Evaluation of POLY4 (polyhalite) as a fertilizer in comparison to sulphate of potash for tobacco

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Abstract

Polyhalite ($K_2SO_4.MgSO_4.2CaSO_4.2H_2O$, POLY4®) can potentially expand the options of low chloride potash sources for tobacco. Two trials were conducted at Yunnan Agricultural University in 2014 and 2015 evaluating POLY4 against Sulphate of Potash (SOP) at 88, 116, 175 and 263 kg K_2O ha^{-1} for yield and quality attributes. Yield and economic returns were significantly enhanced due to potassium fertilization irrespective of sources in both 2014 and 2015. Similarly leaf potassium uptake significantly responded to potassium application in 2014. Reducing sugar concentration was significantly higher for POLY4 compared to SOP and Control in 2014.

In 2014, black shank disease incidence was significantly reduced under POLY4 compared to SOP. Bacterial wilt was similarly reduced with potassium fertilization, although there was no significant difference between potassium sources. We conclude that POLY4 could be used as a source of potassium in tobacco crop nutrient management under local conditions at Yunnan China.

Introduction

- K deficiencies were observed in Yunnan province in China. Tobacco crop consumes on an average 100 kg of K_2O ha^{-1}. Cost of K fertilizer was enhanced by 292% since 2000
- Low chloride potassium nutrition is critical for the production of high yielding quality tobacco. Potassium content in tobacco influences leaf colour, texture, contents of reducing sugars and alkaloids, combustibility, hygroscopic properties, burning properties, reduces tar quantities and thus may influence reduction in harmful substances.
- POLY4® is an alternate potassium sources to SOP and SOP-M having advantages in terms unit cost and available on a large scale. This could ultimately lead to decreased reliance on SOP as a potassium source for tobacco
- Few studies evaluating polyhalite as a K_2O source in tobacco motivated establishing two trials in Yunnan province in China

Objectives

- To assess whether the tobacco crop responds to potassium and other nutrients present in POLY4 in the Yunnan region of China
- What is the effect of POLY4 as K_2O source on tobacco yield, yield attributes and quality parameters?
- Are POLY4 and SOP rate response curves similar in terms of yield, yield attributes and quality parameters?

Methods

- Location was Xundian Daheqiao farm, Yunnan Agricultural University
- Genotype was FCV tobacco – YN-87
- N and P_2O_5 were applied at local recommended rates
- Plant population was 15000 plants ha^{-1}
- Method of fertilizer application was in a hole 5 cm away from plant at the time of transplanting by hand
- Transplanting date was 2nd, May 2014 and harvesting was done 5 times
- Crop was cultivated under rainfed conditions.

Table 1 – Summary of soil analysis at the experimental sites

Year	pH	Organic matter (g kg^{-1})	Alkali-hydrolyzable N (mg kg^{-1})	Available P (mg kg^{-1})	Available K (mg kg^{-1})
2014	7.2	22	95	5	125
2015	7.4	27	109	28	216

Treatments

Table 2 – Summary of potassium fertilizer applications

Treatment number	K_2O Source	Nutrients applied (kg ha^{-1})			
		K_2O	CaO	MgO	S
1	Control	0	0	0	0
2	POLY4	88	107	38	119
3	POLY4	117	142	50	159
4	POLY4	175	213	75	238
5	POLY4	263	319	113	357
6	SOP	88	-	-	32
7	SOP	117	-	-	42
8	SOP	175	-	-	63
9	SOP	263	-	-	95

Experiment design

- Experimental design at each site was a randomised block design with three replications.
- Plot area was 30 m^2

Statistical analysis

Statistical analysis was carried out using GenStat software version 17 (VSN International, 2011) using ANOVA and regression analysis. Treatments of interest in source study were compared by using single degree of freedom contrasts.

Results

Table 3 – Summary of ANOVA p values for yield and yield attributes in 2014

Variable	Control	Control * Type	Control * Rate	Control * Type * Rate
Yield (kg ha^{-1})	<0.001	ns	ns	ns
1st class yield (kg ha^{-1})	<0.001	ns	0.003	ns
2nd class yield (kg ha^{-1})	<0.001	ns	ns	ns
3rd class (kg ha^{-1})	ns	ns	0.055	ns
Financial returns on total yield (Yuan ha^{-1})	<0.001	ns	<0.001	ns
1st class returns (Yuan ha^{-1})	<0.001	ns	0.003	ns
2nd class returns (Yuan ha^{-1})	<0.001	0.027	0.001	ns
3rd class returns (Yuan ha^{-1})	ns	ns	ns	ns
Total K Uptake (g plot^{-1})	<0.001	ns	<0.001	ns
Reducing Sugars (%)	ns	0.003	0.094	ns
Bacterial wilt incidence rate (% occurrence)	<0.001	ns	ns	<0.001
Black shank incidence rate (% occurrence)	<0.001	<0.001	<0.001	<0.001

