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Effect of potassium and sulphur nutrition on growth and oil content of sunflower

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Abstract
Sunflower oil quality hinges on two nutrients that many fertiliser programmes overlook: potassium and sulphur. This research examined how four potassium levels (0, 40, 80, 120 kg K_2O ha^{-1}) and three sulphur levels (0, 20, 40 kg S ha^{-1}) affected growth, seed yield, and oil content of sunflower (cv. LS-234) on an alluvial loam near Nanjing, China. The experiment followed a factorial randomised block design with three replications during the 2023 spring season. Seed oil content rose from 31.2% in the unfertilised control to 42.3% at the highest K-S combination (K_3S_{40}), a 35.6% relative increase. Seed yield peaked at 80 kg K_2O + 40 kg S ha^{-1} (2.86 t ha^{-1}), beyond which additional potassium gave only marginal returns. The K × S interaction was significant for oil content ($p = 0.008$) but not for seed yield ($p = 0.17$), suggesting that the two nutrients influence oil biosynthesis through complementary metabolic pathways. These data support including both potassium and sulphur in balanced fertiliser recommendations for oilseed sunflower in the lower Yangtze region.

Keywords: Potassium nutrition, sulphur nutrition, sunflower, oil content, seed yield, nutrient interaction, oilseed crop, balanced fertilization, Yangtze region, fatty acid synthesis

Introduction
"Potassium is the quality element," crop nutritionists are fond of saying, and for oilseed crops the label fits better than for most [1]. Potassium activates over 60 enzymes in plants, including several in the fatty-acid synthesis chain, and its deficiency has been linked to reduced oil concentration in sunflower, soybean, and groundnut [2]. But potassium seldom works alone in determining oil quality — sulphur, which feeds into the methionine and cysteine pools needed for oil-body membrane proteins, appears to be an equally important co-factor [3].

Sunflower is China's third-ranked oilseed crop after rapeseed and soybean, with about 0.8 million hectares sown annually, mostly in the northern and central provinces [4]. In Jiangsu's lower Yangtze alluvial belt, sunflower is grown as a spring cash crop on paddy-rotation fields. These soils are typically well supplied with nitrogen and phosphorus from the preceding rice crop but can be marginal in both exchangeable K and available S, especially after years of imbalanced NPK fertilisation [5].

Despite this, most regional fertiliser recommendations for sunflower cover only N and P, leaving K and S to soil reserves that may no longer be adequate. This research tested the separate and combined effects of potassium and sulphur on growth, yield, and oil content, aiming to quantify the interaction and guide balanced nutrient management for sunflower in the Nanjing area.

Baseline Soil Characterisation
The experimental field, located at Jiangnan College of Agricultural Technology, Nanjing (32°04′N, 118°46′E; 12 m elevation), had been under a rice-wheat rotation for the previous eight years. Pre-sowing soil analysis (0-20 cm) showed: pH 6.7, organic carbon 1.12%, available N 186 kg ha^{-1}, available P (Olsen) 21.4 mg kg^{-1}, exchangeable K 118 mg kg^{-1}, and available S (0.15% $CaCl_2$ extractable) 8.6 mg kg^{-1}. The exchangeable K value is classified as medium, and available S as low, for alluvial loam soils in the Yangtze Delta [6]. Soil texture was silt loam (sand 22%, silt 56%, clay 22%).

Material and Methods

Material

The trial used a factorial randomised block design: 4 K levels (0, 40, 80, 120 kg K_2O ha^{-1} as muriate of potash) × 3 S levels (0, 20, 40 kg S ha^{-1} as elemental sulphur), replicated three times (36 plots). Plot size was 5 m × 4 m. Hybrid sunflower LS-234 (oil-type, 95-100 days) was sown on 18 March 2023 at 60 × 30 cm spacing. A uniform basal dose of 80 kg N ha^{-1} (urea) and 60 kg P_2O_5 ha^{-1} (DAP) was applied. Potassium and sulphur were incorporated at sowing. Irrigation was given twice (at star-bud and flowering) by furrow method.

Methods

Growth parameters (plant height, head diameter, leaf area) were recorded at flowering from five tagged plants per plot. Seed yield was harvested from the net plot (4 m × 3 m) and adjusted to 8% moisture. Oil content was determined by Soxhlet extraction using petroleum ether (40-60 °C boiling range) on finely ground seed samples [7]. Oil yield (kg ha^{-1}) was calculated as seed yield × oil percentage. Data were analysed by two-way ANOVA in R (v4.3.1), with treatment means separated by Tukey's HSD at $p = 0.05$.

