Phosphorus use efficiency and amino acid composition of different greengram (*Vigna radiata L.*) from Myanmar

Myo Kywe[1], Andreas Buerkert[2] ✉, Maria Finckh[3]

[1]Department of Agronomy, Yezin Agricultural University, Myanmar
[2]Organic Plant Production and Agroecosystems Research in the Tropics and Subtropics, Institute of Crop Science, University of Kassel, Witzenhausen
[3]Ecological Crop Protection, University of Kassel, Witzenhausen
✉ buerkert@uni-kassel.de

Figure 1. Map of Myanmar.

Introduction

'Greengram is an important short-season grain legume and part of the staple diet of man and livestock all over S.E. Asia. Throughout the year, greengram is an important component of the rice-based cropping system in Myanmar, where legumes cover about 8.5% of the total cultivated area. The demand for greengram is partly rooted in its high seed protein, which ranges between 19 and 29%, and in its high concentration of lysine, the first limiting amino acid in cereal proteins for humans and monogastric animals. In Myanmar, the current green gram grain yields of around 800 kg ha^{-1} are significantly below the reported yield potential (around 3000 kg ha^{-1}) for this crop, and little is known about the reasons for this shortfall. Cultivars with high phosphorus (P) use efficiency (with respect to both uptake and translocation) would be particularly valuable in Myanmar where mineral P fertilizers are scare. The objectives of this study were (i) to examine differences in P efficiency between greengram varieties and (ii) to analyze the amino acid composition in greengram seed of different origins.

Materials and Methods

From 2001 to 2003 experiments were conducted under rainfed conditions at Yezin and Nyaung Oo in Myanmar (Fig. 1). Five introduced cultivars (a-V-3726, b-Yezin-4, c-VC-5205A, d-Kanti, e-Myakyemon) and fifteen landraces (f-Yegyi-Kangoo, g-Myaung, h-Gangaw-7375, i-Yinmarbin, j-Gangaw-4187, k-Pakhoku, l-Gangaw-7380, m-Magwe, n-Khinoo, o-Ayadaw, p-Kyemon, q-Thawatti, r-Nyaunglaybin, s-Mahling, t-Pauk) were grown at Yezin Agricultural University Farm at two P fertilization intensities (0 and 15 kg P ha^{-1} applied). A split-plot and factorial designs with three replications were used with P application as the main plot factor and cultivars randomly attributed to subplots. Total dry matter (TDM) as well as shoot and grain yield obtained from the experiment were subjected to analysis of variance. Amino acids in the seed were also determined.

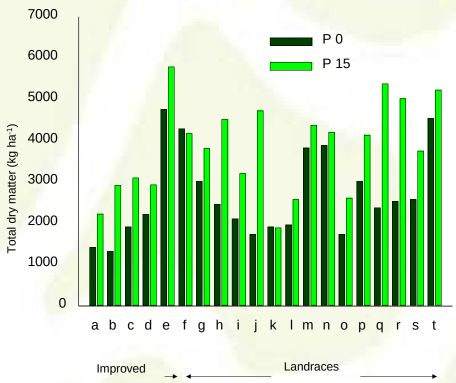

Figure 2. Total dry matter of 20 greengram cultivars from Myanmar grown in a field experiment at Yezin, Myanmar 2001 (0 and 15 kg P ha^{-1} as TSP).

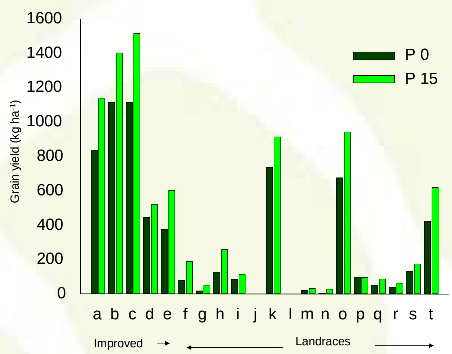

Figure 3. Grain yield of 20 greengram cultivars from Myanmar grown in a field experiment at Yezin, Myanmar 2001 (0 and 15 kg P ha^{-1} as TSP).

Results and Discussion

Significant differences ($P < 0.001$) in TDM were found between cultivars and P levels. There also was a significant interaction ($P < 0.001$) between cultivars and P. The grain yield of VC-5205A was highest followed by that of Yezin-4 and V-3726. The analyses showed large genotypic variation in the amino acid composition of the ten greengram cultivars with Gangaw-4187, Magwe and Mahling having highest lysine concentrations (Table 1).

Table 1. Amino acid concentrations (g 100 g^{-1} protein) of seven landraces greengram cultivars from Myanmar, 2001.

Amino acid (mmol g^{-1})	V-3726	VC-5205	Yezin-4	Ayadaw	Mahling	Thawatti	Nyaunglaybin	Magwe
Aspertate	204	185	202	242	253	245	193	256
Glutamate	281	280	278	332	357	334	255	350
Serine	116	116	114	135	142	134	110	142
Histidine	44	43	43	51	52	51	40	53
Glycine	123	124	131	144	165	152	122	164
Theonine	72	71	71	80	85	81	63	45
Alanine	118	117	117	136	144	136	110	144
Arginine	87	85	84	105	108	105	80	109
Tyrosine	34	33	34	40	44	42	42	32
Cystine	5	5	5	5	6	5	4	5
Valine	112	109	115	131	135	132	104	137
Leucine	148	288	143	174	180	174	137	179
Lysine	117	115	76	134	144	139	110	146
Proline	90	91	91	107	108	105	84	113
Protein%	35.8	41.2	34.3	48.4	35.4	35.9	35.9	35.7

The field experiment showed a large genotypic variation in the P response of TDM and pod yield of greengram (Fig. 2 and 3). This variation was, however, not reproducible in the pot experiment. This could be due to differences in soil properties, but also to the lower light intensity and temperature and the restricted soil volume in the greenhouse compared to the field conditions in Myanmar. Another reason may be genotypic differences in root growth that did not become apparent in the pot experiment with its restricted soil volume. The high lysine concentration in the Mahling, Gangaw-4187 and Magwe landraces were likely related to their lower seed yield. Genetic variation in lysine concentration is certainly important for future breeding programmes. However, it remains open to further investigation, how large genotype x environment interactions are for this trait.

Conclusions

This study indicated large genotypic differences for the effects of P application on shoot and root growth of greengram. Higher grain yields were observed for improved cultivars compared to landraces. Myakyemon, Kanti and Pakhoku cultivars should be grown in Nyaung Oo while V-3726, VC-5205A and Ayadaw should be grown in Yezin. The particularly high lysine concentrations in the Myanmar landrace cultivars Gangaw-4187, Magwe and Mahling makes this germplasm interesting for quality breeding in this important food legume.

Acknowledgements

We want to thank the German Academic Exchange Service (DAAD) for funding this study.

organicagriculturalsciences UNI KASSEL