Effects of Potassium Fertilization on Sunflower (*Helianthus annuus* L.) and Canola (*Brassica napus* ssp. *oleifera* L.) Growth

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Presentation Overview

- Introduction:
  - Objectives
  - Importance of sunflower and canola production in Turkey
- The Impact of Potassium on Sunflower and Canola Yield Physiology
- Influence of Potassium Deficiencies on the Growth of Sunflower and Canola Plants
- Sunflower and Canola Responses to Potassium Fertilizer
- Nutrient Requirements of Sunflower and Canola and their Fertilization
- Conclusion

Introduction

- “Sunflower” and “Canola” are important vegetable oilseed crops in Turkey and the world.

- Both crops have strong demand as a healthy vegetable oil due to their low level of saturated fats, making them popular as cooking vegetable oil.

Objectives

- The objectives of this presentation to review the effects of potassium fertilization on sunflower and canola growth based on our research results and the literature.

Sunflower and Canola Oil

- Sunflower kernels and canola seeds contains 40 to 50% of oil.
- Canola is a name applied to edible oilseed rape.
- The name "canola" was registered in 1979 by the Western Canadian Oilseed Crushers Association to describe "double-low" varieties.
- Double low indicates that the processed oil contains less than 2% erucic acid and the meal less than 3 mg/g of glucosinolates.

The Use of Sunflower and Canola Meal in Livestock Diets

- Both sunflower and canola meal/cake are very good protein sources for livestock.
- **Sunflower and canola meals contains between;**
  - **36 to 40 % crude protein**
  - **28 to 32 % digestible crude protein**

Sunflower Meals

Sunflower Meal Content (Typical Analysis)

Dry Matter (%)	88.0	Neutral Cellulase (Gamanese Digestibility)	60.0	Salt	0.25
Crude Protein (%)	36.0	Neutral Detergent Fibre	47.0	Calcium	0.3
Digestable Crude Protein (g/kg)	28.0	Starch	1.5	Total Phos	1.2
Metabolisable energy M.Joules/kg	9.5	Sugar	6.0	Av Phos	0.35
Crude Fibre (%)	23.0	Starch & Sugars	7.5	Magnesium	0.6
Oil (EE)	2.0	Fermentable Metabolisable Energy (Mega Joules/kg DM)	13.5	Potassium	1.2
Ash (%)	7.0			Sodium	0.05

Canola Meals

Canola Meal Content (Typical Analysis)

Dry Matter (%)	88.0	Neutral Cellulase (Gamanese Digestibility)	70.0	Salt	0.07
Crude Protein (%)	38.5	Neutral Detergent Fibre	36.5	Calcium	0.9
Digestable Crude Protein (g/kg)	32.0	Starch	5.0	Total Phos	1.2
ME (MJ/kg)	12.1	Sugar	9.5	Av Phos	0.4
Crude Fibre (%)	11.0	Starch & Sugars	14.5	Magnesium	0.5
Oil (EE)	3.2	Fermtble. Metbl. Enrgy (Mega Joules/kg DM)	10.5	Potassium	1.3
Ash (%)	7.0			Sodium	0

Sunflower and Canola flowers

- Both sunflower and canola flowers are very important nectar and pollen resources for "honey bees".

- Sunflower blooming generally occurs in summer time in Trakya region of Turkey, and lasts about 1-2 months.

- However, canola blossom is one of the earliest floral species available to commercial honey bees in Trakya region of Turkey.

Sunflower Production in Turkey

- Sunflower is growing mainly under dry conditions in Turkey
- Sunflower productions areas in the rotation system mostly is in Trakya Region of Turkey
- Trakya region has more than 70% of Turkey sunflower production

WORLD AND TURKEY
SUNFLOWER PRODUCTION STATISTICS*

World & Countries	Area harvested (ha)	Production (tonnes)	Yield (kg/ha)	World Compare (%)
France	724.800	1.703.900	2350	+ 175 ↑
Bulgaria	683.711	1.317,979	1930	+ 144 ↑
Turkey	583.979	1.057.125	1810	+ 135 ↑
Ukraine	4.193.000	6.360.600	1520	+ 113 ↑
Romania	761.093	1.098.047	1440	+ 108 ↑
World	23.858.936	32.002.190	1340	100 ↔
Greece	23.500	28.200	1200	- 90 ↓
Russia Fed.	5.597.900	6.454.320	1150	- 84 ↓

*: www.fao.org (FAOSTAT-2009)

Canola production in Turkey

- Canola is rapidly gaining acreage as a rotation alternative with small grains and other crops in last ten years in Turkey.

- Around 90 % canola planting areas is in Trakya region of Turkey.

