Phosphorus response of canola (*Brassica napus* L.) in semi-arid area of Morocco

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Introduction

Morocco is faced a strong deficit in oil meal. In the last years Moroccan government is encouraging the extension of oilseeds crop by implementing a policy that permitted to develop local production of oilseeds (Benassi and Labonne, 2004). The objective is to increase the current cultivated area from 44000 ha to 127000 ha in the horizon 2020 with 42000 ha of canola (*Brassica napus* L.) which is gaining importance in Morocco. Canola is usually cultivated in rainfed favorable regions. Now the strategy is the extension of canola to less rainfall favorable regions such chaouia region with a semi-arid climate. Because many arable lands in Morocco lack sufficient P to optimize yield, phosphorus fertilization still an important input to improve crop production. Previous studies showed that P plays a critical role in canola for attaining a potential yield (Johnston, 2003). Also the application of P-based fertilizers is essential to overcome P deficiency.

An on farm experiment was conducted in the growing season 2012-2013 in Settat province (Morocco) in order to assess P response of canola in semi-arid area. The cumulated rainfall during the growing season was 289 mm. Initial soil analyses showed that soil was available in potassium and deficient in P and N (Table 1). Canola (cv Seven) was planted on November 16, 2012 at the seed rate of 3kg/ha. The area of the main plot was 1 ha. Two treatments were compared: fertilizer P and un-fertilizer P. P fertilizer subplot received 70 kg P_20_5/ha at the sowing. However N was applied in both fertilizer P and un-fertilizer P plots at the rate of 80 kg N/ha.

Table 1: Soil chemical analysis at 0-20 cm depth of the on-farm experimental plot

pH H_2O	pH KCl	SOM (%)	NO_3 (mg/kg)	P_2O_5 (mg/kg)	K_2O (mg/kg)	EC (ms/cm)
8,18	7,04	1,24	31.88	10,2	306,7	0,6

Effect of phosphorus deficiency on growth of rapeseed at flowering stage

At rosette stage, purples leaves due to phosphorus deficiency were observed in canola without phosphorus application (photo 1). At flowering stage, results showed that phosphorus fertilization has a significant effect on the dry matter (DM) of stems, leaves and total biomass. Independently on fertilizer treatments DM was partitioned more in stems than leaves. The early apparition of phosphorus deficiency on canola crops in un-fertilizers P plots retarded growth compared to the crops in P fertilizer plots. The application of phosphorus increased stem DM by 134%, leaves DM by 106% and total biomass DM by 131%.

Table 2: Effect of phosphorus fertilization on dry matter (DM) in flowering stage

Fertilizers treatments	Stem DM (g/m^2)	Leaves DM (g/m^2)	Total DM (leaves + stems) (g/m2)
P fertilizer plots	412.68a	51.66a	464.34a
P un-fertilizer plots	176.21b	25.07b	201.28b

Effect of phosphorus deficiency on nutrient concentration

Phosphorus fertilization increased N and P concentrations in stems and leaves with a significant effect in the case of P concentration in leaves (Table 3). However stems and leaves K concentration were not affected by phosphorus fertilization. Comparing the concentration of macronutrients in the stems and the leaves, results showed that stem N content was lower than leaves N content. Similar results were reported by Hua et al (2012). However the difference between P and K contents in the stems and the leaves depends on P fertilizer treatment. P content was similar in stems and leaves under P fertilizers plots, however without P fertilizers P content was 36% lower in the leaves compared to the stems. For K content results showed that in average Leaves k contents were 10% lower than those in stems.

Table 3: Effect of phosphorus fertilization on N, P and K stem and leaves concentrations in flowering stage

Fertilizers treatments	% Total N		% Total P		% Total K	
	Stems	leaves	Stems	Leaves	Stems	Leaves
P fertilizer plots	0.69a	0.88a	0.30a	0.30a	2.23a	2.01a
P unfertilizer plots	0.63a	0.81a	0.28a	0.18b	2.23a	2.00a

Several researches showed that canola take up more macronutrients than cereals. At maturity, the average macronutrient concentration in the grains was 3.86% N, 0.87% P and 1.10% K. Phosphorus fertilization had a significant effect on N and P concentration in the grains (Table 4). However no response of K concentration was observed due phosphorus fertilization. Even if the difference was not significant, the decrease of N concentration in the leaves in un-fertilizer P plots can explain low N concentration in the seeds at maturity.

Table 4: Effect of phosphorus fertilization on macronutrient concentration in grains of canola at maturity

Fertilizers treatments	% Total N	% Total P	% Total K
P fertilizer plots	4.08a	0.92a	1.10a
P unfertilizer plots	3.65b	0.83b	1.10a

Effect of phosphorus deficiency on grain yield and total biomass of rapeseed

In comparison to the potential yield of canola in Mediterranean area, low grain yields obtained in the current study may be the result of various factors such as the low water availability because the cumulated rainfall during the growing season was less than 300 mm. Hence, most researchers reported that seed yield decrease under drought stress mostly if occurs in post-flowering phase (Gunasekera et al., 2009). Our results showed that phosphorus fertilization increased significantly grain yield, total biomass and harvest index of canola. No application of phosphorus to rapeseed resulted to a small crops, decreased grain yield by 80% , total biomass by 61% and harvest index by 85% compared to P fertilizers plots (Table 5). The accumulated biomass before flowering affected the final biomass at harvest which was mentioned as an important parameter that affects the final grain yield (Gunasekera et al., 2006).

Taking into account that N for grain filling mostly occurs through mobilization of N derived from vegetative tissues (Rosssato et al., 2001). The decrease in N concentration in leaves and stems before grain ripening decrease the remobilization of N to seeds (Noquet et al., 2004). Hence the decrease of N concentration in the vegetative organs due to no phosphorus application can contribute to low grain yields of canola in un-fertilizer P plots. Those results are confirmed by Johnston (2003) who found that optimizing canola yield requires a balancing N and P additions.

Table 5: Effect of phosphorus fertilization on height, grain yield and biomass of canola

Fertilizers treatments	Height (cm)	Grain yield (t/ha)	Total biomass (t/ha)	HI (%)
P fertilizer plots	106.43a	0.88a	4.32a	19.97a
P unfertilizer plots	74.02b	0.18b	1.70b	10.81b

Conclusion

Nutrient management of canola in North Africa is highly based on literature review from similar Mediterranean climate than local research. Our results in semi-arid area of Morocco showed that phosphorus deficiency in canola is associated with low grain yields and low biomass. Further research is needed to analyze the responses of canola to nutrients in low rainfall Mediterranean climate of North Africa.

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