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A Preliminary Field Assessment of Mungbean (*Vigna radiata* L. Wilczek) Yield in the Rain Forest Zone of Southeastern Nigeria

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Abstract: Four mungbean accessions from the Asian Vegetable Research and Development Centre (AVRDC) were grown in a randomized complete block design in eight replicates from September to November 2003. Results showed a significant difference in the yield of the varieties with VC 6372 (45-8-1) producing the highest seed yield of 0.53 t/ha. This was followed by NM 92, 0.48 t/ha; NM 94, 0.40 t/ha; and VC 1163 with 0.37 t/ha. The variety, VC 6372 (45-8-1), also formed good agronomic characters. None of the varieties were affected by *Cercospora* leaf spot disease. Some insects commonly associated with legumes in the region were observed at various growth stages . The conclusion is that the new pulse crop has demonstrated substantial promises in growth and yield characteristics to warrant further trials in other seasons and locations in the humid forest zone of southeastern Nigeria.

Key words: Adaptability · Food security · Genotypic evaluation · Grain legume · Mungbean · Rain forest agro-ecology

INTRODUCTION

Legumes are important in farming systems because of their significant role in human nutrition and soil fertility improvement [1]. Its cultivation in the degraded forest region of southeastern Nigeria has been stressed by various groups [2, 3]. Although cowpea (*Vigna unguiculata*) and more recently, soybean (*Glycine max*) are widely appreciated in the region, their cultivation in the region is not widespread because their optimal planting dates scarcely fit into the existing cropping calendar. This adversely affects availability, affordability and accessibility of grain legumes that most people in southern Nigeria rely on, to meet their body protein requirements [4, 5].

In search of suitable alternatives, Agugo [6] reported possible introduction and adoption of a low-input requiring, quick -growing, short- duration Indian subcontinent-originated mungbean (*Vigna radiata*). The crop fixes nitrogen and is adaptable to marginal conditions and therefore fits well into different cropping systems [7]. It is an excellent source of easily digestible protein [8]. Previous agro ecological assessment studies demonstrate that the conditions of the rain forest of southeastern Nigeria are suitable for mungbean production [9]. The crop has an average potential grain yield of 3.5 t/ha in the region [10]. These empirical results require validation. These will consist in matching the outputs from simulation models (theoretical yield) with the actual or realized yield obtained from trials in the field.

According to Doorenbos and Kassam [11], most crops offer varieties which vary in their general and specific requirements, allowing the crop to be adapted to a wide range of climatic conditions and to the period required and available for production. Information on yield performance of mungbean in the degraded forest region of southeastern Nigeria is scarcely available. The present work was therefore designed to obtain a preliminary assessment of mungbean genotypes obtained from AVRDC Taiwan, under actual field conditions of the region.

MATERIALS AND METHODS

A field experiment was conducted at the western block of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, a humid forest agro ecology of southeastern Nigeria.

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Table 1: Climatic parameters of Umudike during the trial period.

		Temp (°C)		RH (%)		
Weeks	Total rainfall (mm)	Max.	Min.	Max.	Min.	Sunshine (hrs)
1	20.5	31.0	22.6	83.0	75.0	2.7
2	5.2	31.0	22.9	76.8	70.4	5.7
3	62.0	31.0	22.8	82.0	75.0	4.9
4	49.1	31.8	22.6	78.7	75.3	5.5
5	63.8	31.1	19.4	82.0	69.4	4.7
6	38.2	31.4	21.9	79.7	79.0	5.3
7	16.3	31.3	22.2	81.7	70.0	3.9
8	00.0	32.1	23.0	78.7	58.3	6.8
9	14.7	32.9	22.9	78.8	60.1	6.0
Mean	30.0	31.5	22.3	80.2	70.3	5.1

The climatic parameter of the area is shown in Table 1. The soil is a well drained sandy loam classified as Ultisol [12] and categorized in the soil taxonomy group of Typic Paleudult [13]. Some chemical characteristics of the soil were: pH 4.38, organic matter 1.73% total N 1.70 g/kg, available P 13 mg/kg, exchangeable K 0.09 cmol/kg and C:N ratio of 9.82.

Four mungbean varieties viz: NM 92, NM 94, VC6372 (45-8-1) and VC1163 obtained from the Asia Vegetable Research and Development Centre in Taiwan ROC constituted the treatment. The layout was a randomized complete block design (RCBD) with eight replications. The land was ploughed and harrowed into fine tilth and the soil packed into raised beds. Plot size was 5m x 2m with spacing of 50cm between rows and 10cm between hills. Three seeds were sown per hill on the 29th of September and seedlings were thinned to 2 plants per hill, giving a population of 400,000 plants per hectare.

