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

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Abstract

Few experiments evaluating Polyhalite ($K_2SO_4.MgSO_4.2CaSO_4.2H_2O$; POLY4®) as a source of potassium in tea motivated carrying out an NPK balanced trial in Yunnan, China during 2014-15. POLY4 and Sulphate of Potash (SOP) were assessed at 0, 56, 84, 112 and 168 kg K_2O ha^{-1}. An exponential relationship of POLY4 with spring tea yield indicated significantly higher yields for POLY4 (3686,3591 and 3087 kg ha^{-1}) compared to SOP and Control, respectively. Also, potassium fertilizer application increased yield, bud length water extractable compounds, polyphenol and amino acid content in all seasons. In general, POLY4 resulted in either higher bud weight, or bud density at each season than SOP. Results conclude that POLY4 could be used as a source of potassium for tea in Yunnan, China.

Introduction

- 59% of tested Chinese soil samples were found to be deficient in soil K in 1999. However, this increased to 74% in 2010 due to under application of K_2O
- Recent efforts for alternate potassium sources lead to the exploration of polyhalite in North Yorkshire in the United Kingdom (POLY4®) and New Mexico in the USA. This could ultimately lead to decreased reliance on MOP and SOP as a potassium source
- POLY4 can potentially expand the option of low chloride potash sources for crops
- Cost could be an advantage for POLY4, owing to its lower processing losses than for SOP
- A limited number of studies evaluating polyhalite as a K_2O source in tea motivated undertaking the current work to assess the agronomic performance of POLY4

Objectives

- To assess whether tea responds to potassium and other nutrients present in POLY4 in the Yunnan region of China.
- Assess the effect of POLY4 as K_2O source on tea yield, yield attributes and quality parameters
- To assess whether POLY4 and SOP rate response curves similar in terms of yield, yield attributes and quality parameters

Methods

- Field experiments were carried out in the tea garden of the Tea Research Institute, Yunnan Academy of Agricultural Sciences, Menghai, Xishuangbanna.
- 18 year old crop established on a hill side on red soil. Weed control was by hand.
- Tea variety for this experiment is YunKang10
- N and P_2O_5 was applied at local recommended rates

Table 1 – Summary of soil analysis at the experimental site

pH	Organic matter (g kg^{-1})	Alkali-hydrolyzable N (mg kg^{-1})	Available P (mg kg^{-1})	Available K (mg kg^{-1})
5.2	29.4	199.8	5.5	89.5

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	56	68	24	76
3	POLY4	84	102	36	114
4	POLY4	112	136	48	152
5	POLY4	168	204	72	228
6	SOP	56	-	-	20
7	SOP	84	-	-	30
8	SOP	112	-	-	40
9	SOP	168	-	-	60

Experiment design

- Experimental design at the site was a randomised block design with four replications
- Plot dimensions were 10 x 1.5 m^2
- RBD with 3 replications

Statistical analysis

- Statistical analysis was carried out using GenStat software version 17 (VSN International, 2011) using ANOVA

Results

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

Variable	Seasons	Control	Control * Type	Control * Rate	Control * Type * Rate
Yield (kg ha^{-1})	Spring	<0.001	<0.001	<0.001	0.013
	Summer	<0.001	ns	ns	ns
	Autumn	ns	ns	ns	ns
Bud Length (cm)	Spring	0.033	ns	ns	ns
	Summer	0.014	ns	ns	ns
	Autumn	0.043	ns	ns	ns
Hundred Bud Weight (g)	Spring	0.068	ns	0.043	0.037
	Summer	0.048	0.037	0.032	ns
	Autumn	0.026	0.011	ns	0.04
Bud Density (amount/m^2)	Spring	<0.001	<0.001	<0.001	0.005
	Summer	ns	ns	ns	ns
	Autumn	ns	ns	ns	ns

