BEAN BIOMASS YIELD PER POD OF *PHASEOLUS VULGARIS* INDIVIDUALS UNDER DIFFERENT GROWING CONDITIONS

Alan B. Shabel, Sheryl L. Soucy, and John J. Stachowicz

Abstract. We obtained bean biomass yield per pod data for *Phaleolus vulgaris* individuals subjected to various growth conditions at the Loma Linda farm near Las Cruces, Costa Rica. We found that beans invested more resources in each pod (i.e., produced higher bean biomass per pod) when in mulched or fertilized plots, and in plots of lower mean density. Another component of yield, number of pods per plant was also found to respond positively to an increase in resources, in a related study (Bizzarro, *et al*, this volume). The bean biomass per pod values established here will allow others to make biomass estimates based solely on pod counts. (JJS)

INTRODUCTION (SLS)

The *frijol tapado* system is a traditional method of agriculture in Central America, first employed by Pre-Columbian societies. The system involves the cultivation of beans by broadcasting seeds in a secondary growth field, slashing the standing vegetation and using this vegetation as mulch for the beans. The advantages of this procedure include lower soil temperatures, higher soil moisture, delayed release of nutrients from the mulch, and decreased risk of fungal infections as a result of spores splashing onto the leaves from the soil.

Recently the Costa Rican government endorsed the *espequeado* method of bean production which involves the removal of non-crop vegetation and the application of chemical fertilizers. Over time this procedure is likely to lower soil fertility and may have adverse effects on surrounding ecosystems. It does, however, produce a higher crop yield than the *frijol tapado* system (M. Rosenmeyer, pers. comm.).

Experiments are now being conducted to assess the quantitative response of bean production to the various systems of agriculture. Researchers are attempting to achieve the same yield of beans as the productive *espequeado* system from the more sustainable *frijol tapado* system (M. Rosenmeyer, pers. comm.).

Within plots, individuals can allocate resources to reproduction (increasing total bean biomass per plant) by increasing the number of bean pods per plant, the number of seeds per pod, and the biomass of each seed within a pod. This study examined bean biomass per pod in response to various amounts of fertilizer in the two systems.

METHODS (JJS)

We set out to test bean biomass per pod in the four types of plots used by M. Rosenmeyer in her studies (*frijol tapado* with no fertilizer, *espequeado* 30 x 30 with no fertilizer, and with 325 kg/ha fertilizer; and *espequeado* 30 x 50 with 325 kg/ha fertilizer. In those treatments with erosion barriers, *frijol tapado* plots and *espequeado* 30 x 50 plots with 325 kg/ha fertilizer, a plant was selected only from the plot center; whereas in the other plots a plant was selected from edge areas of highest and lowest mulch as well as from the center. We obtained bean biomass per pod by harvesting the beans from each selected plant, weighing the beans from the plant, and then dividing by the number of pods.

RESULTS (JJS)

We found mulched areas to have a higher bean biomass per pod than non-mulched areas (treatment 6, $t=4.11$, $p<.01$; treatment 5, $t=3.27$, $p<.01$; Table 1). However there was no significant difference in bean biomass per pod between areas of high and low mulch (treatment 5, $t=1.05$, $p>0.1$; treatment 6, $t=0.26$, $p>0.5$).

Bean biomass per pod was significantly higher in the low density/high fertilizer plots than the high density/no fertilizer treatment ($t=2.65$, $p<.05$; Table 1). This was the only significant difference between treatments (Table 2) and there was no difference between the high and low density treatments when both had 325 kg/ha fertilizer ($t=1.69$, $p>.05$; Table 1, 2).

DISCUSSION (ABS)

Phaseolus vulgaris individuals that grew in less stressful conditions – plots with a high supply of nutrients (mulch or fertilizer) and/or reduced competition from conspecific neighbors – produced pods with greater bean biomass. Bizzarro, et al. (this volume) sampled plants grown under similar conditions and showed that they produced more pods than those individuals grown in stressed environments (where the nutrient supply was reduced and neighborhood competition was increased). Together, these studies suggest that more bean biomass per plant can be obtained if plants are sown at lower densities and have available a supply of nutrients in the form of mulch or fertilizer. The *espequeado* system, which uses large quantities of fertilizer, however, may have long-term adverse effects on the growing environment (see Introduction). The *frijol tapado* system, although it produces slightly less bean biomass per pod (Table 1), appears to be sustainable. For this reason, this traditional method of agriculture may be the wisest long-term solution in the long run.

Table 1. Biomass of Beans Per Pod.

Treatment	Sample Location	Mean Bean Biomass/Pod
F. tapado 1	Center	.782±.263g
Espequeado 5	Center	.593±.159g
	Low Mulch	.889±.391g
	High Mulch	1.114±.356g
Espequeado 6	Center	.643±.225g
	Low Mulch	1.139±.192g
	High Mulch	1.18±.328g
Espequeado 7	Center	.917±.254g

Table 2. Results of a t-test (df=10) on plants from the various treatments. C = plants from centered plot, H = plants from edge area of high mulch, L = plants from edge area of low mulch.

Plots and Plants tested	t-value
5C v. 5L	1.72
6C v. 6L	4.11**
1C v. 6C	0.98
1C v. 7C	0.90
1C v. 5C	1.51
5C v. 6C	0.44
5C v. 7C	2.65*
6C v. 7C	1.69
5C v. 5H	3.27**
6C v. 6H	3.31**
5L v. 5H	1.05
6L v. 6H	0.26
	*p<.05, **p<.01