MODE OF INHERITANCE OF NUTRIENT UPTAKE IN SUNFLOWER HYBRIDS NS-H-26-RM, NS-H-27-RM, AND NS-H-62-RM

Prof.Dr. Tihomir Vrebalov,
Faculty of Agriculture, Institute of Field and Vegetable Crops, Novi Sad, Yugoslavia

INTRODUCTION

Studying the uptake and distribution of nutrients and trace elements in sunflower, it was observed that hybrids behaved specifically in that respect. These results moved us to study nutrient uptake by parental lines and F_1 hybrids in order to determine mode of inheritance of uptake and distribution of nutrients and trace elements in some Novi Sad sunflower hybrids. The intention was to find those parental components whose gene recombinations will allow dominant and superdominant inheritance of distribution of important nutrients.

METHOD

Experiments which were conducted in 1986 at the experimental field of Institute of Field and Vegetable Crops involved three hybrids: NS-H-26-RM, NS-H-27-RM, and NS-H-62-RM. The hybrids had the same female line and different male lines. The experiments were carried out in 10 replications. Chemical analyses were done by an atomic absorption spectrophotometer.

RESULTS

Inheritance of nitrogen distribution (N) - Table 2

The three hybrids differed in the inheritance of nitrogen uptake and distribution per plant parts. In NS-H-26-RM, the distribution of nitrogen in the lamina was lower than in either parent (Table 1), while the distribution in the stem was inherited dominantly from the parent with a lower uptake. In NS-H-27-RM, the distribution in the stem was inherited intermediately (i).

In NS-H-62-RM, the distribution of nitrogen in the seed was inherited dominantly from the parent with a lower uptake (with a lower mean value, X).

The inheritance of the distribution of nitrogen in the stem and the petioles of the three hybrids could not be determined because the T test did not show any differences.

Inheritance of phosphorus distribution (P) - Table 3

In NS-H-27-RM, the distribution of phosphorus in the lamina was inherited dominantly from the parent with a higher uptake. The T test did not allow us to bring any conclusions for the other two hybrids.

In NS-H-26-RM, the distribution of phosphorus in the petiole was inherited dominantly from the parent with a higher uptake (the male parent). In NS-H-62-RM, there occurred the dominance of the parent with a lower uptake, and in NS-H-27-RM there occurred superdominance (+h), i.e., the hybrid had a higher uptake than either parent.

In NS-H-26-RM, the distribution of phosphorus in the stem was inherited dominantly from the female parent which had a higher uptake. In NS-H-27-RM and NS-H-62-RM, the inheritance could not be determined on the basis of the T test.

In NS-H-26-RM, the distribution of phosphorus in the head was inherited dominantly from the parent with a lower uptake (-d). In NS-H-27-RM, there occurred the dominance of the male parent which had a higher uptake, and in NS-H-62-RM the inheritance could not be determined on the basis of the T test.

The distribution of phosphorus in the seed was inherited dominantly from the parents with a lower uptake.

<u>Inheritance of potassium distribution</u> (K) - Table 4

In NS-H-26-RM and NS-H-27-RM, the distribution of potassium in the lamina was inherited dominantly from the parents with a lower uptake (-d). In NS-H-62-RM, the inheritance could not be determined on the basis of the T test.

In NS-H-27-RM and NS-H-62-RM, the distribution of potassium in the stem was inherited dominantly from the parents with a higher uptake (+d). In NS-H-26-RM, the inheritance could not be determined on the basis of the T test.

<u>Inheritance of calcium distribution</u> (Ca) - Table 5

In NS-H-26-RM, there occurred superdominance, i.e., heterosis, in the inheritance of the distribution of calcium in the lamina (+h). In NS-H-27-RM and NS-H-62-RM, the distribution of calcium was inherited dominantly from the male parents which had a higher uptake (+d).

Superdominance, i.e., interallelic gene action, occurred in all three hybrids with respect to the inheritance of the distribution of calcium in the petiole.

In NS-H-27-RM, the distribution of calcium in the stem was inherited dominantly from the male parent which had a higher uptake (+d).

