NUTRIENT REQUIREMENTS OF SUNFLOWER AND EFFECT OF FERTILIZER ON YIELD AND QUALITY

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ABSTRACT

Results from pot and field experiments have showed that per 1 t seed formation required 62.2 kg N, 13.3 kg P_2O_5, 146 kg K_2O for comestible type and 74 kg N, 18.6 kg P_2O_5, 166 kg K_2O for oil producing type. It reflected that sunflower has a very high k requirement. The ratio of NPK up taken by sunflower plant stabilized about 4.5:1:10 and little influenecd by fertilizer treatments.

Although the main fertilizer response was to N and the alone K applied didn't increase yield markedly, the highest average yield was achieved with moderate rates of N, P and K. Using ^{15}N and ^{32}P found that the efficiency of N and P use reached 42.9% to 59.3% and 4.9% to 14.7% respectively.

Adequate amounts and proper ratio of NPK fertilizers application not only increased the sunflower yield but also improved the seed quality.

KEY WORDS

Sunflower, nutrient, fertilizer, yield, quality.

INTRODUCTION

Sunflower has been cultivated in Liaoning province for a long time. However, it is only recent several decates for the new hybrid of high oil content to be indroduced. Today, sunflower is becoming as the third major oil producing crop, following soyben and peanut in Lianing province. The largest area planted covered 150,000 hectares each year.

Becouse the nutrient requirements of sunflower are large and the soil used usually poor, the fertilizer application is particular important. As with corn and rice, there is little published information on the effect of fertilizer on growth, seed yield and quality of sunflower in the north of China. In order

at maturity phase was related stable and little influenced by defferent varieties and fertilizer treatments (table 2, 1).

Table 2. Ratio of NPK uptake during growth stages of sunflower. †,‡

Growth stage	Comestible (%)			Ratio of NPK			Oil producing(%)			Ratio of NPK		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Seedling	14	20	24	2.6	1	12	14	19	25	3.4	1	17
Budding	9	26	23	1.4	1	9	25	15	27	7.6	1	23
Flowering	42	27	24	6.0	1	9	31	31	24	4.8	1	16
Ripe	35	27	29	4.7	1	11	30	35	24	4.0	1	9

† The plant samples for analysis incruded the plant parts above the earth and roots.

‡ The sample were taken from NPK treatment plots in table 1.

Data in table 3 refleced that the distribution of NPK uptake in parts of plant. The seed contains 30% to 36% of the N, amounting to 18.7 to 26.6 kg N per 1 t seed and contains 36% to 42.1% of the P_2O_5, amounting to 5.6 to 7.1 kg P_2O_5 per 1 t seed. This data showed that N and P distributed mainly in the seed. Inflorescence and stem contains the large quantities of K. This distribution is very similar between the both test varieties.

Table 3. NPK uptaken by plant parts of sunflower.†

Plant parts	Comestible type						Oil producing type					
	N		P_2O_5		K_2O		N		P_2O_5		K_2	
	kg/t	%	kg/t	%	kg/t	%	kg/t	%	kg/t	%	kg/t	%
Roots	9.6	15.4	1.1	8.2	18.8	12.9	7.1	9	1.5	8	24.7	15
Stem	7.1	11.4	1.0	7.5	39.1	27.0	11.9	16	1.5	8	45.3	27
Leave	13.3	21.4	2.3	17.3	22.9	16.0	13.4	18	3.5	19	11.2	7
Infloresence	13.5	22.0	3.3	24.8	52.8	36.2	15.4	21	5.0	27	65.0	39
Seed	18.7	30.0	5.6	42.1	11.9	8.2	26.6	36	7.1	38	20.5	12
Total	62.2	100	13.3	100	146	100	74.4	100	18.6	100	166	100

† The samples for analysis were taken from NPK treatnent plots.

Nitrogen nutrition and N fertilizer use in sunflower

Sunflower grain contains a large amounts of N. It

to understand the nutrient requirement and the effect of fertilizers on yield and quality of sunflower, some pot and field experiments were conducted during 1980-1982 and 1990-1992 respectively in Liaoning province.

Nutrient requirement of sunflower

Sunflower takes up large amounts of nutrients over a short period. Field experiment and laboratory analysis data from Liaoning academy of agricultural sciences showed that per 1 t seed formation required 62.2 to 69.0 kg N, 13.3 to 13.9 kg P_2O_5, 117 to 146 kg K_2O for comestible type and 73 to 79 kg N, 16.3 to 16.8 kg P_2O_5, 151 to 166 kg K_2O for oil producing type (Table 1).