Table 4 – Summary of ANOVA p values for yield and yield attributes in 2015

Variable	Control	Control * Type	Control * Rate	Control * Type * Rate
Yield (kg ha^{-1})	<0.001	ns	ns	ns
1st class yield (kg ha^{-1})	<0.001	0.089	0.052	0.029
2nd class yield (kg ha^{-1})	0.005	ns	ns	ns
3rd class (kg ha^{-1})	ns	ns	ns	ns
Financial returns on total yield (Yuan ha^{-1})	<0.001	ns	0.005	ns
1st class returns (Yuan ha^{-1})	<0.001	ns	<0.001	<0.001
2nd class returns (Yuan ha^{-1})	<0.001	ns	<0.001	<0.001
3rd class returns (Yuan ha^{-1})	ns	ns	ns	ns
Bacterial wilt incidence rate (% occurrence)	<0.001	ns	0.083	0.026
Black shank incidence rate (% occurrence)	<0.001	0.024	ns	0.013

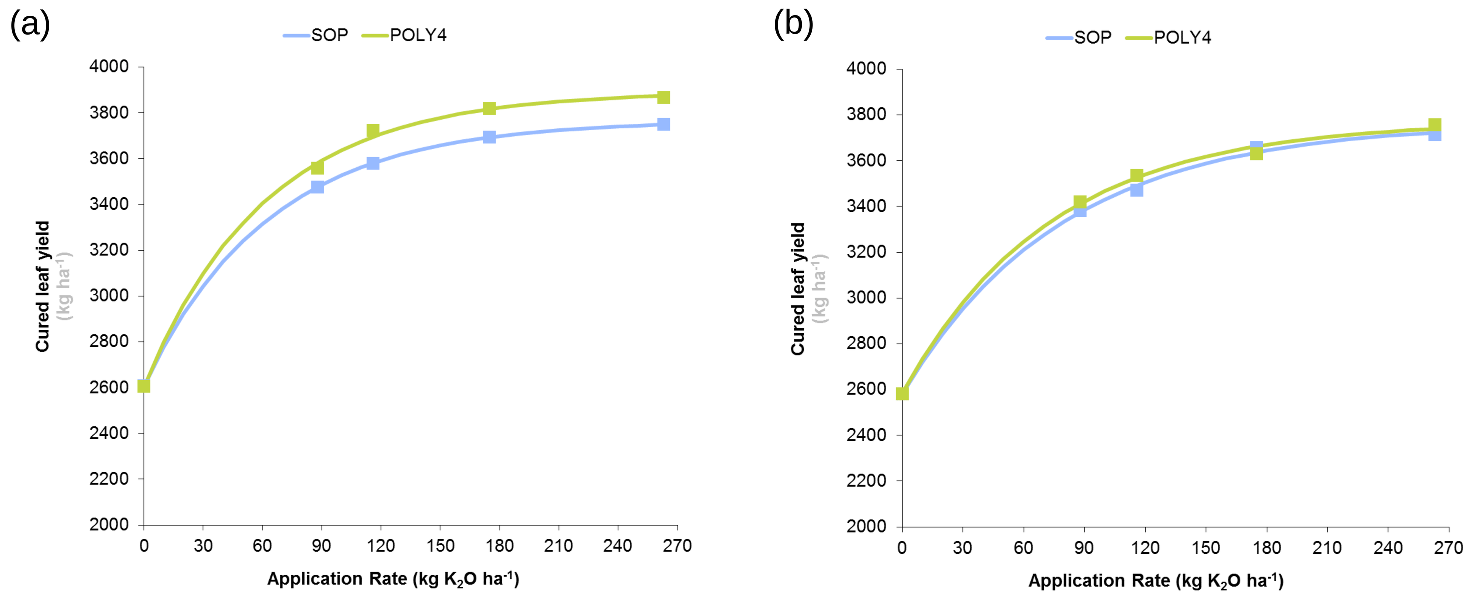

Figure 1 – Total cured leaf yield in (a) 2014 and (b) 2015

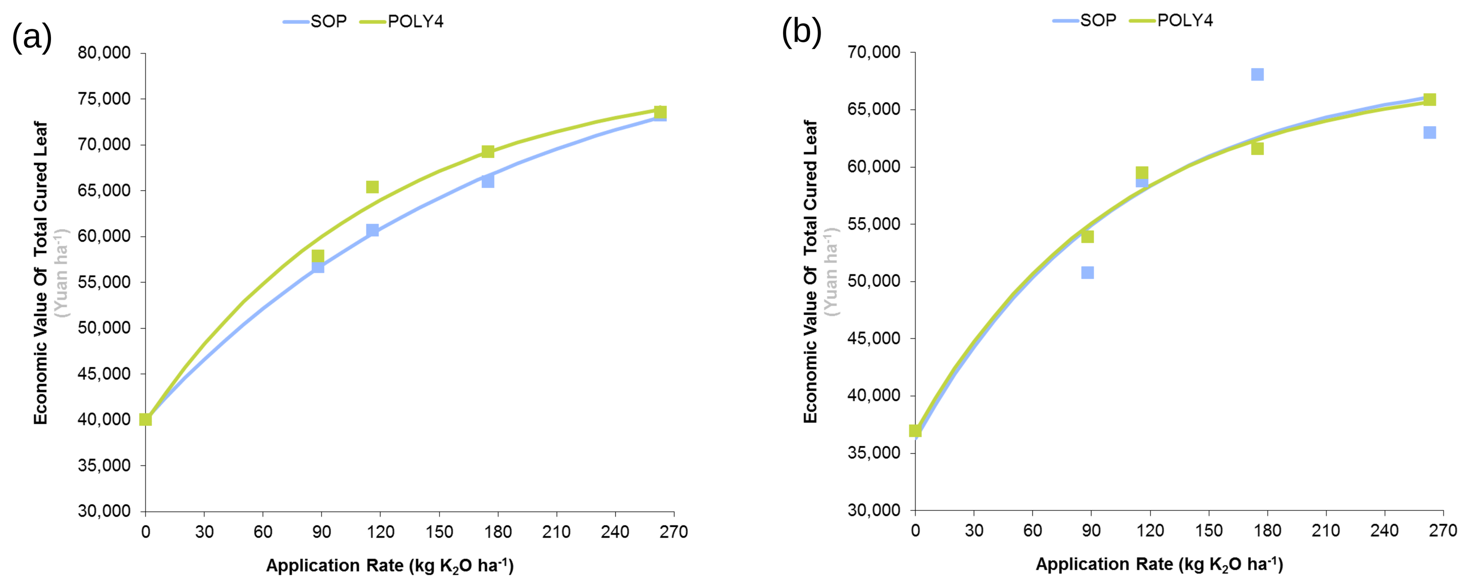

Figure 2 – Financial returns from total yield in (a) 2014 and (b) 2015

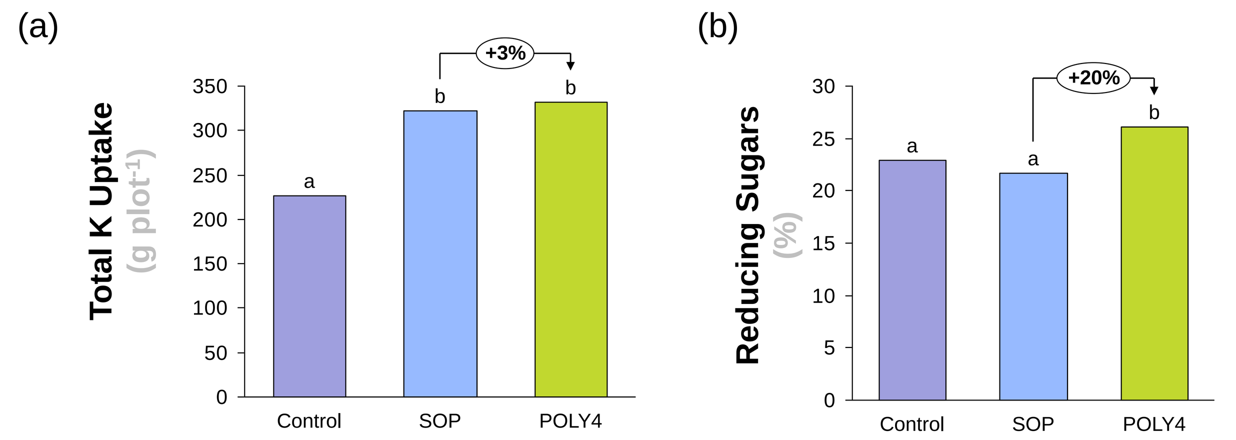

Figure 3 – Total K uptake (a) and reducing sugars (b) as influenced by source of potassium in 2014

