SEARCH OF MUNGBEAN (Vigna radiata (L.) Wilczek) GENOTYPES FOR OPTIMAL AND SUB-OPTIMAL NITROGEN LEVELS

Author
Hossain, Md. Altaf

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Mungbean is a pulse crop under leguminous species, grown principally for its protein rich edible seeds. The species is a C$_3$ plant originated in the India-Burma region of Asia. Due to its rapid growth and early maturity, mungbean is adopted to multiple cropping systems in the drier and warmer climates of the lowland tropics and sub-tropics (Yohe and Poehlman, 1972). Mungbean contains about 23.9 percent protein with protein efficiency ratio of 2.12, digestibility of 81%, biological value of 70% and net protein utilization of about 46%. Mungbean is rich is lysine which is generally low or deficient in cereal.

Although mungbean has a number of advantages in terms of food value, production and crop management, the area and production is not increasing proportionately as compared with other cereals. However, in the recent years mungbean has registered a steady growth in production as well as area under cultivation in Bangladesh (Hamid, 1988). Now, among the pulses, mungbean ranks 3rd in terms of area and production in Bangladesh. It occupies an area of 0.453 M ha producing 0.31 M t of dry grain annually.

The crop can be grown almost throughout the year. The inclusion of legumes in crop rotations has numerous benefits including breaks of pests and diseases, increasing N content of soils, and enhancing subsequent cereal yields. However, the yield of mungbean is generally low. The high yield potential of mungbean in the well-managed research field and farmers’ field are 2.0 and 1.0 t ha$^{-1}$ respectively, although actual yield in farmer-managed field is only about 0.5 t ha$^{-1}$ (Anonymous, 1972).

With the advent of high yielding varieties of rice and wheat the production of cereal crops increased dramatically during the past four decades with the concomitant decrease in area and production of pulses. In view of the growing demand of the cereal crops it is unlikely that the HYV cereals would give way to pulses like mungbean. In Bangladesh, extensive cultivation of mungbean is constrained by strong competition with rice, particularly during wet season.

Development of mungbean varieties is viewed in two different perspectives. While the marginal land with low-nutrient environment will remain the major production area in Bangladesh in the foreseeable future, it is probable that the crop will occupy some productive lands where the cropping systems profitably accommodate mungbean as cash crop (MOA, 2000). Therefore, varieties that fit in the low productive zone may not serve the purpose of nutrient-rich commercial enterprises. To maximize yield under low-nutrient conditions the challenge is to maximize nutrient uptake and to optimise the use of the elements among competing processes. The exploitation of plant genetic variation to increase the efficiency with which plants absorb and use nutrients has been increasingly emerging as an alternative approach towards low nutrient environments.

On nutrient deficient soils, the traditional approach is to change the soil to fit the plant, i.e. fertilizers and other soil amendments are applied to increase soil fertility and/ or to make soil nutrients available for plant uptake. The exploitation of plant genetic variation to increase the efficiency with which plants absorb and use nutrients has been increasingly emerging as an alternative approach towards low-nutrient environments (Gunawardena et al. 1992).

Islam (2003) evaluated five hundred mungbean genotypes for their tolerance to excess soil moisture. Islam (1994) evaluated seventy-seven mungbean genotypes of diverse origin for yield potential. Earlier, Tickoo et al. (1996) worked with 418 accessions and 130 breeding lines of the AVRDC and evaluated the variations in 14
characters including morphological traits and disease reactions. But the work on the genetic variations in adaptability under low and high-nutrient environments has not been reported so far.

Therefore, three experiments were carried out to gain an understanding of rooting and nutrient uptake behaviour of selected mungbean genotypes under sub-optimal nutrient environments; to evaluate the productivity and nitrogen uptake behaviour of mungbean genotypes under sub-optimal and optimal nutrient environments and to study the nitrogen uptake kinetics and use efficiency of mungbean genotypes under sub-optimal and optimal nutrient environments. In this paper only the results of the third experiment is discussed.

Materials and Methods

Two mungbean genotypes viz. GK 3, IPSA 25 formed the treatment variables in the experiment. The genotypes were raised under high (N=154 ppm) and low (N=34 ppm) nitrogen levels.

The seeds were sown on 9 September 2001. In all cases, nine uniform seeds of each genotype were germinated in net bag filled with vermiculite. When root extension was sufficient to allow satisfactory transfer (c. 14 day), 9 uniform plants were transferred to individual containers holding high and low N solutions which were reduced to 3 plants per 20liter container at 21 DAE. Two extra pots were monitored to ensure that no N was lost from solution by denitrification.

Solution pH was adjusted to 6.5. The solution in the pot was sampled continuously @ 5 ml every 30 minutes for 5 hours following plant transfer to the solution at 21, 35, 49 and 63 DAE. N content in the sample solution was measured colorimetrically by using double beam Spectrophotometer (Hitachi: model 200-20) at 625 nm.

One plant from each pot was harvested at 21, 35, 49, and at 63 DAE for growth analysis and determining N use efficiency. Harvested plants were separated into root, stem, leaf, petiole and seeds and were dried at 70°C till constant weight was attained. Dry weight of individual plant parts was measured to evaluate partitioning of dry matter in the plant. Nitrogen content of plant parts at vegetative, flowering, pod filling and at maturity stage were assayed by chemical analysis and N uptake were determined by multiplying the N content by dry weight.