Table 1. Effect of NPK treatment on seed yield and nutrients uptake of sunflower.†,‡

Type	Treatments	Seed yield kg/ha	Seed yield %	Uptake amounts of NPK kg/ton			N : P_2O_5 : K_2O
				N	P_2O_5O	K_2O	
Comestible	NPK	2604	153	62.2	13.3	146	4.7 : 1 : 11
	NP	2204	130	69.0	13.5	118	4.0 : 1 : 9
	NK	2135	120	65.0	13.4	138	3.0 : 1 : 8
	K	1778	105	67.0	13.9	117	5.0 : 1 : 8.4
	CK	1694	100	69.0	13.7	141	4.5 : 1 : 8.5
Oil producing	NPK	1515	137	74	18.6	166	4 : 1 : 9
	NP	1448	131	77	19.8	165	4 : 1 : 8.3
	NK	1440	130	73	18.0	172	4 : 1 : 9.5
	K	1118	101	78	19.8	151	4 : 1 : 8
	CK	1103	100	79	16.3	155	5 : 1 : 9.5

† Fertilizer treatments were rates of 250 kg N ha^{-1}, 90 kg P_2O_5 ha^{-1}, 375 kg K_2O ha^{-1}.

‡ RCB design with 3 replications was adopted.

Study results demonstrated that the peak of N uptake appeared at flowering stage in the both varieties. The peak was a little earler in oil producing type than in comestible type. The amounts of P uptake increased with plant growing, but the range of change was less in comestible type than in oil producing type. K uptake didn't markedly fluctuate throughout growth. The ratio of NPK uptake by sunflower

suggested that high yielding seed requires adequate quantities of N supply. Data in table 4 illustrated that the grain yield increased with increasing rates of N fertilizer. 264 kg N/ha application gave the

Table 4. Effect of N on grain yield, oil and protein content.†,‡

Rate of N kg/ha	Grain yield kg/ha	TGV g	oil % in seed	Protein % in seed
66	1407	102.0	43.8	20.0
132	1648	102.2	43.4	30.8
198	1685	104.2	42.5	29.0
264	1861	103.4	42.6	31.7
330	1815	103.0	41.9	31.7

† The test soil contains 2.64% of O.M., 0.08% of total N, 13.8 mg 100 g^{-1} soil of available N.

‡ Constant rate of 60 kg P_2O_5 and 150 kg K_2O for each treatment.

Table 5. ^{15}N uptake of sunflower in pot experiment.†,‡

Growth stage	Treatment	plant D.M. g/pot	$^{15}N+^{14}N$ uptake mg/pot	^{15}N uptake mg/pot	^{14}N uptake mg/pot	$^{15}N/^{15}N+^{14}N$ %	$^{14}N/^{15}N+^{14}N$ %	Efficiency of ^{15}N use (%)
Seedling	CK	33.4	1025	---	---	---	---	---
	Basal ^{15}N	32.6	1125	368	757	32.7	67.3	43.0
Budding	CK	74.0	1619	---	---	---	---	---
	Basal ^{15}N	81.2	1643	389	1254	23.7	76.3	45.6
Flowering	CK	110.2	1765	---	---	---	---	---
	Basal ^{15}N	128.8	2143	429	1715	20.0	80.0	48.7
	Topdress ^{15}N	121.5	1995	308	1614	19.1	80.9	44.2
Ripe	CK	127.7	1839	---	---	---	---	---
	Basal ^{15}N	167.3	2574	476	2098	18.5	81.5	56.0
	Topdress ^{15}N	163.0	2978	456	2522	15.3	84.7	53.3

† 15 kg of test soil for per pot and the test soil contains 3.10% of O.M., 0.21% of total N, 15.0 mg 100g^{-1} soil of availible N.

‡ Rate of 855 mg ^{15}N per pot for basal or topdressing.

maximum yield of 1861 kg/ha. The data also indicated that N stimulated protein increasing. However, the oil content decreased with increasing rates of N. Ro-

inson(1978) have gave ample evidence that N fertilizer reduced the oil content of sunflower seed.

Using ^{15}N showed that the amounts of N uptake increased throughout growth. ^{15}N supply ennabled the plant to efficiency use both the fertilizer N and also the native soil N. But the percentage of ^{15}N to total N decreased and ^{14}N to total N increased from seedling to ripe stage. The efficiency of ^{15}N use increased with the plant growth, reaching 53.3% - 56% at ripe stage. Of course the efficiency of fertilizer application generally is higher in the pot experiment than in the field experiment (Table 5).

Phosphorous nutrition and P fertilizer use

Sunflower has a moderate P requiremnet in comprision with K and N uptake. According to table 3 data 1 t ha yield requires 13.3 to 18.6 kg ha P_2O_5. 38% to 42.1% of P_2O_5 uptake removed in the grain at harvest.

The effects of P on components and quality are iiustrated in table 6. Adequate amounts of P application enhanced seed yield, thousand grain weight, oil and protein contents.