Trakya Region of Turkey

WORLD AND TURKEY
CANOLA PRODUCTION STATISTICS*

World & Countries	Area harvested (ha)	Production (tonnes)	Yield (kg/ha)	World Compare (%)
Germany	1.471.200	6.306.700	4.287	+ 216 ↑
France	1.480.800	5.584.100	3.771	+ 190 ↑
Turkey	**32.709**	**113.886**	**3.482**	**+ 175 ↑**
U. Kingdom	581.000	1.951.000	3.358	+ 169 ↑
Poland	809.970	2.496.825	3.083	+ 155 ↑
World +Total	**31.023.788**	**61.630.798**	**1.987**	**100 ↔**
Canada	6.104.500	11.825.400	1.937	- 97 ↓
China	7.200.010	13.500.010	1.875	- 94 ↓
India	6.190.000	7.201.000	1.163	- 59 ↓

*: www.fao.org (FAOSTAT-2009)

Deficit of oil seed production in Turkey

- Sunflower and canola production are not enough for domestic consumption in Turkey.
- Almost 50% of vegetable oil needs imported.
- Turkey vegetable oil consumption per capita between 18-21 kgs.
- Therefore, Turkey needs to increase sunflower and canola oil seeds crops production by using intensive modern plant growing techniques.

Increasing Sunflower and Canola Production in Turkey

- Fertilizer researches shows that sunflower and canola oil seed crops respond to fertilizers.
- Nitrogen, phosphorus and potassium (NPK) are the major nutrients required to significantly increase sunflower and canola yields.
- Balanced N-P-K fertilization ensures high seed and oil yield in both sunflower and canola production.

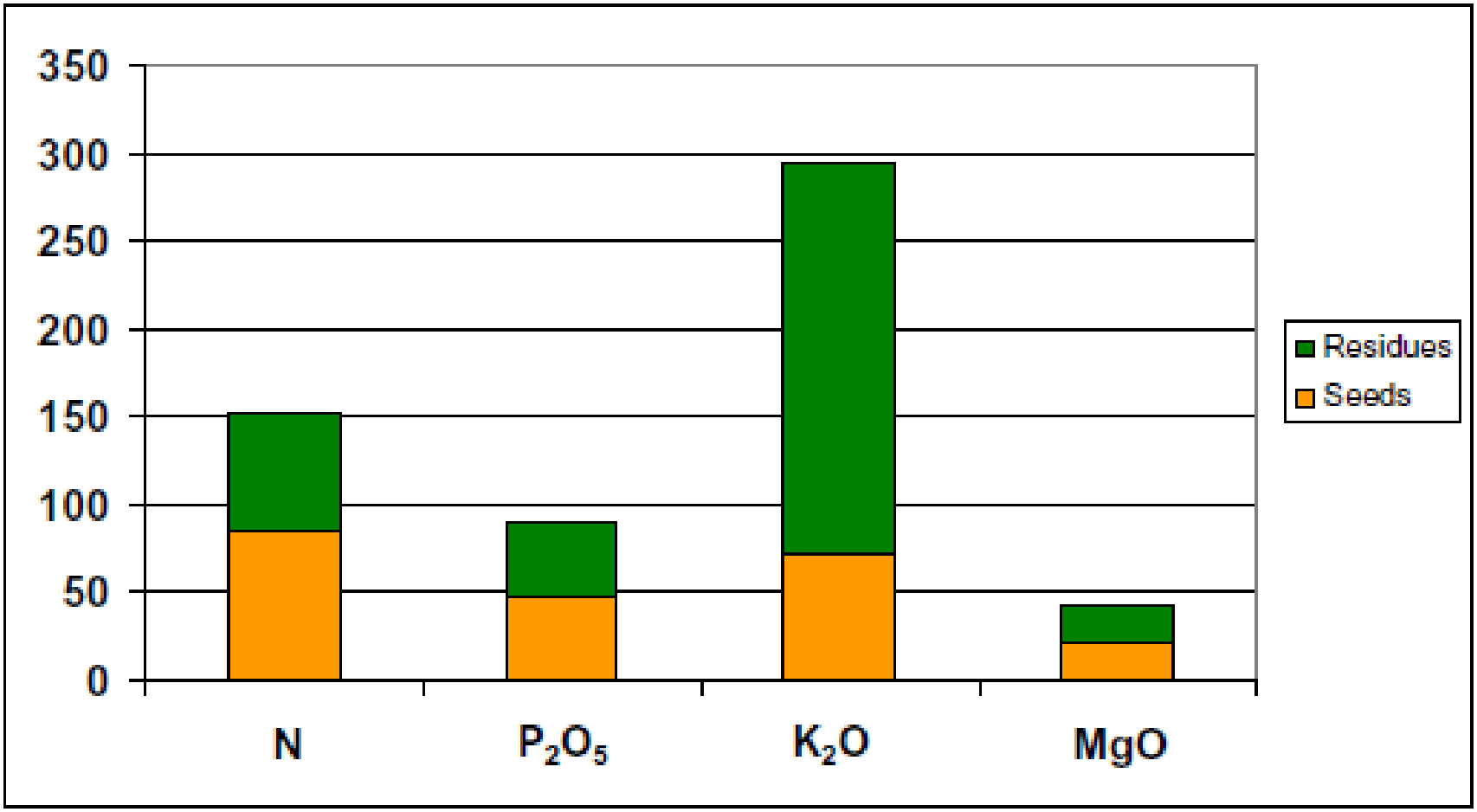
The Impact of Potassium on Sunflower and Canola Yield Physiology

