31	0.10	-0.39	-0.26	-0.17
8	0.19	0.29	0.27	0.20	0.09	0.12	0.80**	–	0.03	0.09	-0.28	0.16
9	-0.37	-0.41	-0.14	-0.16	0.06	-0.02	-0.76**	-0.73**	–	0.51*	0.52*	0.34
10	0.24	0.23	-0.21	0.01	-0.49	-0.29	-0.38	-0.24	0.00	–	0.58*	0.79**
11	-0.41	-0.35	0.11	-0.09	0.07	0.14	-0.66**	-0.79**	0.84**	-0.02	–	0.39
12	-0.24	-0.29	-0.22	-0.26	0.00	-0.08	-0.84**	-0.78**	0.78**	0.45	0.72**	–

$=Character pod yield/tree; 1=Pod yield/tree, 2=Seed yield/tree, 3=Shelling %, 4=Pod inf. %, 5=% SIIP, 6=% SIHP, 7=NSIP, 8=NSHP, 9=Wt 100-HSIP, 10=Wt 100-ISIP, 11=Wt 100-HSHP,12= Wt 100-ISHP Values of 2005 are above diagonal; Values of 2006 are below diagonal; * P<0.05, ** P<0.01.

infested seeds in both infested and healthy pods and infestation was more in the first year. About 20% seeds in infested pods were infested, whereas in healthy pods seed infestation was 6% in the first year and reduced to about half in the second year. Number of rainy days (20 in each year) and amount of rains (283 mm in 2005 and 270.4 mm in 2006) were almost same, but in 2006 rains were late and 2/3rd of it was in August. Rains during the later part of the monsoon may be helping in better pod and seed yield, less pod and seed infestation and better seed size. In the desert, late monsoon reduces the yield of the annual crops, but this situation may be beneficial for the perennial components.

The correlation coefficient of tree morphological traits, pod length, pod yield, seed yield, shelling percentage and pod infestation are given in Table 3. There was positive and significant association of height with collar diameter and dbh, collar diameter with dbh and canopy diameter during both the years. Pod yield and seed yield had positive association with tree height and collar diameter but it was significant only during the second year. Shelling percentage did not show any significant correlation with any of the characters. Pod infestation had negative relationship with pod yield and seed yield in both the years but this relationship was highly significant only during the first year. In 2005, negative correlation was observed between number of seeds in infested pod with pod yield, seed yield and pod length, however, in 2006 all these associations were the other way i.e. positive. Significant correlation of number of seeds in infested pods was observed in 2005 with shelling percentage and pod infestation.

The relationship of pod yield, seed yield, pod infestation, seed infestation and 100 seed weight are presented in Table 4. Pod infestation had negative association with pod

Table 5. Correlation coefficients of different parameters with values of previous year

Tree morphological and seed yield		Pod and seed infestation	
Character	'r' value	Character	'r' value
Tree **height**	0.57*	Pod inf. %	0.66**
Collar **diameter**	0.58*	% SIIP	0.17
dbh	0.53*	% SIHP	0.33
Canopy diameter	**0.76****	NSIP	0.61*
Pod length	**0.43**	NSHP	0.50
Pod yield/tree	**0.31**	Wt. 100-HSIP	0.47
Seed yield/tree	**0.35**	Wt. 100-ISIP	0.09
Shelling %	0.11	Wt. 100-HSHP	0.75**
		Wt. 100-ISHP	0.15

yield and seed yield in both the years but this association was significant during 2005 only. Per cent seed infestation in infested pods showed negative and significant association with number of seeds per infested pod and 100 infested seed weight of infested pods during first year only. Per cent seed infestation in healthy pods had negative association with pod yield and seed yield during both the years, but this was significant only during 2006. The other important positive and significant association was of seed infestation in healthy pods with pod infestation during 2006 only. Number of seeds in infested pods had negative relationship with pod yield, seed yield, number of healthy seeds per pod and per cent seed infestation in infested pods. The association of number of seeds in infested pods with per cent seeds infested in infested pods was significant and negative in 2005. Number of seeds in infested pods did not show any significantly association with 100 seed weight of healthy and infested seeds in both types of pods i.e., infested and healthy during 2005. However, weight of 100 infested seed in healthy pods had significant association with number of seeds/ pod in infested and healthy pods. Though there were differences in pod yield, seed yield, shelling percentage, pod infestation, per cent seed infested in healthy seeds and some seed related traits over the years, but the genotypes which performed better or poor performed the same way in the next year showing that performance of the trees was influenced more by the genotype rather than the environmental conditions. With this view the relationships of parameters with values of previous years were worked out which are given in Table 5.There was positive association for all the characters but it was significant for tree morphological traits, pod infestation, number of seeds per infested pod and weight of 100 healthy seeds of healthy pods. The positive and significant association of the values of pod infestation and number of seeds in the infested pod with values of previous year may be due to the concentration of secondary metabolites in the pods and seeds causing resistance to the bruchids. Similar observations have been reported by Solbrig and Cantino (1975) in *Prosopis* species.

In the present study two bruchid species i.e., *Bruchus bilineatopygus* Pic. and *Caryedon serratus* Olivier were found to

infest *A. senegal* seeds. *C. serratus* was observed to be dominant than *Bruchus bilineatopygus* with occurrence of 3:2 ratio. Vir and Jindal (2000) have reported infestation of *A. senegal* seeds by *B. bilineatopygus* Pic. only. Jamal (1994) reported *Bruchus baudni* Caill (Bruchiae) as pest on seed of *A. senegal* in Sudan. Sary and Some (1990) reported holes in valves, malformation of seeds and evidence of parasitism by bruchid larvae and adults in the pods of *A. senegal* collected from different sites in Burkino Faso. *C. serratus* has been reported to cause severe losses to seeds of many *Acacia* species (Singh and Bhandari,1987; Singal and Toky, 1990).

Overall EC 87/7490, a collection from Niger, showed more than 30% survival after 17 years of establishment with more than 1.5 kg seed yield per tree, better shelling percentage and moderate pod infestation, minimum seed infestation and can be directly exploited. The variation present in the material among individual trees can be used for population improvement, better survival, and more seed yield and minimum pod/seed infestation due to bruchids.

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