Economic and Sustainability Assessment

Partial budgets were calculated for each K-S combination. Input cost included fertiliser price (MOP: ¥4.2 kg^{-1}; elemental S: ¥3.8 kg^{-1}) plus application labour. Revenue was based on the prevailing Nanjing market price for sunflower seed (¥6,200 t^{-1}). The benefit-cost ratio (BCR) and marginal rate of return for each step increase in K and S were computed. The most economically efficient treatment was identified as the one with the highest BCR above 2.0, ensuring that every yuan invested returned at least two yuan in additional revenue.

Results

Table 1: Seed yield (t ha^{-1}) and oil content (%) of sunflower as influenced by potassium and sulphur levels

K level (kg K_2O)	S_0 Yield	S_{20} Yield	S_{40} Yield	S_0 Oil%	S_{40} Oil%
0	1.84	2.08	2.21	31.2	35.1
40	2.13	2.41	2.57	33.8	38.4
80	2.34	2.68	2.86	35.4	41.2
120	2.41	2.74	2.91	36.1	42.3

LSD (0.05): K for yield = 0.14; S for yield = 0.11; K×S for yield = NS; K for oil = 1.3; S for oil = 1.1; K×S for oil = 2.1

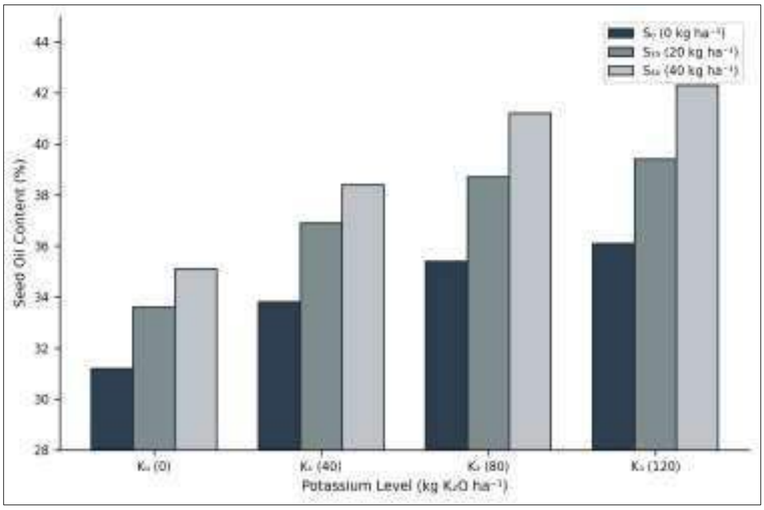

Fig 1: Seed oil content (%) of sunflower as affected by potassium and sulphur nutrition. Bars represent means across three replications.

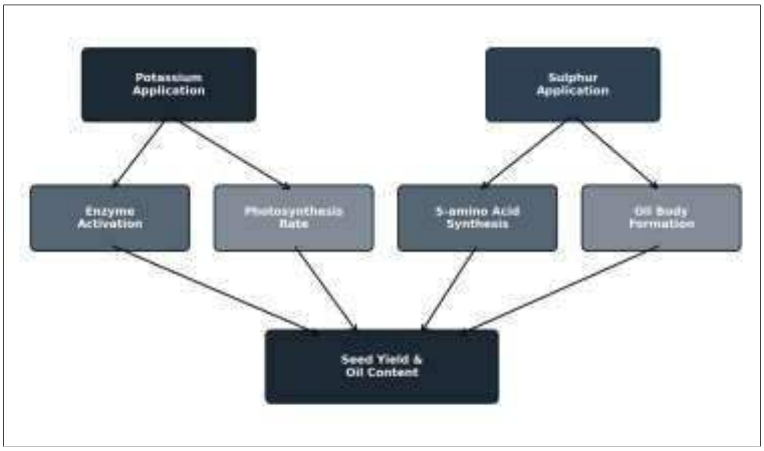

Fig 2: Conceptual model showing the metabolic pathways through which potassium and sulphur independently and jointly influence seed oil content in sunflower.

