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STUDIES ON REPRODUCTIVE ABSCISSION AND SEED YIELD OF MUNGBEAN (*VIGNA RADIATA)* IN SUB-HUMID SAVANNA OF NIGERIA

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ABSTRACT

A field study was conducted on the Research and Experimental Farm of the University of Agriculture Makurdi (7°41'N, 08°37'N, and 400 m above mean sea level), Nigeria, in 2001 and 2002 to examine the abscission of reproductive structures in mungbean (*Vigna radiata*). Four exotic cultivars (VC 2768A, VC 1178A, VC 2778A and VC 1973A) and a local cultivar (Ex–Zaria) were used for the study, which was laid out in a randomized complete block design and was replicated four times. Grain legumes generally undergo considerable abscission of their reproductive structures during flowering and fruiting stages. In this study the abscissions of flowers and pods differed widely among the cultivars. The abscissions of flowers and young pods varied from 14.4 to 36.8% and 12.3 to 38.5%, respectively. The number of flowers and harvestable pods per plant also varied from a high of 77.2 and 48.8 in VC 2768A to a low of 49.1 and 24.0 in VC 2778A, respectively. Conversely, young pods varied in number from 56.0 in VC 1973A to 38.9 in VC 2778A. In all the cultivars, more flowers occurred at the bottom of the canopy where abscission was also highest. The cultivar VC 2778A had highest (50.8) percent total abscission compared to the lowest of 29.1percent in VC 1973A. Seed yield ranged from 541.67 kg/ha in VC 2778A to 2000.2 kg/ha in VC 2768A. Seed weight and the number of seeds per pod, however, did not vary significantly. There was a high positive correlation (r = 0.94) between flowers and harvestable pods. Seed yield also correlated positively with the number of flowers, harvestable pods, seed weight and the number of seeds per pod. This study has shown that reproductive abscission exists in mungbean but it is of less intensity when compared to other legumes. The lower rate of abscission coupled with low incidences of pests and diseases and high nutritive value make the crop a dependable source of protein for resource-poor rural farmers in the tropics.

Key words: Reproductive abscission, seed yield, mungbean

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INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilczek] is an ancient and widely used pulse crop, which originated from India and has not been widely domesticated in Tropical Africa [1]. On the African continent it is grown mainly in the East where it goes by such local names as ndengu (Kenya), chiroko and/or chikasano, kifudu (Uganda), kayensi (Zambia) and lubia chiroko [2]. In Nigeria, the crop was first introduced in Plateau State and other drier states in the North of the country because of its drought tolerance and short maturity period of 60-70 days [3]. It fixes nitrogen, and the dry beans contain 21-28% protein [4], which is higher than cowpea (23%), common bean (22%) and broad bean (23%) [5]. Mungbean is, therefore, a source of cheap dietary proteins and other nutrients.

Grain legumes generally undergo considerable abscission of their reproductive structures during flowering and fruiting stages. The extent of abscission has been put at more than 50% in most cases [5]. Workers familiar with particular legume crops have reported varying levels of reproductive abscission. Abscission rates of 43 to 81% have been reported in soybean and 48-76% in the common bean (*Phaseolus vulgaris*) [5, 6, 7]. Flower and pod shedding has also been reported in cowpea [8].

Low grain yield in legumes has been attributed to abortion of flowers and pods [9, 10]. Flower and pod abortions are generally ascribed to genetic causes, heat, wind, pests and diseases, competition for nutrients, light and sowing date [11]. As far as the authors are aware, no studies have been done on abscission of reproductive structures in the sub-humid savanna [12]. This is so because mungbean is relatively new to the West Africa region [13, 14]. Consequently, studies are being conducted to determine the possible yield limiting factors of mungbean in the humid savanna of Nigeria. Hence an experiment was conducted to determine flower and pod abscission levels and patterns in five commonly cultivated mungbean cultivars in Nigeria.

MATERIALS AND METHODS

The trial was conducted at a research farm located in Makurdi (7.41^{o}N, 8.37^{o}E, and located 94 m above sea level), Nigeria. Randomized complete block design with four replicates was used with plot size of 4 m x 3 m.