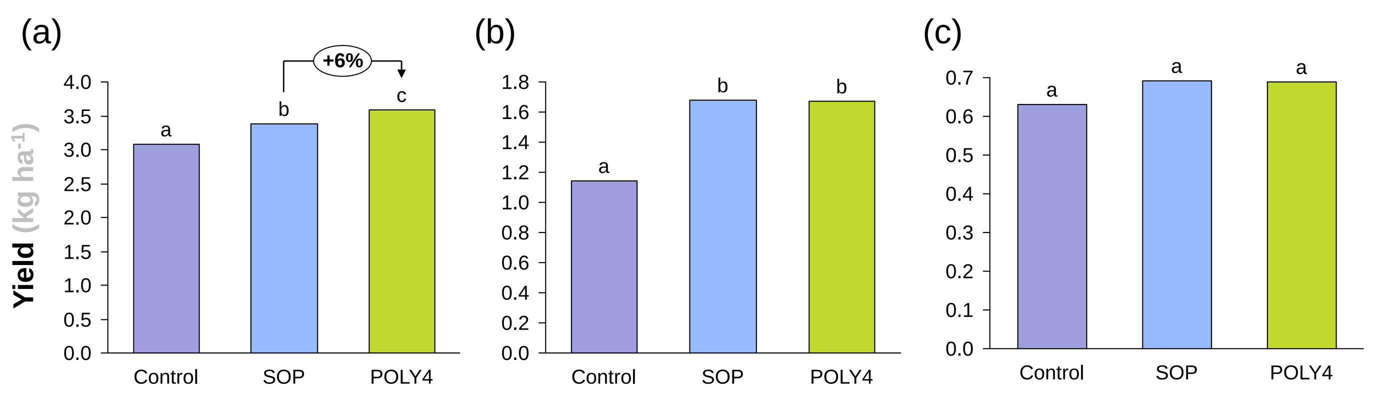

Figure 2 – Tea yields for (a) spring; (b) summer and (c) autumn

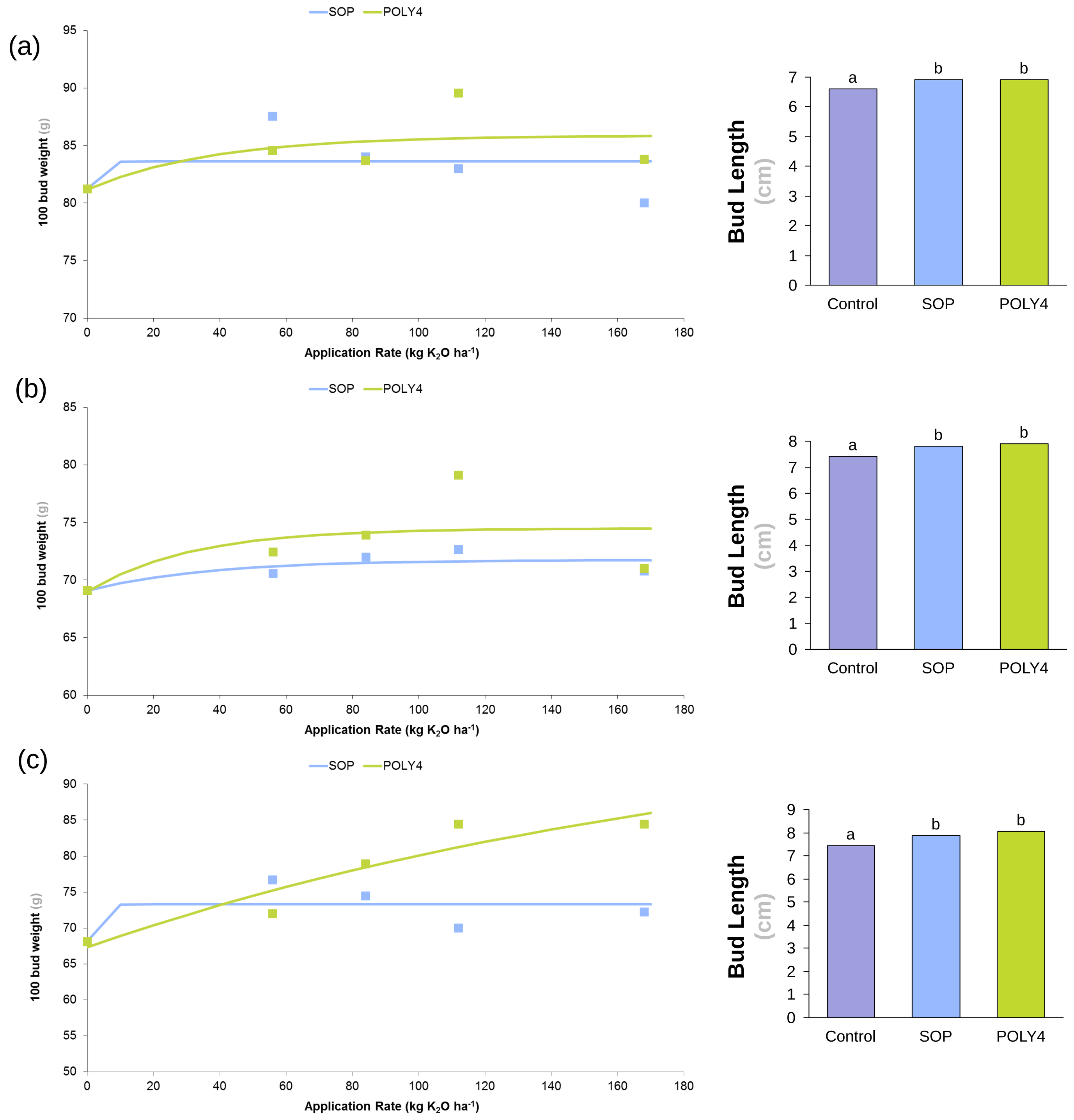

Figure 3 – 100 bud weight and bud length for (a) spring; (b) summer and (c) autumn

Table 4 – Summary average tea quality attributes and ANOVA p values

Variable	Leaf Age	Season	Average tea quality attributes: Control	Average tea quality attributes: SOP	Average tea quality attributes: POLY4	p value: Control	p value: Control * Type	p value: Control * Rate	p value: Control * Type * Rate
Leaf water extractable contents (%)	Newer	Spring	47.2	50.6	49.3	0.061	ns	ns	ns
		Summer	46.7	51.2	51.1	0.009	ns	ns	ns
		Autumn	45.6	49.1	49.2	<0.001	ns	ns	0.074
	Older	Spring	46.9	50.7	49.6	0.071	ns	ns	ns
		Summer	40.7	46.5	45.7	0.004	ns	0.097	ns
		Autumn	38.0	44.6	44.2	<0.001	ns	ns	ns
Amino acid (%)	Newer	Spring	1.9	2.6	2.4	<0.001	0.047	ns	ns
		Summer	2.8	3.0	2.9	0.032	ns	ns	ns
		Autumn	0.3	0.3	0.3	0.002	0.042	0.005	0.001
	Older	Spring	1.8	2.1	1.9	0.056	0.05	ns	ns
		Summer	0.2	0.2	0.2	0.007	0.006	<0.001	ns
		Autumn	0.2	0.3	0.3	<0.001	ns	<0.001	<0.001