- Potassium owing to its specific functions in plant metabolism has the potential to improve quality of crops.

- The role of potassium in photosynthesis and water economy of plants is crucial mainly for growth and yield formation.

- There are other vital functions of K, such as;
  - the role of K in the cation/anion balance,
  - its function in phloem loading/unloading,
  - the transport of assimilates and minerals,
  - its direct involvement in enzyme activation.

Uptake and removal of N, P, K and Mg of sunflower at yield level of 3 tones /ha



Potassium Physiological Functions on Sunflower and Canola plants

- Potassium is present in unbound form in the plants cytoplasm where K is highly mobile.
- K provides strength to plant cell walls and is involved in the lignification of sclerenchyma tissues of both sunflower and canola.
- K nutrient is involved in the activation of a large number of enzymes and hence controls many physiological functions of sunflower and canola plants.

Effects of Potassium on Sunflower and Canola Growth

- K maintain cell turgor in plants and hence, this is important for drought periods during vegetation.
- K increases leaf area and leaf chlorophyll content, delays leaf senescence and therefore contributes to a greater canopy photosynthesis.
- Potassium is well known to improve resistance to a number of pests, diseases and environmental stresses caused by temperature, moisture, transpiration, wind, saline conditions...
- Potassium deficiency can be one reason for early lodging because of a reduced growth rate of the cambium in stems of sunflower and canola crops.

How potassium works to increase sunflower and canola crop yields?

- Increases root growth and improves drought resistance.
- Maintains turgor and reduces water loss and wilting.
- Helps in photosynthesis and food formation.
- Reduces respiration, preventing energy losses.
- Produces seed, rich in oils and proteins.
- Builds cellulose & stronger stems, reduces lodging.
- Improves winter hardiness & frost resistance.
- Protects against pests and diseases.

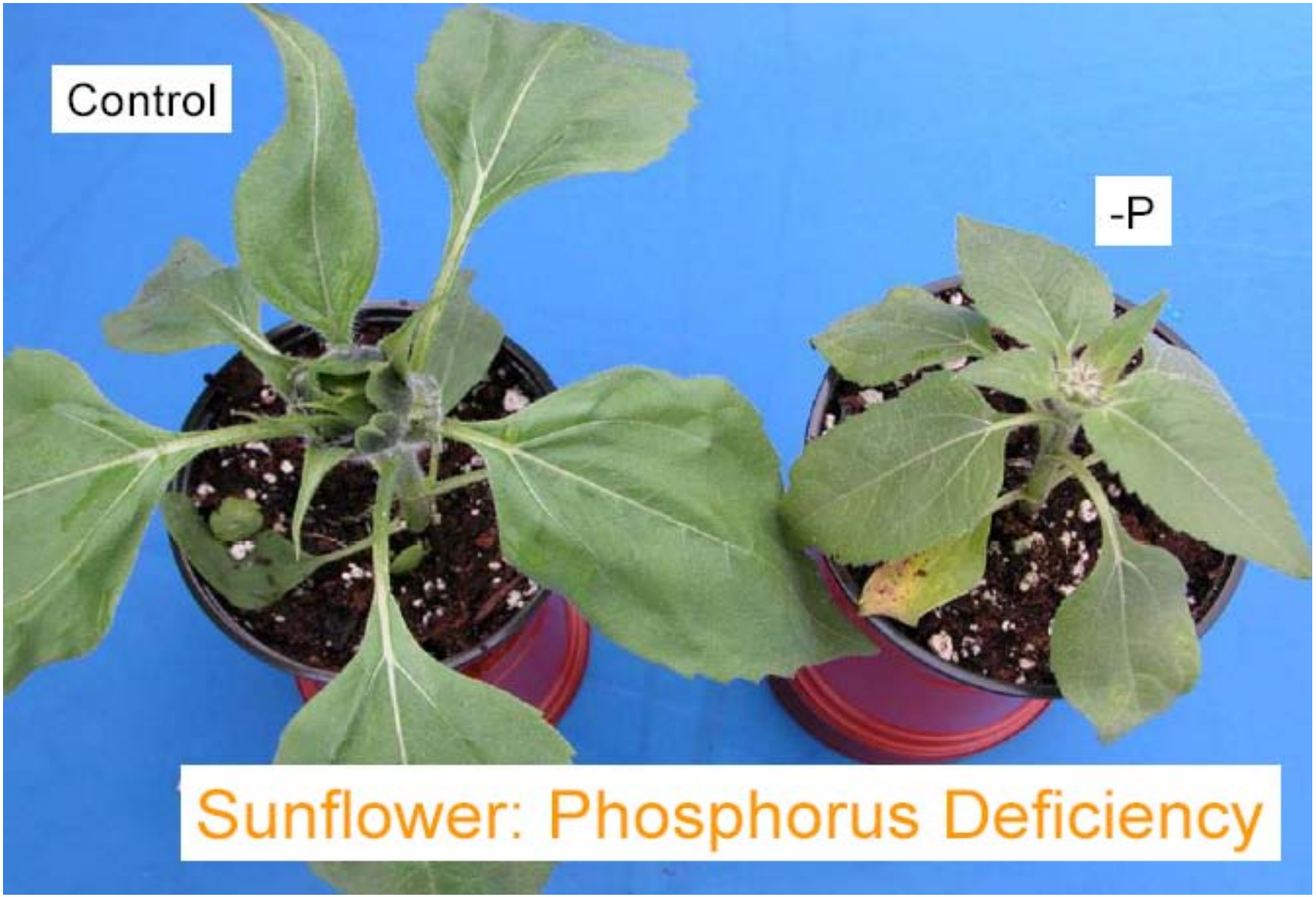
Influence of Potassium Deficiencies on the Growth of Sunflower and Canola