There were five treatments, viz: a local cultivar of mungbean (Ex-Zaria) and four exotic cultivars, viz: VC 2768A, VC 1178A, VC 2778A and VC 1973A. Seeds were planted in 50 cm rows at 10 cm within row. Plots were weeded twice at 2 and 6 weeks after planting (WAP). The insecticide 'Karate' was applied once during the reproductive phase at 0.8 l/ha to control insect pests, which contribute to flower and pod abortion in legumes.

The numbers of flowers and pods were determined by counting [11]. Just before flower initiation (4 WAP), 4 plants from a 2 m portion of four central rows of each plot were randomly selected and tagged for subsequent flower and pod count. During flowering (6-8 WAP), flowers were counted once every 3 days. Emerging flowers were marked with an oil base paint at the standard petal to avoid a repeat count in subsequent visits. The region of the plant- top, middle or bottom – at which the branches bearing the flowers originated were recorded. During pod formation (7-12 WAP), pods were counted every 5 days by touching the tips of all young pods not less than 2 cm long with an oil base paint. Pod location on the stem was also recorded.

At maturity (from 10 WAP), pods from the tagged plants were harvested, counted and weighed. Seeds obtained by threshing the pods were also counted and weighed. Two meter portions of the four inner rows in each plot were harvested and processed to get clean seeds. Flower abscission was estimated by subtracting the number of young pods produced from total number of flowers produced while pod abscission was determined as the number of young pods less the number of harvestable pods. Total abscission was obtained by summation of flower and pod abscission. Percentages of flower, pod, and total abscission were obtained by multiplying the appropriate values by 100. A combined analysis of variance was performed on all the characters due to existence of homogeneity of the error variance. Correlation analysis among characters was also carried out.

RESULTS

The cultivars exhibited significant differences in reproductive characters (Table 1). VC 2768A had the greatest number of flowers, young pods and harvestable pods, while VC 2778A had the least. Abscission of flowers and pods differed among cultivars. Flower and young pod abscissions were 14.4-36.8% and 12.3-38.5%, respectively. The contribution of flowers to total abscission was more than that of pods. The total abscission was 29.1- 50.8%. Though seed weight and number of seeds per pod did not differ significantly among cultivars, VC 2768A produced the highest seed yield of 2,000.2 kg/ha compared to 541.7 kg/ha produced by VC 2778A.

More flowers were formed at the bottom of the canopy in all the varieties, while the middle had the least (Figure 1). Similarly, more flowers abscised at the bottom than at the top. There was high positive correlation (r = 0.94) between flowers and harvestable pods (Table 2). Seed yield also correlated positively with number of flowers, harvestable pods, weight per seed and seeds per pod. The high positive correlation between flowers and harvestable pods confirms the low rate of abscission of these important structures, which determine agronomic yield in mungbean. The cultivar, VC 2768A, with highest number of flowers and harvestable pods gave highest seed yield, while VC 2778A with least reproductive structures gave the lowest seed yield (Table 1).