Weeding was carried out once manually before flowering and neither fertilizer nor pesticide was used. Ten plants were selected at random from each plot for data collection. Data recorded included days to flowering, days to maturity, plant height at maturity (cm). At maturity, 5 plants in each plot were labeled, from which pods were harvested and threshed for yield determination. Parameters recorded included pods/plant, pod length (cm), seeds/pod, grain yield per plant (g); 100-seed weight (g), biological yield (kg/ha) and grain yield (kg/ha). Harvest index was computed as the ratio between sum of seed dry weights of all three picks and the total plant dry weight at final harvest, which included the pod weight from all picks. Data was subjected to Analysis of Variance (ANOVA) and means compared at 5% probability level using Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Growth Parameters: There was significant difference in days from emergence to flowering among the genotypes ranging from 32 days for NM 92 to 34.1 days for VC 1163 (Table 2). A mean of 33.09 days appears to be earlier compared to mungbean grown in Asia, where minimum of 36 days and a mean maximum of 63 days are prevalent in Taiwan [14]. Similarly, number of days to maturity differed significantly with a mean of 52.9 days. NM 92 matured in 51.1 days, while VC 1163 matured in 54.1 days.

The mean final plant height of all genotypes was 23.8 cm. The shortest variety of 19.6 cm was recorded for VC 1163, while the tallest of 28 cm was observed for VC 6372 (48-8-1). Similar significant difference between legume cultivars for plant height has been reported by Boerma [15].

Yield and Yield Components: Mungbean genotypes also exhibited significant differences in yield and yield components (Table 3). While VC 6372 (45-8-1) produced the highest number of pods of 10, VC 1163 exhibited the shortest pod length of 5.2 cm. It can be observed that VC 6372 (45-8-1) which produced the largest pod mass also yielded the greatest number of seeds of 9.6 per pod. The other genotypes did not significantly differ in the number of seeds per pod. A mean seed weight as indicated by 100 seed weight of 5.5 g is comparable to the seed wight of premium grade of mungbean produced in Taiwan [16]. Interestingly, the highest yielding variety produced the smallest seed wight. This contrasts the findings of Moregham [17] who associated larger seed wights with higher yields.

Table 2: Growth characteristics of mungbean genotypes in Umudike.

Genotype	Final plant height (cm)	Leaf number	Days to flowering	Days to mature pod
NM 92	21.50	4.87	32.00	51.10
NM 94	26.00	5.37	33.00	53.00
VC 6372 (45-8-1)	28.00	6.00	33.20	53.30
VC 1163	19.63	4.75	34.10	54.10
Mean	23.78	5.25	33.09	52.87
$LSD_{(0.05)}$	2.80	NS	1.60	1.60

Table 3: Yield and yield components of mungbean genotypes in Umudike.

Mungbean Genotypes	No od pods $plant^{-1}$	Length of pod (cm)	No of seeds/pod	100-seed wt (g)	Pods yield/ plant (g)	Seed yield / plant (g)	Seed yield tha^{-1}
NM 92	8.70	6.27	8.87	5.20	2.90	2.50	0.48
NM 94	8.70	5.67	81.00	5.70	2.50	2.00	0.40
VC 6372 (45-8-1)	10.00	6.56	9.60	5.30	3.30	2.70	0.53
VC 1163	7.30	5.20	7.60	5.60	2.20	1.90	0.37
Mean	8.68	5.90	8.60	5.42	2.76	2.27	0.46
$LSD_{(0.05)}$	0.99	0.37	1.06	0.28	0.36	0.36	0.06

In terms of seed yield VC6372 (45-8-1) significantly out yielded NM 94 and VC 1163. Mungbean mean seed yield of 0.46 t/ha in this preliminary study appears promising given the average yield of 0.49 t/ha in farmers' fields in the Asian region [18]. However, the mean yield of 0.46 t/ha in these genotypes evaluation is too low as against potential yield of 3.4 t/ha obtained through a simulation modeling in Umudike for the same period of cultivation[10] suggesting a production efficiency of only 14%. Nonetheless, the mean yield of these genotypes can be enhanced to 2.56 t/ha within this period of cultivation by improvement in the management practices in line with the concept of Imerie and Shanmugasundaram [19] on sources of variation in mungbean yield. Additionally, improvement of the genotypes for greater adaptability would contribute to grain yield increase of about 0.88 t/ha.The significantly low yield of 0.37 t/ha recorded for VC 1163 probably suggests weak adaptation of this genotype to field conditions of Umudike during September to November trial period. Mean seed yield of 0.46 t/ha recorded in the experiment is also far below 2.7 t/ha obtainable during the summer season at AVRDC plot in Taiwan [14]. It is also lower than the 2.5 t/ha reported to be the experimental yield in the Asian region [20].This may be explained in the following ways: firstly, the summer is a season of higher solar radiation that gives a plant possibilities of higher photosynthetic rates whereas the period of September and October are months of moderately high light intensity while November is a month of relatively low light intensity in the humid tropics. Ezedinma [21] observed that in the humid tropics, the insolation could be poor compared to the subtropical region. The weekly mean daily sunshine duration during the growth period ranged from mere 2.7 to 6.8 hours per day. Thus, low insolation during crop growth might be a cause of poor growth rates and eventual poor yields. Under limiting light, high rates of photosynthesis are impossible and the capacity of electron transport, adenosine triphosphate (ATP) synthesis and carbon assimilation are reduced.