- Potassium deficient sunflower and canola plants exhibit reduced plant height, leaf number, and root length.
- Because potassium nutrient is mobile within the plant, deficiencies are first visible in older leaves.
- The edges and areas between veins of older leaves tend to turn yellow, followed by withering.

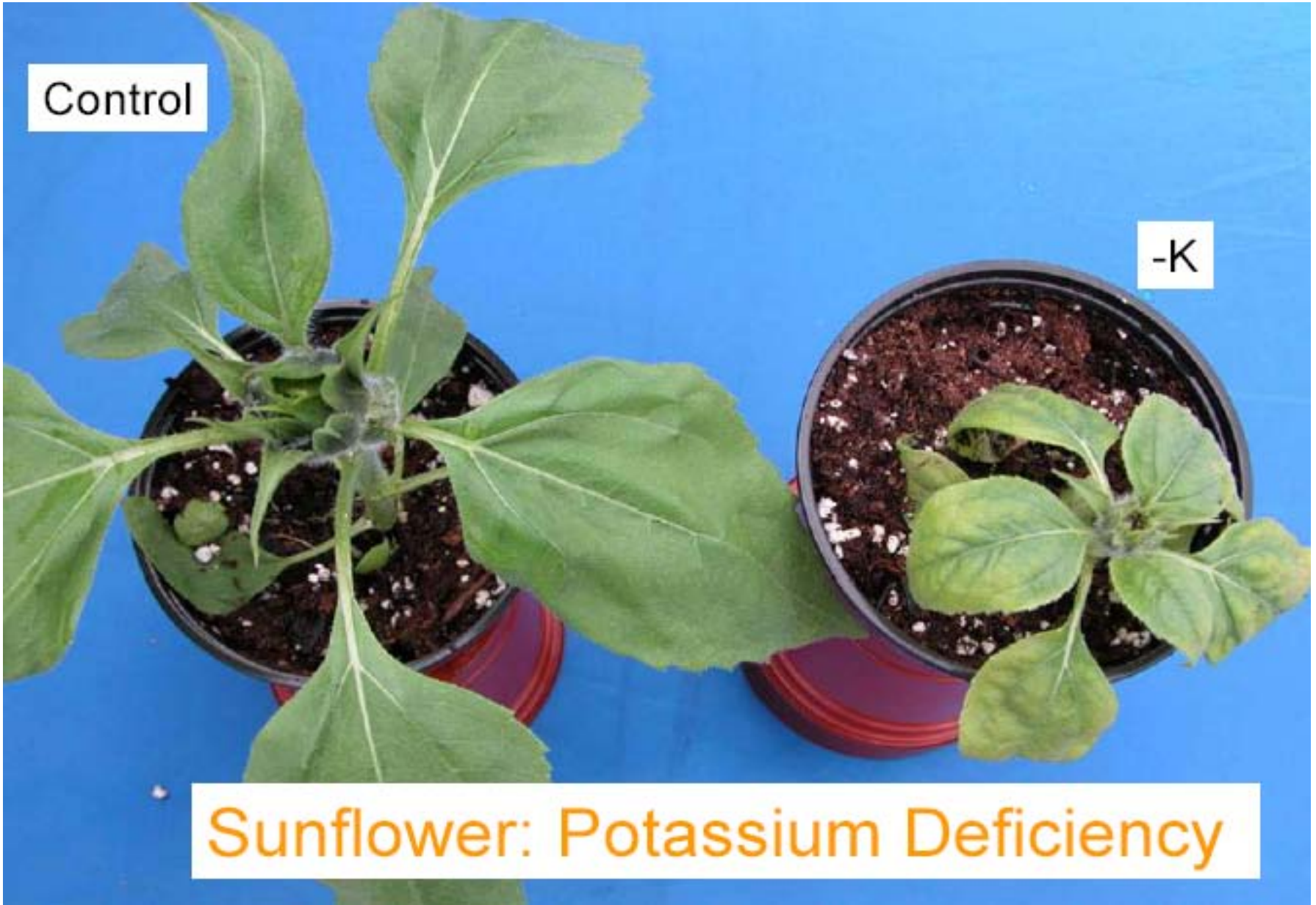
Typical Nutrient Deficiency symptoms on Sunflower Plants