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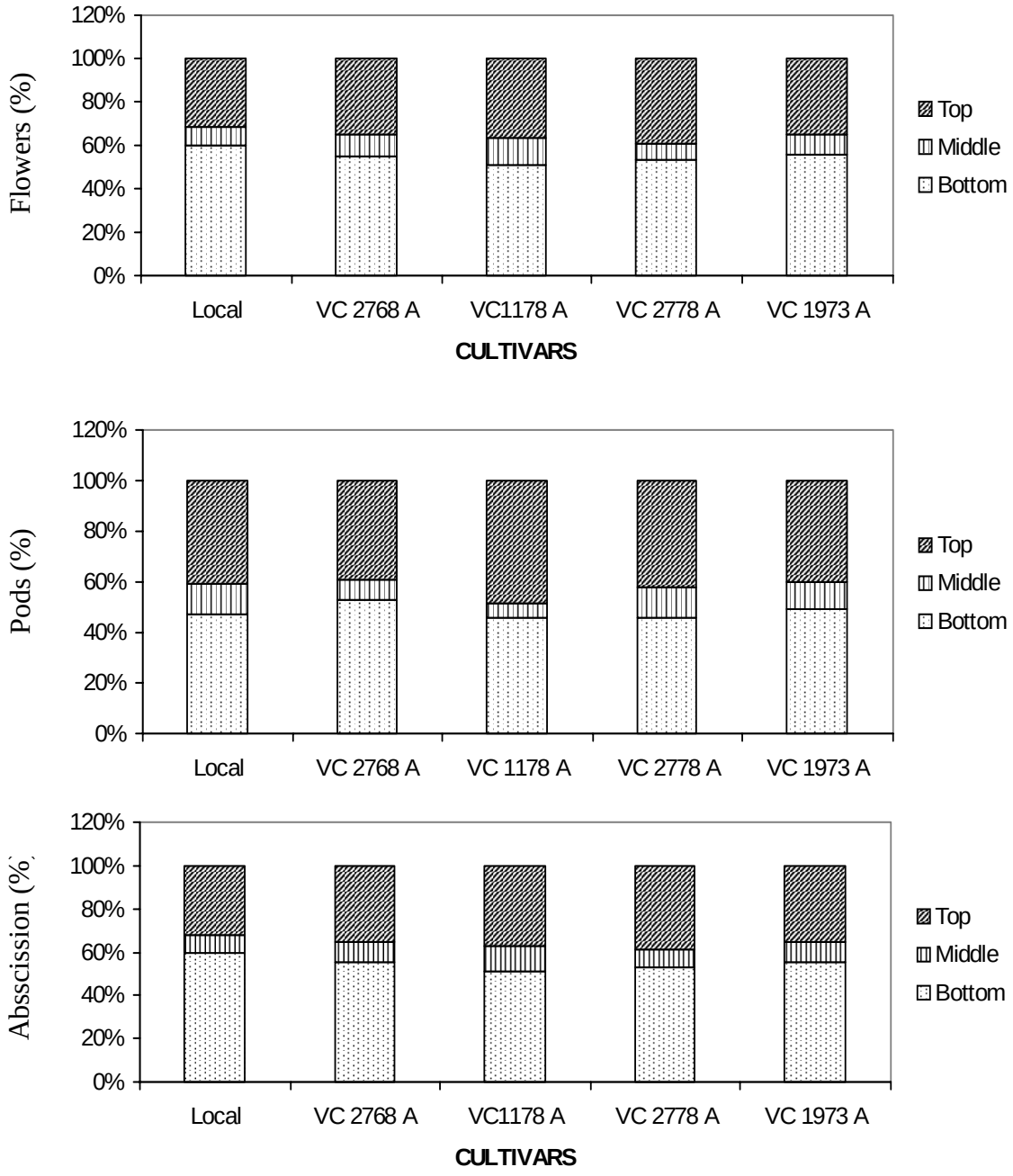

Figure 1: Production and abscission of reproductive structures in five mungbean cultivars grown at Makurdi in 2001 and 2002

DISCUSSION

The variation in the number of reproductive organs produced by the cultivars of mungbean may be attributed to genetic variability. Flower and pod abortions are generally ascribed to genetic causes among other factors. This finding is similar to that obtained for soybean [11]. The total abscission of 29.1- 50.8% obtained in this study is less than that reported for cowpea and soybean, in which the abscission levels were up to 70% or more [11]. Thus, the abscission of reproductive structures could be higher in other legumes than mungbean. This attribute could be insurance for stable seed yield production under varying environmental conditions when compared with other legumes [5, 6, 7].

More flowers were at the bottom of the canopy while the middle had the least. Similarly, more flowers abscised at the bottom than at the top. This pattern of abscission may be due to the amount of light available at each canopy region since irradiance is said to decrease with depth into the canopy [15].

