

The Role of P Fertilizer in Soybean's Yield and Quality under Moderate Drought Conditions

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Introduction

Soybean (*Glycine max* (L.) Merrill) is among the most grown crops worldwide (He et al., 2016). Phosphorus (P) is one of the most important limiting nutrients in plant growth and production (Elser et al., 2007). Soybean is a Phosphorus-dependent crop (Yan et al., 1995), consequently, deficiency of available P in the soil results in limitations in soybean development and yield (Wissuwa, 2003).

One of the major abiotic stresses affecting soybean plants is drought stress (Fan et al., 2013). Under drought stress conditions, P can enhance vegetative development and root morphology which, in part, enhances the yield (Jin et al., 2006). The aim of our research was to investigate the influence of different P rates on both yield and quality traits of soybean (cv. *Boglár*) under irrigated and moderate drought-stressed regimes.

Materials and methods

Soybean (cv. *Boglár*) was grown in Debrecen in 2018. Three P fertilizer rates; 0, 45 and 90 kg ha⁻¹ P₂O₅ (0P, 45P and 90P, respectively) were applied under two irrigation regimes; moderate drought stress regime and irrigated regime. Each treatment consisted of three replications. SPSS (ver. 25) software was used for statistical analysis.

Results and discussion

1- Yield (t ha⁻¹): under drought stress conditions, (45P) treatment resulted in significantly higher yield compared to (0P), however, (90P) treatment did not result in noticeable yield enhancement. Under irrigated regime, applying P fertilizer resulted in relatively better yield. Similar conclusions were previously reported (Wang et al., 2006).

The effect of drought was obvious in (0P) plots; the drought-stressed treatment resulted in significantly less yield relative to the irrigated counterpart. In addition, the irrigated plots which received P fertilizer were better than the drought-stressed counterparts. Many papers reported that applying P fertilizer can enhance drought tolerance in soybean (e.g. Jin et al., 2006).

2- Protein Concentration (%): under both irrigation regimes, protein concentration was enhanced in (45P) treatment, whereas (90P) treatment resulted in a very slight decrease. The effect of drought was more obvious; the drought-stressed treatments resulted in higher protein concentration relative to the irrigated counterparts. Our findings are consistent with many previous papers (e.g. Wang and Frei, 2011).

3- Oil Concentration (%): under both irrigation regimes, applying P fertilizer noticeably enhanced oil concentration in the seeds. Our results are consistent with those of Dadson

and Acquaaah (1984). The effect of drought was measurable regardless of P application and rate; irrigation increased oil concentration in all plots compared to their drought-stressed counterparts. Many researchers reported drought stress to reduce oil concentration in soybean seeds (e.g. Bellaloui and Mengistu, 2008).

Table 1: The effect of different P fertilizer rates on yield (t ha⁻¹), protein concentration (%) and oil concentration (%) of soybean (cv. Bolgár) under two irrigation regimes

Trait	Moderate Drought Stress Regime			Irrigated Regime		
	0P	45P	90P	0P	45P	90P
Yield (t ha ⁻¹)	3.80 ^{b2}	4.47 ^{a1}	4.50 ^{a1}	4.60 ^{a1}	5.13 ^{a1}	5.23 ^{a1}
Protein Concentration (%)	39.7 ^{a1}	40.6 ^{a1}	40.3 ^{a1}	33.6 ^{a1}	34.0 ^{a2}	33.6 ^{a2}
Oil Concentration (%)	21.8 ^{b2}	22.8 ^{ab2}	24.2 ^{a1}	23.5 ^{b1}	24.8 ^{ab1}	25.2 ^{a1}

· Same letter indicates no significant difference at .05 level among P rates within certain irrigation regime.

· Same number indicates no significant difference at .05 level between the two irrigation regimes within certain P rate.

Conclusions

P fertilizer has positive effects on both yield and quality of soybean. P fertilization is extremely important under drought stress conditions as it can alleviate drought's negative effects on the yield. Drought stress also has noticeable effects on soybean; it results in reducing the yield to distinctive levels; however, it measurably increases protein concentration while slightly decreases oil concentration.

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