THE 'MAFFEI 15' LIMA BEAN COMPENSATES FOR REDUCED PLANT STAND

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Abstract. **'Maffei 15' baby lima beans seeds were sown every 6 cm in rows 76 cm apart to yield a nominal stand of 215,000 plants/ha at two locations in Delaware over two years. Seedlings were thinned within two weeks of planting to provide 0, 16.7, 33.3 and 50.0 % stand reduction at two in-row spacing patterns to determine subsequent effects on vegetative and reproductive growth. Shoot fresh weight/m^2 was decreased only in 2003 by 21% and bean fresh weight/m^2 was decreased only in 2004 by 13.8% when plant stand decreased to 50%. This disproportional vegetative and reproductive growth response to stand reduction resulted from a compensatory linear increase in shoot fresh weight, usable pod number, and bean fresh weight of individual plants. Thus, the 'Maffei 15' lima bean tolerates a considerable loss of plant stand with little or no effect on yield.**

The study was conducted during June – September on Kalmia loamy sand (fine loamy silicaceous, thermic Typic Hapludult) near Georgetown, Del. (lat. 38.7° N, long. 75.3° W) in 2003, and on Matapeake silt loam (fine silty, mixed mesic Typic Hapludult) in Newark, Del. (lat. 37.3°N, long. 75.5°W) in 2004. Seeds of 'Maffei 15' lima bean were machine planted every 6 cm in rows 76 cm apart to provide a nominal stand of 215,000 seeds/ha. Plant population densities were created by hand–removal of plants within two weeks of planting. In addition to the full stand (0% stand reduction), three percentages of stand reduction were created at two in-row spacings (gaps) by removing plants. The percentages and gaps were: 16.7% (one plant out of every consecutive six, or two consecutive plants out of every twelve); 33.0% (one plant out of every consecutive three, or two consecutive plants out of every six; and 50% (every other plant, or two consecutive plants out of every four). Each treatment consisted of four 6 m-long rows.

The 4 (stand reduction) by 2 (gaps) factorial experiment was arranged in randomized block design with four replications. Blocks consisted of four 6m long rows per treatment with two border rows on each side. Plots received 90 kg N/ha from 14N-3P-12K (14-7-14) on the day of planting. Imazethapur herbicide was incorporated preplant at 36g a.i./ha. Manual cultivation subsequently controlled weeds. Other pest control measures followed Univ. of Delaware recommendations (Univ. of Delaware, 2003). Plots received at least 50 mm of water each week from rain or irrigation from planting to harvest.

At the time of harvest, plants from the central 3m of the two inner rows of each treatment were pulled out of the ground, counted and weighed. Pods were manually stripped from plants and separated and counted as flat (immature), usable (green), and dry (overly mature). The green pods were threshed mechanically and the seed fresh weight (economic yield) determined. All data were recorded on a per plant and per unit area (m^2) basis. In 2004, the numbers of nodes and branches on 10 plants from each treatment-replicate combination were counted.

Since in-row gaps had no effect on any variable in either year, only the results of percentage stand reduction are reported. The 17.8 and 20.0 plants per m^2 achieved in 2003 and 2004, respectively, with no stand reduction represented 83% and 93% of the potential stand of 215, 000 plants/ha. The nominal 16.7, 33.3 and 50.0% nominal stand reductions were, respectively, 23.6, 35.9 and 49.4% in 2003, and 19.5, 31.5 and 49.5% in 2004.

As stand decreased from 100% to 50%, shoot fresh weight/m^2 decreased only 21% in 2003 and was unaffected in 2004; while bean fresh weight/m^2 was unaffected in 2003 and decreased only 13.8% in 2004. This absence or less than proportional decrease in shoot or bean fresh weight in response to stand reduction reflects the ability of plants to respond vegetatively and reproductively in a compensating manner to the decreasing population density.

The numbers of flat, dry or usable pods/m^2 were unaffected by stand reduction in either year. In both years, the usable pods were 87% of the total pod number per plant, indicating that plant population density had no effect on crop maturation rate.

Linear increases in shoot fresh weight, number of usable pods and bean fresh weight of individual plants in response to decreasing stand during both years confirmed the ability of plants to respond positively to reduced population density. The positive relationship between the number of usable pods or bean fresh weight with the numbers of nodes and branches per plant in response to decreasing plant stand may indicate that the increase in branches supported the increase in reproductive structures.

The reproductive structures of lima beans are indeterminate racemes, with the first flowers produced on the early inflorescences being the most critical for fruit production. It remains unknown whether the greater pod set/retention and bean fresh weight of individual plants with decreasing plant stand was associated with more racemes borne on more branches. The greater leaf area per plant may have decreased the temperature and increased the relative humidity within the canopy, conditions known to favor pod set and retention.

The results of this study have shown that reducing 'Maffei 15' lima bean stand by up to 50% reduced bean fresh weight per unit area by only 16%, averaged over two years. This disproportional relationship resulted from increased vegetative growth and reproductive yield of individual plants which compensated for the reduced plant stand. It remains unknown whether indeterminate lima beans would compensate similarly for reduced plant stand.