Nitrogen deficiency

Phosphorous deficiency

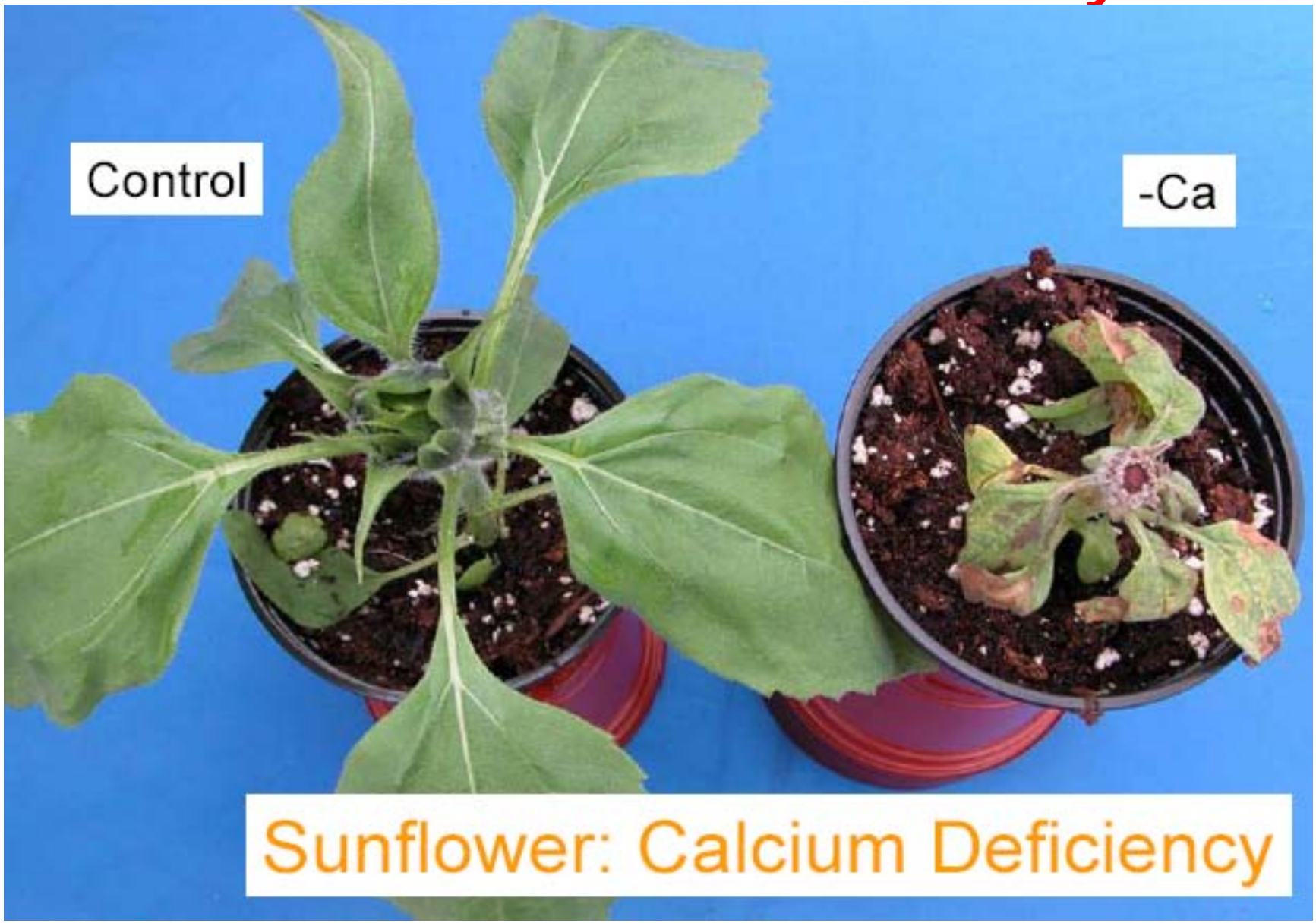


Potassium deficiency



Potassium deficiency

Calcium deficiency



Magnesium deficiency

Boron deficiency

Boron deficiency in sunflower field

Sulfur deficiency

Iron deficiency

Manganese deficiency

Zinc deficiency

Typical Nutrient Deficiency Symptoms on Canola Plants

Nitrogen deficiency

Phosphorous deficiency

Potassium deficiency

Potassium deficiency

Calcium deficiency

Sulfur deficiency

Sulfur deficiency

Sulfur deficiency

Molybdenum deficiency

Boron deficiency

Sunflower and Canola Response to Potassium Fertilizer

- Sunflower and canola plants absorb large amounts of K during over the growing season.
- Both oil seed crops response to K are mostly in sandy soils.
- Critical levels are often stated to be around 280 kg K/ha or 112 ppm in the top 15 cm soil layer.
- The other factors that increase the likelihood of K deficiency are;
  - free lime in the rooting zone,
  - acid soil,
  - poor drainage,
  - cool temperatures,
  - soil compaction,
  - and shallow root zone.

Example: Soil Potassium Status in Trakya Region of Turkey **(Eyüpoğlu, F. 1999).**

Provinces	Potassium levels (kg K_2O/ha)				
	Low *200 kg/ha	Medium 200-300 kg/ha	High 300-400 kg/ha	Very High 400 kg/ha	Total ha
Çanakkale	28.931	45.493	56.886	291.461	**422.771**
Edirne	29.993	67.455	84.878	291.142	**473.468**
İstanbul	12.927	19.077	25.522	123.785	**181.311**
Kırklareli	37.008	49.196	46.352	208.749	**341.305**
Tekirdağ	25.523	73.445	84.807	310.576	**494.351**
Total	**134.382**	**254.666**	**298.445**	**1.225.713**	**1.913.206**

***: Potassium level.**

Nutrient Requirements of Sunflower and Fertilization

- Sunflower plants are deep rooted crops that respond to fertilizer applications most when soil nutrients levels are low.
