RELATIVE IMPORTANCE OF STEMS AND ROOTS AND THE CHEMICAL COMPOSITION OF SUNFLOWER

By

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The practical application of this research is maintenance of soil productivity in sunflower production which is a long term study; crop rotation aspects were presented at the First International Sunflower Conference.

The immediate objectives of the research presented today were to determine the relative contribution of root and stem to morphology, dry matter yields, and chemical composition of sunflower.

The sunflower plant has a vertical axis of stem on top, root on bottom, and transitional area (hypocotyl) in between where conducting tissues rearrange from stem-to root-like structure. The cotyledons or first leaves are attached at the first node, and the stem begins at the first node. Separations between root and stem for yield and chemical analyses were made at or just below the first node.

By use of the grafting technic, roots and stems were interchanged so that a grafted plant could have its root and stem differing in genotype. Cleft grafts were made with a razor blade and the stem of one plant transferred to the root of another. Grafts were held in place with masking tape, and the plants were covered with clear plastic bags for 4 days to prevent the stems from drying before their new root systems could supply water. Adventitious roots appeared at the grafts but were pulled off before they reached the soil.

Three varieties--Mingren, Arrowhead, Peredovik--were compared in all nine possible root-stem graft combinations. Data on seed weight and oil content of seeds from the nine combinations follow:

Effect on seed weight and oil content of grafting 3 sunflower varieties in 9 combinations of root and stem

Stem Variety	Root Variety: Mingren	Arrowhead	Peredovik	Stem Average
		Weight 100 seeds, gm.		
Mingren	14	15	14	14
Arrowhead	11	9	10	10
Peredovik	8	8	7	8
Root average	11	11	10	
		Oil content, %		
Mingren	21	21	23	22
Arrowhead	25	25	25	25
Peredovik	42	40	37	40
Root average	29	29	28	

Mingren has a large seed of very low oil content, Arrowhead has a medium size seed of low oil content, and Peredovik has a small seed of very high oil content. Inspection of the data and the root and stem averages indicate that roots had little effect, and stems were the major cause of varietal differences. Thus roots of any of the three varieties supplied water and fertilizer nutrients, but the genotypes of the stems determined the plants' varietal characteristics. This was also true for morphological data not reported here such as number of leaves, date of bloom, etc.

The next data comes from a trial of six varieties at seven dates of planting in 1967 on silt loam soil at Rosemount, Minnesota. All dates of planting were sampled the same day so that the seven stages of growth could be compared under nearly identical environmental conditions. The six varieties were 66VI, Krasnodarets, Armavirec, Arrowhead, Mingren, and Peredovik. Stem-root ratios on a dry weight basis varied from 2 1/2/1 to 5/1 July 10 when plants varied from 7 1/2 cm. tall to heading and from 2 1/2/1 to 7/1 August 31 when plants varied from early bloom to mature. Thus roots comprised a much smaller portion of the total dry matter yield of sunflower than did stems.

Chemical analyses of roots, stems, and seed were made to determine whether or not chemical composition varied among varieties or among stages of growth. Nitrogen content was determined by the Kjeldahl method. Phosphorus, potassium, calcium, magnesium, sodium, molybdenum, copper, zinc, boron, manganese, strontium, and iron contents were determined with an emission spectograph.

F values reported in the following table are on data of five stages of growth from head just visible in whorl to 8 cm diameter on July 10, and seven stages (five stages for seed) from early bloom to mature on August 31. Many differences were significant at 1 and 5% levels. Nitrogen was particularly affected by stage of growth varying from over 4% (5 cm seedlings) to about 0.8% in mature plants.

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Significance of F for differences in % compostion among 7 stages of growth and 6 varieties of sunflower. Rosemount, Minn. 1967

	Chemical elements												
	N	Ca	Sr	Fe	Zn	Mn	Mg	Mo	P	K	B	Cu	Na
						Stems + leaves, July 10							
Stage	**	**	**	**	**	**	**	**	*	*	*	N	N
Variety	**	N	N	*	*	N	N	**	**	N	N	*	N
						Stems + leaves, August 31							
Stage	**	**	**	**	**	**	N	N	**	N	N	N	N
Variety	N	N	N	N	N	N	N	N	N	**	N	**	N
						Seed, August 31							
Stage	N	N	**	N	N	N	N	N	*	N	N	N	N
Variety	*	N	N	**	N	*	*	N	**	N	N	**	N

**1%
*5%
N not significant

Except for seed, variation among stages was more often signicant than variation among varieties. Varieties did not significantly differ in compostion with seven elements on July 10 and with eleven of the thirteen elements on August 31. Differences among varieties at the earlier date may be caused by stage differences among the varieties. If variation in chemical compostion among mature plants of these genotypes is not very great, fewer varieties might be used in future studies of this kind.

The calculated elemental contents (yields) of sunflower in kg/ha are shown in the following table.

Yield of elements from sunflower. Rosemount, Minn. 1967

Element	Root*	Stem	Seed	Total
		kg/ha		
N	10	29	81	120
P	2	8	19	29
K	22	62	25	108
Ca	20	60	5	85
Mg	11	33	10	54
Na	1	2	0	3
Mo, Cu, Zn, B, Mn, Sr, Fe .013 to .793 kg/ha				

*Root yields, stem analyses

These data are an average of the six varieties from the three stages of growth where plants were nearly mature August 31. Root analyses are not yet completed so stem composition data and root dry matter yields were used for this column. The seed contained considerably more N and P than did the vegetative parts whereas the reverse was true for most of the other elements. These calculations indicate that total elemental uptake by a high yielding (8300 kg/ha, including root + stem + seed) sunflower crop is not extremely different from that of an average corn crop in the U.S. Cornbelt. However only seed is removed from the field so this column is the most important in considering soil depletion.

Data from a similar trial on sandy soil highly fertilized with K gave similar results with most elements but uptake of K by the stem was very high. This suggests that "luxury consumption" and possibly cation substitution should be considered in using plant chemical composition data.

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