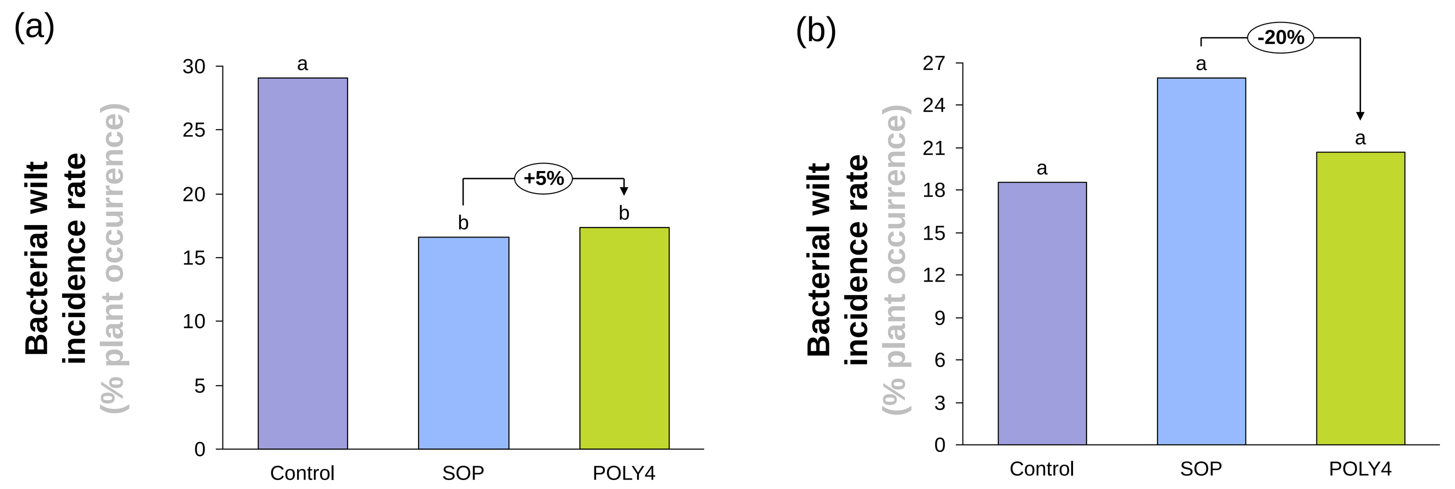

Figure 4 – Average bacterial wilt disease incidence rate as influenced by source of K_2O in (a) 2014 and (b) 2015

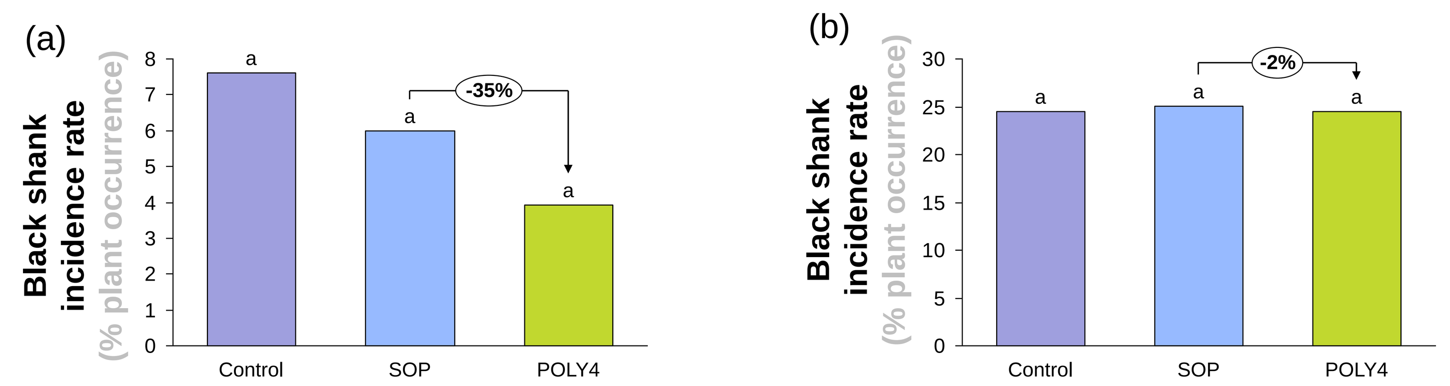

Figure 5 – Average black shank disease incidence rate as influenced by source of K_2O in (a) 2014 and (b) 2015

Conclusions

- POLY4 was as effective as SOP in enhancing tobacco cured leaf yield, economic returns and the cured leaf K uptake values
- POLY4 resulted in significantly enhanced reducing sugars than SOP in 2014
- Potassium application consistently reduced Black shank and Bacterial wilt incidences in 2014 when soil K levels was 125 mg kg^{-1}. However, in 2015 when initial soil K was 216 mg kg^{-1} Black shank and Bacterial wilt incidences were not reduced by fertilizer potassium application.

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