- Profitable sunflower production requires adequate soil fertility based on soil tests.
- Nitrogen, phosphorous, potassium, calcium are the most yield-limiting nutrients.
- Potassium should be applied preplant-broadcast.
- Preferred fertilizer placement should be 5 cm deep and 2 cm away from the seed in the soil.

Potassium Fertilizer Recommendations

- To improve the accuracy of fertilizer recommendations, farmers should take soil samples before planting crops.
- Optimum production of high-yielding, high-quality sunflower requires fertilization based on an evaluation of the current soil fertility level.
- If the yield goal for sunflower is more than 2.5 tons per ha and the potassium fertility level is low, the fertilizer recommendation would be 100 kg per ha of K_2O.

The amount of broadcast potash (K_2O) recommendations for sunflower specified yield goals (Dahnke *et al*., 1992).

		Soil Test Potassium, ppm (Bray-I Olsen)				
Yield Goal	Soil N plus fertilizer N required	VL 0-40	L 41-80	M 81-120	H 121-160	VH 160+
kg/ha	kg/ha	----------kg K_2O/ha----------				
1500	60	50	40	25	7	0
2000	80	70	50	30	8	0
2500	100	90	60	35	9	0
3000	120	110	70	40	10	0
Bray-I Olsen Potassium recommendation = (0.04653-0.00027 STK)YG						

Seed yield (kg/ha) of sunflower as affected by levels of K and P application (Amanullah *et al*., 2010).

Levels of K (kg ha)	Levels of P (kg/ ha)				
	0	**45**	**90**	**135**	**Mean (K)**
0	813	1049	1220	1356	**1110**
25	888	1118	1244	1376	**1157**
50	917	1145	1381	1538	**1245**
75	1058	1278	1473	1494	**1326**
100	961	1560	1582	1647	**1438**
125	859	1277	1571	1623	**1333**
Mean (P)	**916**	**1238**	**1412**	**1507**	

Seed oil content (%) in sunflower as affected by levels of K and P application (Amanullah *et al*., 2010).