Nitrogen use efficiency is was determined following Moll et al. (1982). They defined N use efficiency as unit of grain production per unit of N available in the soil (Gw/Ns). Two primary components of N use efficiency are expressed as follows: uptake efficiency = Nt/Ns and utilization efficiency = Gw/Nt, where Nt is total N in the plant at maturity.

The data (all in mg/plant) served for analysis were Gw = grain weight, Nt = total aboveground plant N at maturity, Nv = total aboveground plant N at flowering, Na = Nt-Nv = aboveground plant N accumulated after flowering, and Ng=N accumulated in the grain at harvest.

Analysis of variance was computed for these five traits. Contribution of the various components to variation among genotypes in efficiency of N use at each level of N fertilizer was determined by sums of squares and sums of products of log ratios of genotype means as outlined above in the previous section.

Results and Discussion
Analysis of variance showed significant differences in N use efficiency among genotypes between N levels for all five primary traits. Both the genotypes (GK 3 & IPSA 25) were less efficient in N use at the high level of N supply (Table 1). Differences in N use efficiency (Gw/Ns) among genotypes appear to have been due to a number of factors. Even relatively inefficient genotypes may be average for one or more of the component factors. Furthermore, genotypes with comparable high levels of N use efficiency may differ markedly in the way that level of efficiency is achieved (Berendse and Aerts, 1987). GK 3 was relatively efficient at both levels of N supply and between two genotypes. IPSA 25 was relatively low in uptake efficiency, but it was highly efficient in utilizing the N taken up in grain production (Gw/Nt) at high N level. It was also above average in the fraction of total N that was translocated to grain (Ng/Nt).

Interaction of genotypes and N rate was significant for all traits except utilization efficiency (Gw/Nt), Gw/Ng, uptake efficiency (Nt/Ns), N taken up after flowering (Na/Nt) and Ng/Na. Causes of variation in N use efficiency in terms of component factors appear to differ between levels of N supply and among genotypes (Capuro and Voss, 1981; Ghildiyal and Sirohi, 1986).

Table 1. N use efficiency and components of N use efficiency of mungbean genotypes at two N levels

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Gw/Ns</th>
<th>Nt/Ns</th>
<th>Gw/Nt</th>
<th>Ng/Nt</th>
<th>Na/Nt</th>
<th>Ng/Na</th>
<th>Gw/Ng</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS</td>
<td>31.56</td>
<td>20.58</td>
<td>15.33</td>
<td>0.55</td>
<td>0.12</td>
<td>0.84</td>
<td>27.97</td>
</tr>
<tr>
<td>IPSA25</td>
<td>28.62</td>
<td>18.79</td>
<td>15.23</td>
<td>0.53</td>
<td>0.79</td>
<td>0.67</td>
<td>28.84</td>
</tr>
<tr>
<td>Mean</td>
<td>30.09</td>
<td>19.69</td>
<td>15.28</td>
<td>0.54</td>
<td>0.46</td>
<td>0.75</td>
<td>28.40</td>
</tr>
<tr>
<td>GS</td>
<td>18.77</td>
<td>29.89</td>
<td>6.28</td>
<td>0.24</td>
<td>0.90</td>
<td>0.26</td>
<td>26.48</td>
</tr>
<tr>
<td>IPSA25</td>
<td>16.19</td>
<td>12.18</td>
<td>13.29</td>
<td>0.49</td>
<td>0.80</td>
<td>0.62</td>
<td>26.95</td>
</tr>
<tr>
<td>Mean</td>
<td>17.48</td>
<td>21.03</td>
<td>9.79</td>
<td>0.37</td>
<td>0.85</td>
<td>0.44</td>
<td>26.71</td>
</tr>
</tbody>
</table>

Note: Gw/Ns = N use efficiency, Nt/Ns= N uptake efficiency, Gw/Nt= N utilization efficiency, Ng/Nt= N translocated to grain, Na/Nt= N taken up after flowering, Ng/Na= N translocated to grain after flowering, Gw/Ng= grain yield per grain N

Conclusion

The importance of variation in uptake efficiency relative to variation in utilization efficiency was in sharp contrast between levels of N supply. The present results indicate that the species may develop different strategies to acquire nutrients in relation to nitrogen availability. Whether these differences are of importance for recommending genotypes or varieties for efficient catching of nitrogen from the soil and reliable establishment of catch crop stands in nutrient deficient soils needs further investigation.

Direction for Future Research

The results of the study revealed that there exists a wide range of variations among mungbean genotypes under consideration in their response to sub-optimal and optimal nitrogen levels. Significant differences in growth, root uptake kinetic properties were observed between genotypes, implying that nitrogen utilization may be improved by screening out efficient genotype(s). Among 200 mungbean genotypes GK 3 was found promising for both sub-optimal and optimal N conditions and IPSA
25 was found promising for sub-optimal N fertility conditions. Since nutrient uptake may be influenced not only by root kinetic properties but also by root morphological and metabolic traits, further comparative studies should be conducted to correlate these inter-specific differences with root morphology and activities.

REFERENCES