Polyphenol content (%)	Newer	Spring	21.6	24.0	22.9	0.017	0.022	0.023	ns
		Summer	22.1	26.2	24.6	<0.001	0.001	<0.001	ns
		Autumn	26.6	30.2	31.1	<0.001	0.007	<0.001	0.012
	Older	Spring	11.4	13.8	14.4	<0.001	0.086	<0.001	ns
		Summer	15.3	18.5	19.1	<0.001	0.021	<0.001	ns
		Autumn	14.7	20.1	19.3	<0.001	<0.001	<0.001	<0.001

Table 5 – Summary ANOVA p values for leaf nutrient concentration

Variable	Leaf Age	Season	Control	Control * Type	Control * Rate	Control * Type * Rate
K (%)	Newer	Spring	<0.001	<0.001	<0.001	<0.001
		Summer	ns	0.004	0.08	ns
		Autumn	ns	0.004	0.08	ns
	Older	Spring	ns	ns	ns	ns
		Summer	<0.001	<0.001	<0.001	ns
		Autumn	0.002	0.045	<0.001	ns
Ca (%)	Newer	Spring	<0.001	<0.001	<0.001	0.002
		Summer	<0.001	0.009	ns	ns
		Autumn	<0.001	<0.001	0.019	ns
	Older	Spring	<0.001	<0.001	0.006	ns
		Summer	<0.001	<0.001	0.006	ns
		Autumn	<0.001	0.002	<0.001	<0.001
Mg (%)	Newer	Spring	<0.001	ns	0.053	ns
		Summer	<0.001	<0.001	<0.001	ns
		Autumn	0.003	ns	0.015	ns
	Older	Spring	0.007	0.007	0.08	ns
		Summer	<0.001	0.003	0.024	ns
		Autumn	<0.001	ns	<0.001	0.002