Secondly, the lowest seed yield could be a result of inadequate rainfall regime during the vegetative and pod filling stages. Poehlman [22] showed that mungbean requires monthly rainfall of 50 to 84 mm, while Muchow [23] indicated that frequent irrigation with 50 -60 mm of water during each irrigation at weekly intervals in a wet regime produced the highest grain yield in mungbean. It could be observed that rainfall at 6^{th}, 7^{th} and 8^{th} week of growth were 36, 16.3 and 0.00 mm, respectively (Table 1), corresponding to the periods of pod development and maturity. Moreso, water supply during the 2^{nd} and 3^{rd} weeks after sowing and during the pod filling and maturity stages, were probably below the crop's water requirements. This was worsened by the poor moisture storage capacity of the soil, which is dominated by sand fraction with its high void ratio and macro porosity [24]. High seed yield in mungbean occurs where moisture is available during vegetative period as well as flowering and pod filling [25]. The process of photosynthesis is highly sensitive to water deficit [26].

Table 4: Stover and harvest index of Mungbean genotypes in Umudike.

	Residue Dw plant (g)	Residue Dw (t/ha)	Husk/plant (g)	Harvest index without leaves
Nm 92	6.20	1.25	0.50	0.32
Nm 94	5.50	1.10	0.45	0.28
VC 6372 (45-8-1)	6.30	1.27	0.59	0.34
VC 1163	6.50	1.33	0.41	0.25
Mean	6.20	1.20	0.41	0.29
$LSD_{(0.05)}$	0.85	0.17	0.07	0.015

Dw - Dry weight

Limited water supply probably restricted canopy development and reduced crop growth rate through its adverse effects on various morphophysiological processes [23, 27, 28]. Soil moisture stress reduces the number of pods and dry weight of seeds [29], seeds per pod and seed yield [29, 30]. Generally at pod filling stage, most assimilates produced by the plant are used for pod filling so that reduction in net photosynthesis due to perhaps soil moisture deficit at this time must have reduced the amount of assimilates available for pod filling and hence the low yield. This might be very important for a grain legume like mungbean that depends much on current carbon account (assimilate) for pod filling [31].

Thirdly, the lowest seed yield may also be in response to the environment x genotype interaction since it has been reported that legumes moved to latitudes lower than that of their origin develop with a shortened vegetative phase [32]. Shortened vegetative phase means that accumulated dry matter may be too small to partition a substantial quantity to the seeds. It is also likely that there was a temperature effect. The crop duration coincided with the period of relatively high temperatures with mean monthly maximum and minimum of 32.1°C and 22.6°C, respectively. Choudhury *et al.* [33] found that a maximum and minimum of 29.5 and 21.1°C were optimum for pod development and maturity of mungbean for high yields. Newaj *et al.* [34] showed that optimum yield of mungbean was drastically reduced beyond 30°C.

It was noticeable that all the genotypes had similar number of leaves at the peak of vegetative and flowering stages, while their ultimate grain yields differed. Similarly, the final dry weights of the stover of all the genotypes were somewhat alike with a general mean of 1.2 t/ha (Table 4). This seems surprising as mean seed yield and harvest index differed significantly. The genotype VC 1163 that produced the largest biomass dry weight produced the least seed yield and lowest harvest index. This indicated that not much of the photosynthate was partitioned to main economic part to make significant contribution to seed yield and harvest index. This observation supported the earlier indication that VC 1163 showed weak adaptation. Shibles [35] described a crop well adapted to its environment as one that efficiently balances the time available for growth between producing an adequate vegetative structure and maximum partitioning of assimilate to yield. The seeming inability of these genotypes to transfer equally, large biomass into seed yield indicated that these genotypes probably had different photosynthetic and translocation rates. Kuo *et al.*[36] reported some genetic variability in photosynthetic rates among higher yielding Mungbean (*Vigna radiata*).

Although mungbean is new to Umudike environment the plants did not lodge at maturity. Viral and other diseases were minimal. This may be because the trial period was not during the high rainfall peak when high relative humidity induces the growth and proliferation of pathogens. However, a number of insects usually associated with other legumes were observed during the study. Such insects included the adult stages of *Dysdercus superstitious* and *Mixen jaculus* known to feed on the foliage of legumes, the nymph and adult stages of *Nazera viridula* and *Claviralle tomentosicllus* that attack legume pods.

Although, the stover left after pod harvest was not analyzed, it is likely to contribute to amelioration of an already degraded soil of the region through organic matter inputs, mineralization and release of nutrients and fixed nitrogen.

CONCLUSION

Mungbean evidently flourished under hot humid conditions that prevailed between September and November in Umudike - a lowland rain forest zone of southeastern Nigeria. The average seed yield of 0.46 t/ha obtained appears promising enough to justify further trials in other seasons of the year so as to establish standard agronomic practices necessary for high seed yield and improved production of mungbean in the region.

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