Levels of K (kg ha)	Levels of P (kg/ ha)				
	0	**45**	**90**	**135**	**Mean (K)**
0	37.3	37.0	37.7	38.0	**37.5**
25	39.3	39.0	39.3	38.7	**39.1**
50	39.7	39.3	40.3	41.0	**40.1**
75	41.3	42.0	42.7	43.3	**42.3**
100	42.3	43.0	43.0	43.3	**42.9**
125	43.3	43.7	44.0	44.3	**43.8**
Mean (P)	**40.6**	**40.7**	**41.2**	**41.4**	
LSD for K≤ (p 0.05) = 0.78; LSD for P≤ (p 0.05) = 0.40; LSD for KxP≤ (p 0.05) = ns					

Oil yield (kg/ha) of sunflower as affected by levels of K and P application (Amanullah *et al*., 2010).

Levels of K (kg ha)	Levels of P (kg ha)				
	0	**45**	**90**	**135**	**Mean (K)**
0	304	388	460	515	**417**
25	349	436	489	533	**452**
50	364	451	557	630	**630**
75	437	537	629	647	**562**
100	407	671	680	713	**618**
125	372	558	691	719	**585**
Mean (P)	**372**	**507**	**584**	**626**	
LSD for K≤ (p 0.05) = 35.84; LSD for P≤ (p 0.05) = 29.72; LSD for KxP≤ (p 0.05) = 72.80					

Protein yield (kg/ha) of sunflower as affected by levels of K and P application (Amanullah *et al*., 2010).

Levels of K (kg ha)	Levels of P (kg ha)				
	0	**45**	**90**	**135**	**Mean (K)**
0	191	258	301	342	**273**
25	206	264	295	334	**275**
50	206	258	311	347	**281**
75	235	287	336	338	**299**
100	210	344	354	370	**320**
125	186	280	353	361	**295**
Mean (P)	**206**	**282**	**325**	**349**	
LSD for K≤ (p 0.05) = 23.73; LSD for P≤ (p 0.05) = 15.45; LSD for KxP≤ (p 0.05) = ns					

Fertilization Recommendations On Sunflower in Trakya region of Turkey

- First soil analyses should be done.

Yield goal per hectare: 2.5-3.5 **tones**/ha

Nitrogen (N) 70-90 Kg/ha

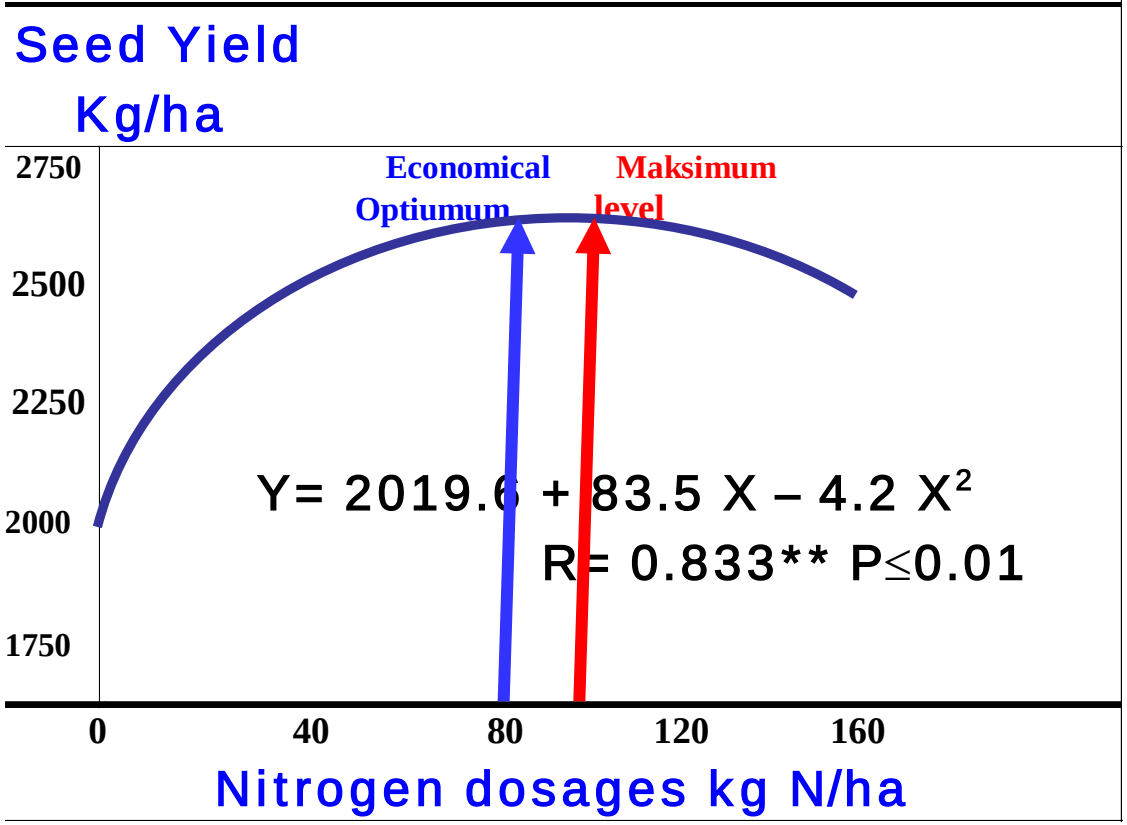
Phosphorus (P) 40-90 Kg/ha (if recommended by soil test)

