Root Traits for Phosphorus Acquisition in Brazilian Common Bean

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Introduction

Phosphorus (P) deficiency is a primary limiting factor for crop growth in developing countries, while in developed nations intensive P fertilization has substantial economic and environmental costs.

Plants employ a wide array of physiological and morphological adaptive responses to low the P availability that enhance phosphorus acquisition and utilization (Lynch and Brown, 2006; Ramaekers et al., 2010; Wang et al., 2010).

Aims

We aimed to evaluate the P use efficiency (PUE) of Brazilian bean cultivars and assess differences in root architecture which have an impact on phosphorus acquisition by determining rooting angle, basal root number, basal root whorl number, adventitious root number, total length and mean diameter.

Material and Methods

A set of 19 bean cultivars was evaluated for performance under low phosphorus availability in the greenhouse and in the field. First, an isotopic dilution technique was utilized with ^{32}P to determine L-value in order to evaluate P uptake; Next, 10 cultivars were analyzed for root traits via shovelomics methods at the flowering period in the field.

The results were compared using Test t at α = 0.05

Greenhouse experiment

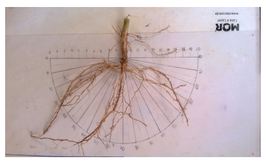
Field experiment

High P

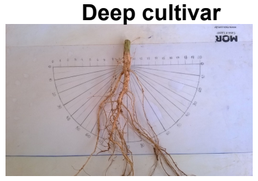
Low P

Shovelomics

Shallow cultivar



Deep cultivar



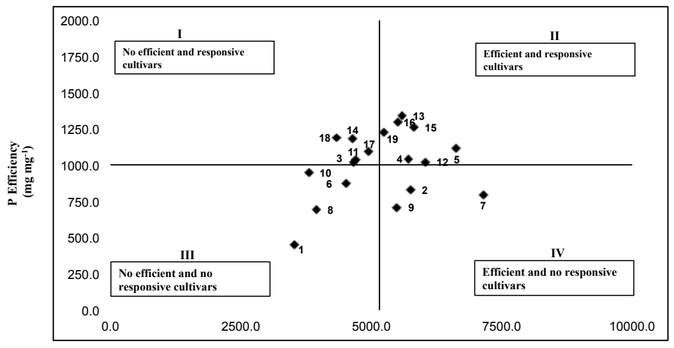
Results and Discussion

There were substantial variations in the growth traits, such as shoot dry weight, P-concentration and P-uptake under low-P condition of the first experiment (Table 1 and Figure 1

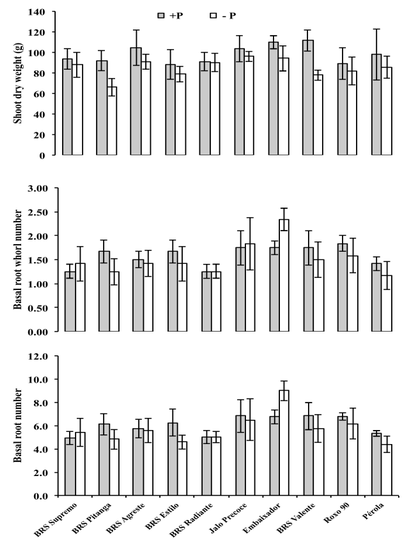
Table 2. Mean values of SDW, [P], PU and Sa of cultivars of bean cultivated in the low P (20 mg kg^{-1})

Cultivares	SDW[a]	[P][b]	PU[c]	Sa[d]
	g	g kg^{-1}	mg pot^{-1}	DMP µg P^{-1}
BRS Radiante	3.5	0.8	2.7	415.6
BRS Pontal	5.9	0.6	3.5	238.1
BRS Pitanga	4.6	0.7	3.3	434.6
BRS Requinte	5.7	0.6	3.5	294.0
BRS Executivo	6.6	0.6	3.8	275.0
BRS Ametista	4.5	0.7	3.0	294.0
BRS Campeiro	6.0	0.4	2.3	330.5
BRS Supremo	4.0	0.6	2.3	370.7
BRS Marfim	5.5	0.6	3.4	296.5
BRS Estilo	3.8	0.5	1.9	333.5
BRS Valente	4.7	0.7	3.4	237.8
BRS Esplendor	6.0	0.6	3.4	321.3
BRS Agreste	5.6	0.5	2.8	263.7
IAC Una	4.6	0.7	2.9	350.5
Jalo Precoce	5.9	0.7	4.1	182.3
Pérola	4.9	0.7	3.3	346.3
Embaixador	4.9	0.6	2.8	185.4
Roxo 90	5.2	0.9	4.7	263.4
Sangue de Boi	4.6	0.8	3.5	409.9
Mean	5.8	0.6	3.2	307.5
F	1.7^{ns}	2.1*	1.6^{ns}	1.4^{ns}
LSD	1.8	0.23	1.45	169.4
CV (%)	25	26	32	39

[a] SDW represent dry weight of shoots
[b] [P] represent concentration of phosphorus
[c] PU represent phosphorus uptake
[d]Sa represent specific activity
*, **, *** Significant levels of probability of 5%, 1% and 0.1%. respectively, from T-test.



In field root traits varied significantly among bean cultivars, the results indicate that basal root number and basal root whorl number are associated with an increased of PUE.



Conclusion

New crop cultivars incorporating these traits may be used for improved yield in low phosphorus soils and offers the potential for breeding more stress-tolerant cultivars of this crop.

Acknowledgments

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