Improvement of Root Nodule Nitrogen Fixation and Soil Fertility by Balanced Fertilization of Broad Beans

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Balanced fertilizer application is the foundation for higher yields of broad beans, and can also improve soil fertility.

In the traditional agricultural practices of Yunnan province, no fertilizer is applied to broad beans. Even in the more advanced agricultural areas, farmers generally apply only phosphorus (P) fertilizer, while potassium (K) is almost always neglected. To increase broad bean yields in large areas where deficiencies of soil nitrogen (N), P and K occur, agricultural researchers in Yunnan conducted experiments to demonstrate to local farmers the benefits of P and K. Balanced fertilization could also improve the fertility of their soils.

Application of both P and K is needed for high yields of broad bean.

Field experiment treatments were established on the basis of soil analyses. Seven NPK treatments were used. Broad bean varieties and plant populations followed local practices. Trials were conducted at Qujing in 1993 and Jinning in 1994.

It is well established by experimental results that N, P and K are important for obtaining high broad bean yields.Results indicate that in most cases, the N required by broad beans can be supplied through N fixation, provided P and K supplies to the plant are adequate (Table 1).

Table 1. Broad bean yield at the two locations in Yunnan.

	Treatments, kg/ha			Yield, kg/ha	
	N	P_2O_5	K_2O	Qujing	Jinning
	0	135	135	3,022	3,444
	39	135	135	3,044	3,491
	54	135	135	3,050	3,275
	0	0	135	1,925	1,877
	0	75	135	2,403	2,495
	0	135	0	2,302	2,106
	0	135	75	2,639	2,812
F-Test	Treatment			5.34 **	8.59 **
	Replication			2.88	3.1

In cases where N is extremely deficient in the soil, a small starter dose of N fertilizer may be needed. Excessive use of N will normally inhibit the effectiveness of N fixing bacteria.

Data also show that application of rational amounts of P and K to broad beans is the foundation for obtaining high yields. Application of 135 kg/ha P_2O_5 increased yields by 57 and 84 percent, respectively, at the Qujing and Jinning test sites. Potassium applied at 135 kg/ha K_2O increased yields from 2.30 to 3.02 t/ha (31 percent) at Qujing and from 2.11 to 3.44 t/ha (63 percent) at Jinning. Thus, as demonstrated at these locations, application of both P and K is essential for high yields of broad beans.

Measurements of nodule dry weight per hectare (based on 2 m^2 sampling area) were made when the crop was in full-bloom (Table 2). Also, the N-fixing capacity of nodules was calculated according to initial and final soil-N analysis and the N content of broad bean plant parts. These data clearly demonstrate that application of P and K increased nodule weight and N-fixing capacity dramatically. While supplemental N gave a slightly higher nodule weight, it did not increase the amount of N fixed. The greatest amount of fixed N resulted with high P and K inputs and no supplemental N. In fact, with 54 kg N/ha, a decline in total N fixation resulted.

Table 2. Effect of N, P and K on nodule weight and biological N fixation of broad bean in Yunnan province.

Fertilizer, kg/ha			Dry weight of nodules, kg/ha		N fixed by nodules, kg/ha	
N	P_2O_5	K_2O	Qujing	Jinning	Qujing	Jinning
0	135	135	130.45	147.56	220.81	247.47
39	135	135	136.67	150.39	187.04	214.16
54	135	135	131.11	151.41	147.71	179.92
0	0	135	95.20	109.27	131.21	112.80
0	75	135	100.78	120.38	181.18	177.03
0	135	0	97.89	105.43	156.90	130.16
0	135	75	122.38	132.98	183.45	196.10

Notes: Plant population 238,095 plants/ha. Nitrogen fixing capacity by root nodule = N1 (removed in pots, seeds, stems, leaves and roots) plus N2 (final soil analysis) minus N3 (added in fertilizer) minus N4 (initial soil analysis).

A study of the input to output ratio was made for N, P and K at both locations. Considering that only the pods and seeds were removed from the field and that the leaves, stems and roots were returned to the soil, calculations were made to measure the effect treatments had on soil fertility. Similar results were obtained for both locations.

As would be expected, there were negative balances (more removal than input) for P and K when the plant nutrients were not applied. When only N applied as fertilizer was considered, the balance was also negative. However, in all cases, the application of P and K showed positive balances, indicating that these plant nutrients could be built up in the soil with repeated applications over time, and when only the pods and seeds were removed from the field at harvest. This indicates that balanced fertilizer application is not only the foundation for higher yield, but is also a prerequisite for improving soil fertility. BCI

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