The high positive correlation between flowers and harvestable pods on one hand and between seed yield and the number of flowers, harvestable pods, weight per seed and seeds per pod on the other, suggests that abscission of reproductive organs could reduce seed yield. Thus, if less number of flowers and pods abort there will be high seed yield. In soybean, however, higher rates of abscission were observed among cultivars producing higher number of reproductive structures, a trend attributable to more intense competition for assimilates by the reproductive structures particularly the developing pods [3, 11]. The near absence of such a trend in this study suggests that genetic influences are more pronounced in mungbean compared to soybean. Cultivars that produce high numbers of flowers and pods with low rates of abscission can be selected for increased seed yield.

CONCLUSION

This study has shown that reproductive abscission exists in mungbean. It is more pronounced at the bottom of the canopy. Cultivars which produce high number of flowers and harvestable pods produce high seed yield. Abscission of reproductive structures in mungbean is less compared to other legumes, especially cowpea, which may not be produced successfully without spraying with pesticides. The lower abscission coupled with low incidences of pests and diseases and the high nutritive value make the crop a dependable source of proteins for resource poor rural farmers in the tropics.

Table 1: Cultivar means for the various reproductive characters*

Cultivar	Plant Reproductive Characteristics											
	F	YP	HP	FA	%FA	YPA	%YPA	TA	%TA	WPS(mg)	SPP	Seed yield (kg/ha)
Ex-Zaria	64.0	40.6	34.6	23.4	36.8	6.0	13.6	29.4	45.9	115.0	9.0	891.7
VC2768A	77.2	55.8	48.8	21.5	26.9	7.0	12.3	28.5	35.6	103.0	10.0	2000.2
VC1178A	58.9	42.0	35.3	16.9	27.7	6.7	16.5	23.6	39.0	110.0	9.3	1075.0
VC2778A	49.1	38.9	24.0	10.2	17.4	14.9	38.5	25.1	50.8	115.0	9.0	541.7
VC1973A	65.8	56.0	44.8	9.8	14.4	11.2	17.3	21.0	29.1	104.0	9.6	1233.3
Mean	63.0	46.7	37.5	16.4	24.6	9.1	19.7	25.5	44.3	105.4	9.4	1148.4
F-LSD (.05)	16.4	7.7	11.4	3.9	8.2	5.5	19.6	5.2	8.1	NS	NS	279.9
CV (%)	11.3	7.1	13.1	10.5	14.4	25.8	13.0	8.8	7.5	6.0	5.1	10.2

Key

*F = flowers, YP = young pods, HP = Harvestable pods, FA = flower abscission, % FA = Percent flower abscission, PA = Pod abscission, %PA = percent pod abscission, TA = total abscission, %TA = Percent total abscission, SPP = seed number per pod, WPS = weight per seed

Table 2: Correlations among the various plant reproductive characters*

	F	YP	HP	FA	% FA	YPA	% YPA	TA	% TA	WPS	SPP	Seed Yield
Seed yield	0.907*	0.857	0.915*	0.327	0.006	-0.417	-0.628	0.134	-0.709	-0.879*	0.919*	-
SSP	0.824	0.950*	0.919*	0.064	-0.253	-0.219	-0.523	-0.124	-0.830	-0.973**	-	
WPS	-0.773	-0.994**	-0.911*	0.079	0.379	0.101	0.476	0.254	0.887*	-		
%TA	-0.667	-0.886*	-0.877	0.109	0.302	0.255	0.625	0.477	-			
TA	0.332	-0.222	-0.005	0.848	0.784	-0.485	-0.246	-				
%YPA	-0.831	-0.504	-0.792	-0.679	-0.553	0.895*	-					
YPA	-0.627	-0.113	-0.491	-0.875	0.833	-						
%FA	0.283	-0.351	0.019	0.940*	-							
FA	0.564	-0.055	0.295	-								
HP	0.942*	0.921*	-									
YP	0.794	-										
F	-											

* and ** - Correlation is significant at the 0.05 and 0.01 levels of probability, respectively

*F = flowers, YP = young pods, HP = Harvestable pods, FA = flower abscission, % FA = Percent flower abscission, PA = Pod abscission, %PA = percent pod abscission, TA = total abscission, %TA = Percent total abscission, SPP = seed number per pod, WPS = weight per seed

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