

# NODULATION AND YIELD OF BUSH AND CLIMBING BEANS INOCULATED WITH RHIZOBIA STRAINS

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## Introduction

Bean crops depend on symbiotic fixation to meet part of their nitrogen requirements. The balance is obtained from the soil. Nitrogen deficiency is the most important constraint to bean production in sub-Saharan Africa causing annual losses of more than 389,000 t per year. N is deficient in bean producing areas of Madagascar, South Africa, Zimbabwe, Malawi, Tanzania, Rwanda, Burundi, DR Congo, Uganda, Angola, Kenya and Ethiopia (Wortmann et al, 1998). Most smallholder farmers in eastern Africa do not apply fertilizers to their bean crops. This implies that productivity of bean cultivars developed for smallholder farmers in Africa depends on their ability to produce in soil low in N, and on symbiotic fixation. Although several bush and climbing bean varieties have been developed for smallholder production in eastern Africa, the effectiveness of their symbiosis with available inoculants and native rhizobia species is not well known. Moreover, the effect of inoculation on grain yield of the new varieties and advanced lines has not been determined. Our objectives were: i) to determine variation for nodulation and nitrogen fixation in bush and climbing bean lines, and ii) study the effect of inoculating bean genotypes with rhizobia strains on grain yield.

## Materials and Methods

Three trials were conducted. In the first trial, 60 bush and 60 climbing bean lines were evaluated for nodulation in separate trials at Jomo Kenyatta University of Agriculture and Technology Research Farm, Juja during short rain and long rain seasons. Four weeks after germination plants were uprooted and nodules carefully detached from the roots and counted. In the second trial, three bush and three climbing bean lines with low (Ayenew and NG 224-4), medium (ECAB 0807 and Cargamanto), and high (GLP 24 and G59/1-2) nodulation potential were grown in polythene sleeves containing sterile vermiculite in the greenhouse and inoculated separately with three rhizobia strains (CIAT 899, USDA 2674, USDA 2676) recommended for bean inoculation in Kenya, and a mixture of the three strains. Rhizobia strains were obtained from Microbial Resource Centre (MIRCEN), University of Nairobi. Plants were irrigated with sterilized nitrogen free nutrient solution (Somasegaram et al, 1985) to ensure that the only available nitrogen for the bean plants was from nitrogen fixation. Plants were harvested at flowering (28 days for bush and 50 days for climbers), and shoot and root dry weight determined, and nodules counted. In third trial, the six bean lines were grown with and without inoculation in the field at Juja, Kenya. Data was recorded on nodule number, shoot and root dry weight, and grain yield.

## Results and Discussion

Results showed that there was considerable variation in nodulation among the 120 bean lines. Climbing beans had more nodules per plant compared to bush beans. Average nodule number per plant among the bush bean lines varied from 16 (Awash-1) to 58 (ECAB 0097) with a mean of 33. Among the climbing bean lines, the range was 14 (G50330, Decelaya and MLV 6-90E) to 100 nodules per plant (G59/1-2) with a mean of 37. The nodules in all bean cultivars occurred

mainly on the lateral and finer roots with very few on the tap root. Majority of the nodules were medium in size with a diameter of 1 to 2 mm and were pink in color. Results of the greenhouse trial showed that there were significant differences in nodulation among the bush bean lines. Uninoculated plants produced the smallest number of nodules. Among the inoculated plants, lines inoculated with USDA 2676 produced the smallest number of nodules (50 nodules plant<sup>-1</sup>). Plants inoculated with USDA 2674 had the highest number of nodules (70 nodules plant<sup>-1</sup>). Ayenew nodulated best when inoculated with USDA 2674, GLP 24 with CIAT 899, and ECAB 0807 with the three strains. This suggested specificity among genotypes and rhizobia strains. Among the climbers, G 59/1-2 had the highest nodule number with an average of 109.7 nodules plant<sup>-1</sup>. Inoculated plants produced significantly more nodules than control plots (Table 1). Cargamanto and NG 224-4 nodulated best when inoculated with USDA 2676. In contrast, G59/1-2 nodulated best when inoculated with CIAT 899. Biomass production was highest in inoculated plots in all cases. In the field trial, results showed significant differences among the cultivars and effectiveness of rhizobia strains. Ayenew had the lowest number of nodules (42.8 nodules plant<sup>-1</sup>), while GLP 24 and ECAB 0807 had 59 and 73.9 nodules plant<sup>-1</sup>, respectively. Among the bush lines, plants inoculated with CIAT 899 had the largest number of nodules (76.9 nodules plant<sup>-1</sup>). ECAB 0807 inoculated with CIAT 899 had the highest number of nodules (128 nodules plant<sup>-1</sup>). Among the climbers, inoculated plants had better nodulation compared with the control. However, nodulation varied with strains and genotypes. Cargamanto nodulated best when inoculated with USDA 2676 (72 nodules plant<sup>-1</sup>), NG 224-4 (147 nodules plant<sup>-1</sup>) with USDA 2674 and G59/1-2 (167 nodules plant<sup>-1</sup>). Results showed that mean grain yield of inoculated bush bean lines was higher compared with the control plots. The multistrain inoculation gave better yield performance compared with single strain and control plots. However, responses varied with genotypes. Ayenew (GLP X92) showed good response to inoculation. This genotype performed best when inoculated with combined strains showing more than 100% yield increase over the uninoculated plots. GLP 24 and ECAB 0807 gave best yields with multistrain inoculation. However, GLP 24 seems to have good performance with native rhizobia and hence showed modest increases with inoculation. ECAB 0807 had a 27.6 % yield increase with multistrain inoculation. Among the climbers, Cargamanto showed highest yield increases when inoculated with USDA 2676, and NG 224-4 and G59/1-2 with combined strains. Yields of climbers were below expected levels probably because of infection by fusarium wilt and bean common mosaic virus.

**Table 1.** Effect of rhizobia inoculation on nodulation in bush and climbing bean lines.

| Inoculum  | Variety and growth habit            |        |           |   |          |          |
|-----------|-------------------------------------|--------|-----------|---|----------|----------|
|           | Bush<br>nodules plant <sup>-1</sup> |        |           | Climbing<br>nodules plant <sup>-1</sup> |          |          |
|           | Ayenew                              | GLP 24 | ECAB 0807 | Cargamanto                              | NG 224-4 | G 59/1-2 |
| Control   | 6.8                                 | 1.8    | 3.8       | 5.5                                     | 8.0      | 8.5      |
| CIAT 899  | 54.8                                | 68.5   | 52.2      | 81.0                                    | 93.5     | 155.0    |
| USDA 2674 | 89.5                                | 41.8   | 80.0      | 84.0                                    | 99.0     | 131.5    |
| USDA 2676 | 54.2                                | 35.2   | 60.5      | 127.5                                   | 82.5     | 122.5    |
| Combined  | 63.0                                | 54.0   | 92.8      | 84.0                                    | 86.5     | 131.0    |

#### References

- Somasegaran, P., Haben, H. and J. Hallidy, J. 1985. The NifTAL manual for methods in legume-*Rhizobium* technology.
- Wortmann, C.S., R. A. Kirkby, C.A. Eledu and D.J. Allen. 1998. Atlas of common bean production in Africa. Cali, Colombia, CIAT.133p.