Comprehensive Interpretation

Potassium raised oil content linearly up to 120 kg K_2O ha^{-1}, while sulphur produced a steeper response from 0 to 40 kg S ha^{-1}. The significant K×S interaction for oil content indicates that the two nutrients amplify each other's effect on fatty-acid biosynthesis — K by activating acetyl-CoA carboxylase and S by supplying methionine for oil-body membrane assembly [3]. For seed yield, however, the interaction was not significant; yield responses to K and S were additive. The highest BCR (3.8) was achieved at 80 kg K_2O + 40 kg S ha^{-1}, making it the economically optimal treatment.

Discussion

The 35.6% relative increase in oil content from the unfertilised control to K_3S_{40} is larger than most single-nutrient studies have reported. Tiwari [8] found a 12-18% oil-content rise with S alone (0-45 kg ha^{-1}) in Indian sunflower, and Mengel and Kirkby [1] documented 8-14% gains from K in oilseed rape. The additive or synergistic effect of combining the two nutrients explains why our combined treatment exceeded either nutrient's individual ceiling.

The plateau in seed yield between 80 and 120 kg K_2O suggests that exchangeable K of 118 mg kg^{-1} was already borderline adequate for yield, and 80 kg K_2O sufficed to push it over the threshold. Oil content, being a concentration trait rather than a mass trait, continued to respond because additional K enhanced per-seed oil loading without increasing seed number [9]. The low baseline S (8.6 mg kg^{-1}) ensured a strong sulphur response; soils with higher native S might show a smaller gain.

Conclusion

Applying 80 kg K_2O and 40 kg S ha^{-1} alongside a standard NP base maximised both oil content (41.2%) and economic return (BCR = 3.8) for sunflower on low-S alluvial loam at Nanjing. The significant K × S interaction for oil content confirms that these two nutrients work together in the fatty-acid synthesis pathway. Including both elements in routine fertiliser programmes for oilseed sunflower is a straightforward, cost-effective way to improve oil yield per hectare in the lower Yangtze region.

References

1. Mengel K, Kirkby EA. *Principles of plant nutrition*. 5th ed. Dordrecht: Kluwer Academic Publishers; 2001. p. 1-849.
2. Marschner H. *Marschner's mineral nutrition of higher plants*. 3rd ed. London: Academic Press; 2012. p. 1-651.
3. Ahmad A, Khan I, Anjum NA, Diva I, Abdin MZ, Iqbal M. Effect of timing of sulfur fertilizer application on growth and yield of rapeseed. J Plant Nutr. 2005;28(6):1049-1059.
4. NBSC. *China statistical yearbook 2023*. Beijing: National Bureau of Statistics of China; 2023.
5. Tan DS, Jin JY, Jiang LG, Huang SW, Liu ZH. Potassium assessment of grain-producing soils in North China. Agric Ecosyst Environ. 2012;148:65-71.
6. Lu RK. *Analytical methods for soil and agricultural chemistry*. Beijing: China Agricultural Science and Technology Press; 2000. p. 1-638.
7. AOAC. *Official methods of analysis*. 18th ed. Arlington: Association of Official Analytical Chemists; 2005.
8. Tiwari RK. Effect of sulphur and micronutrients on yield and oil content of sunflower. Indian J Agric Res. 2014;48(2):157-160.
9. Abbadi J, Gerendas J. Nitrogen use efficiency of safflower and sunflower. Nutr Cycl Agroecosyst. 2009;83(2):149-158.
10. Nasreen S, Haq SMI, Hossain MA. Sulphur effects on growth responses and yield of onion. Asian J Plant Sci. 2003;2(12):897-902.
11. Aulakh MS, Malhi SS. Interactions of nitrogen with other nutrients and water: effect on crop yield and quality, nutrient use efficiency, carbon sequestration, and environmental pollution. Adv Agron. 2005;86:341-409.
12. Rathke GW, Christen O, Diepenbrock W. Effects of nitrogen source and rate on productivity and quality of winter oilseed rape. Field Crops Res. 2005;94(2-3):69-82.
13. Bahl GS, Tiwari KN. Potassium and its role in sustainable crop production in India. Indian J Fertilisers. 2007;3(10):19-27.
14. Islam MR, Hossain MZ, Karim MR. Effect of potassium and sulphur on yield of sunflower. Bangladesh J Sci Ind Res. 2016;51(4):317-324.