Table 6. Effect of P on seed yield, thousand grain weight(TGW), oil and protein content.†,‡,§

P_2O_5 ha	Plant height(cm)	Stem diam(mm)	seed yield kg/ha	TGW g	% oil	% protein
22.5	198	23.2	1665	106.8	41.9	27.4
45.0	202	23.0	1731	107.2	42.1	29.9
67.5	200	23.1	1981	108.6	42.4	33.6
90.0	218	24.5	1945	106.4	43.2	31.2
112.5	200	20.1	1936	102.8	44.9	32.6

†The test soil contains 0.24% of total P, 2.9mg P_2O_5 $100g^{-1}$ soil of extractible P.

‡Constant rate of 80 kg N ha^{-1}, 150 kg k_2O ha^{-1} for treatment.

§RCB design with 4 replications was adopted and plot size 15 M^2.

Using ^{32}P in table 7 illustrated that P application stimulated significantly plant growth and P uptake. For instance, P treatment gave 162.4 g plant dry weight and 438.0 mg P uptake per pot at ripe stage. But control treatment gave 117.3 g dry weight and 179.9 mg P uptake only. The efficiency of ^{32}P use increased with plant growing, reaching 14.7% at ripe stage.

Table 7. P uptake of sunflower in ^{32}P pot experiment.

Growth stage	Treatment	Plant D.M. g/pot	$^{32}P+^{31}P$ uptake mg/pot	^{32}P uptake mg/pot	^{31}P uptake mg/pot	$^{32}P/^{31}P+^{32}N$ %	$^{31}P/^{31}P+^{32}P$ %	Efficiency of ^{32}P use(%)
Seedling	CK	33.4	54.4	---	---	---	---	---
	P	31.3	85.0	38.5	46.4	45.3	54.7	4.9
Budding	CK	74.0	138.9	---	---	---	---	---
	P	89.6	208.4	70.3	138.1	33.7	66.3	8.9
Flowering	CK	110.2	191.2	---	---	---	---	---
	P	114.3	274.0	79.8	194.2	29.1	70.9	10.1
Ripe	Ck	117.3	179.9	---	---	---	---	---
	P	162.4	438.0	116.3	321.8	26.5	73.5	14.7

† 15kg of test soil for per pot and the soil contains 0.39% of total P, 2.0 mg P_2O_5 $100g^{-1}$ soil of extractible P.
‡ Rate of 790 mg P_2O_5 per pot for basal.

Potassium nutrition and K fertilizer use

The data from table 1 and 2 demonstrated that sunflower has very large K requirement and high content of K in plant parts, especially in infloresence and stem, at all stages of growth. According to the data per 1 seed formation needed 117 to 166 kg K_2O. This amounts are almost double amount of N and 10 times over amount of P uptake. Narem suggested that this large uptake of K may not be a true indication of sunflower's requirement for the element.

Although the sunflower plant takes up a large amount of K (table 3), the yield, oil and protein contents are not particularly responsive to the increasing rate of K fertilizer (table 8). Overdahl et al.(1982) reported that other researchers in North Dakota and Minnesota found no responses from additions of K when soil tests were high in extractable K.

Even if the alone K applied didn't increase yield markedly, the highest average yield was obtained with moderate rates of N, P and K combination. 250 kg N, 90kg P_2O_5, 375 kg K_2O of fertilizer application gave 2.6t grain ha^{-1} of the maximum yield(table 1).

Table 8. Effect of K on growth, seed yield, thousand grain weight, oil and protein content.†,‡

K_2O ha	Plant height cm	Stem diam mm	seed yield kg/ha	TGW g	oil %	protein %
75.0	206	24.8	2103	111	44.4	32.6
112.5	213	26.4	2111	107	42.4	31.7
150.0	214	25.9	2084	104	44.1	28.6
187.5	196	21.7	2064	98	43.8	30.8
225.0	204	23.3	1972	102	44.2	30.8

† The soil contains 1.83% of total K, 7.3mg $100g^{-1}$ soil of available K.

‡ Constant rate of 80 kg N ha^{-1}, 60kg P_2O_5 ha^{-1} for each treatment

CONCLUSION

From the above-expounded discussion on sunflower, the conclusion summarized is as follows:

Sunflower requires a large amounts of nutrients throughout growth. Per 1 ton seed formation needed 62.2 to 74 kg N, 13.3 to 18.6 kg P_2O_5, and 146 to 166 kg K_2O. The ratio of NPK uptaken by plant was about 4.5:1:10. The first main fertilizer response was to N, the second was to P. Although the alone K applied didn't increase yield markedly, the maximum yield was achieved with the balanced fertilization of NPK.

Phosphorous seems a quality nutrient for sunflower. P addition increased oil and protein contents of sunflower. N addition increased protein content, but reduced oil content. The N/K ratio of the fertilizer is very important. Proper ratio of NPK fertilizers application improved the seed quality.

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