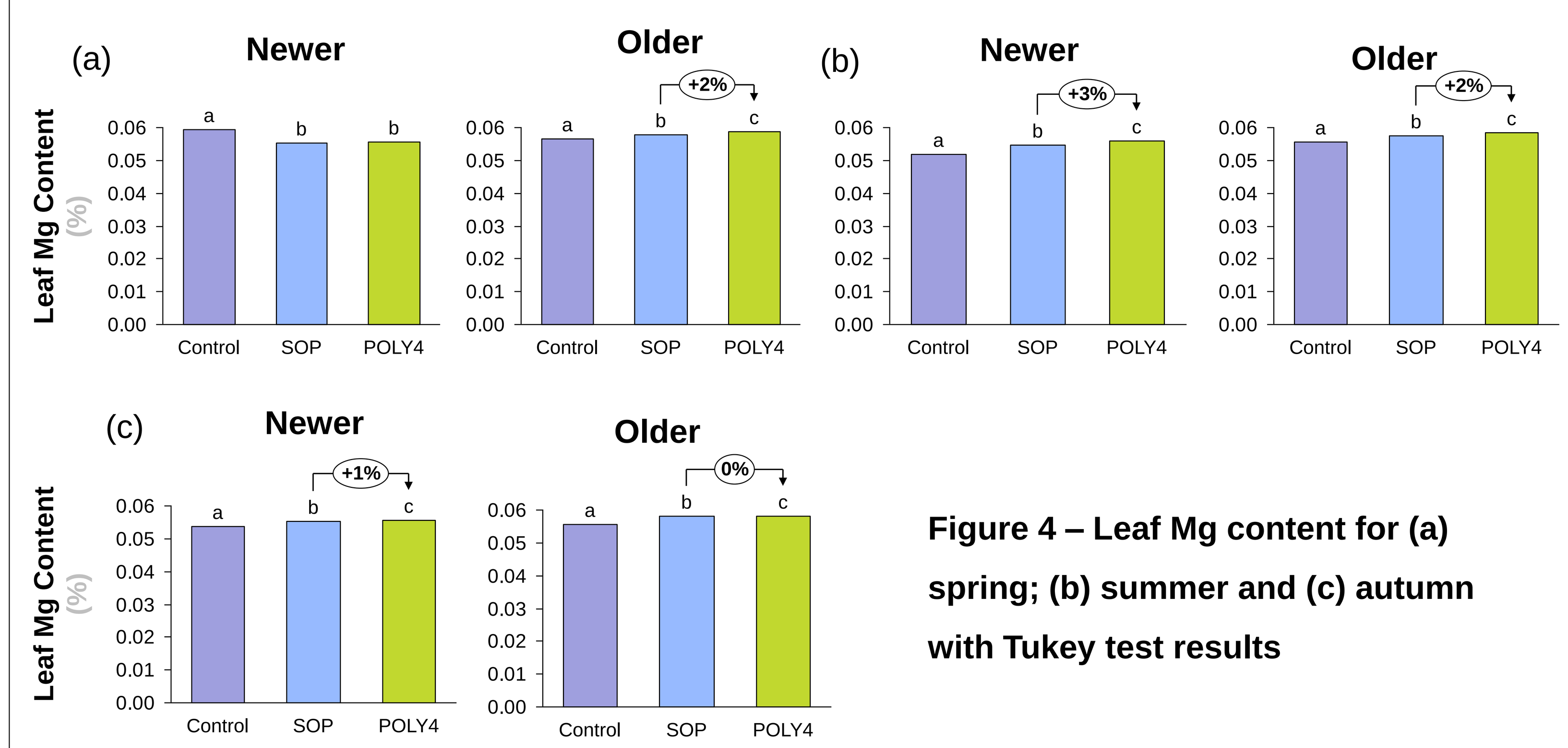

Figure 4 – Leaf Mg content for (a) spring; (b) summer and (c) autumn with Tukey test results

Conclusions

- POLY4 significantly enhanced spring yield over SOP and Control
- Potassium fertilizer enhanced tea yield in summer season. No significant difference due to potassium application was observed during autumn season
- POLY4 significantly enhanced leaf Mg content during spring in old leaves; and both newer and old leaves during summer harvest
- Bud length at all seasons, water extractable compounds, polyphenol and amino acid content were generally enhanced by potassium application

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