Potassium (K) 40-100 Kg/ha (if recommended by soil test)

Magnesium (Mg) 30-40 Kg/ha (if recommended by soil test)

Boron (B) 300 g/ha (if recommended by soil test)

Economical optimum nitrogen dosage for sunflower (Trakya-80) fertilization*



*: Edirne conditions

Nutrient Requirements of Canola and Fertilization

- Nutrient uptake by canola depends considerably on species, variety type (winter-/ spring-), yield potential, and water supply.
- Nutrient uptake before winter amounts about 50-100 kg/ha of nitrogen and potassium, also 20-40 kg/ha of calcium and phosphorus.
- At the beginning of growth in spring nutrient uptake starts early and intensively.
- This is particularly the case for potassium which from the start of vegetative growth in spring until flowering, shows highest daily uptake rates (Orlovius, 2003).

Approximate Amounts of Nutrients in the Above-Ground Portion of a 1,960 kg/ha Canola Crop (Orlovius, 2003).

Elements	kg/ha
Nitrogen (N)	**112-134**
Phosphorus (P)	**1-28**
Potassium (K)	**67-134**
(S)	**22-28**
Calcium (Ca)	**45-67**
Magnesium (Mg)	**13-20**
Iron (Fe)	**~1**
Chlorine (Cl)	**~0.8**
Manganese (Mn)	**~0.2**
Zinc (Zn)	**~0.2**
Boron (B)	**~0.2**
Copper (Cu)	**~0.7**
Nickel (Ni)	**~0.004**
Molybdenum (Mo)	**~0.004**

Production efficiency of canola (*Brassica napus* L.) as affected by different K levels Treatments (Khan *et al*., 2004).

Treatments (K kg ha-1)	No. of pods/ plant	No. of seeds/pod	1000-seed weight (g)	Seed yield (kg ha-1)	Seed oil content (%)	Protein content (%)
T0 (0)	607.0 d*	19.67 c	3.043 c	2585 c	42.86 a	19.26 d
T1 (25)	606.3 d	20.30 bc	3.293 bc	3055 b	41.65 ab	20.46 c
T2 (50)	616.7 cd	22.37 ab	3.337 b	3174 ab	40.65 bc	20.55 c
T3 (75)	622.0 c	23.07 a	3.367 bc	3248 ab	39.74 cd	20.71 c
T4 (100)	640.7 b	22.97 a	3.437 ab	3314 ab	38.99 de	21.35 bc
T5 (125)	665.0 a	24.30 a	3.507 ab	3426 a	38.29 ef	21.80 ab
T6 (150)	658.7 a	23.50 a	3.603 a	3473 a	37.4 2f	22.37 a

*: Any two means not sharing a letter in common differ significantly at 5% probability level.

Fertilizer program for canola, Edirne-Turkey

- First soil analyses should be done.

Yield target per hectare: **3.0-4.0 tones** /ha

Nitrogen (N) 140-150 Kg/ha

Phosphorus (P) 40-80 Kg/ha (if recommended by soil test)

Potassium (K) 40-100 Kg/ha (if recommended by soil test)

Sulfur (S) 30-40 Kg/ha (if recommended by soil test)

Magnesium (Mg) 30-40 Kg/ha (if recommended by soil test)

Boron (B) 300 g/ha (if recommended by soil test)

Conclusion

- Nutrient balances are important to sustainability of sunflower and canola production.
- Potassium application plays equally important role as nitrogen and phosphorus in sunflower and canola plants for their growth.
- Integrated nutrient management on sunflower and canola production helps to increase yield and income of farmers.
- According to soil tests, application of 100 kg K ha-1 to sunflower and canola could results in maximum net returns and is therefore, recommended for profitable production.



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