In NS-H-26-RM and NS-H-62-RM, there occurred superdominance in the inheritance of the distribution of calcium in the head. In NS-H-27-RM, the distribution was inherited dominantly (+d) from the male parent.

In NS-H-26-RM, the distribution of calcium in the seed was inherited dominantly from the male parent which had a higher uptake (+d). The same was observed in NS-H-62-RM (+d) but in this case the female parent had a higher uptake. In NS-H-27-RM, the inheritance was intermediate.

<u>Inheritance of manganese distribution</u> (Mn) - Table 6

In NS-H-26-RM and NS-H-27-RM, the distribution of manganese in the lamina was inherited intermediately (i), and in NS-H-62-RM there occurred the dominance of the male parent, with a lower uptake (-d).

In NS-H-26-RM and NS-H-27-RM, there occurred superdominance in the inheritance of the distribution of manganese in the petiole. In NS-H-62-RM, the inheritance was intermediate.

In NS-H-26-RM and NS-H-27-RM, the distribution of manganese in the stem was inherited dominantly from the male parent which had a lower uptake (-d) while in NS-H-62-RM the distribution was lower than in either parent (-h).

In NS-H-27-RM and NS-H-62-RM, the distribution of manganese in the head was inherited dominantly from the male parents, with a lower uptake (-d). In NS-H-26-RM, the inheritance was intermediate.

The distribution of manganese in the seed was inherited dominantly from the inferior parent or superdominantly, i.e., it was lower than in either parent.

Inheritance of magnesium distribution (Mg) - Table 7

In NS-H-26-RM, there occurred superdominance in the inheritance of the distribution of magnesium in the lamina. In NS-H-27-RM and NS-H-62-RM, the inheritance was dominated by the male parents which had a higher uptake (+d).

In NS-H-26-RM and NS-H-27-RM, there occurred superdominance in the inheritance of the distribution of magnesium in the petiole. In NS-H-62-RM, the distribution was inherited dominantly from the parent with a higher uptake.

In NS-H-26-RM and NS-H-27-RM, the distribution of magnesium in the stem was inherited intermediately (i). In NS-H-62-RM, the inheritance was dominated by the male parent which had a lower uptake (-d).

In NS-H-26-RM and NS-H-27-RM, the distribution of magnesium in the head was inherited dominantly from the male parents, with a higher uptake (+d). In NS-H-62-RM, the inheritance was superdominant, i.e., there occurred a positive heterosis.

In NS-H-26-RM and NS-H-27-RM, the distribution of magnesium in the seed was inherited dominantly from the male parents, with a higher uptake (+d). In NS-H-62-RM, the inheritance was dominated by the parent with a lower uptake (-d).

Inheritance of iron distribution (Fe) - Table 8

In all three hybrids, negative dominance or superdominance were expressed in the inheritance of iron distribution in the lamina, the petiole, and the stem.

In NS-H-27-RM, the distribution of iron in the seed was inherited intermediately (i). In NS-H-62-RM, the inheritance was dominated by the male parent which had a higher uptake (+d).

Inheritance of zinc distribution (Zn) - Table 9

In NS-H-26-RM, the distribution of zinc in the lamina was inherited intermediately (i), and in NS-H-27-RM there occurred superdominance (+h), i.e., the hybrid had a higher uptake than either parent.

In NS-H-27-RM, the distribution of zinc in the petiole was inherited superdominantly (+h) and in NS-H-62-RM the inheritance was dominated by the parent with a higher uptake (+d). Regarding the inheritance of the distribution of zinc in the stem, extreme and opposite values were found, a positive superdominance in the case of NS-H-27-RM and a negative superdominance in the case of NS-H-62-RM.

In NS-H-27-RM, the distribution of zinc in the head was inherited dominantly from the parent with a lower uptake (-d), and in NS-H-62-RM there occurred a negative superdominance.

In NS-H-27-RM, the distribution of zinc in the head was inherited dominantly from the parent with a lower uptake (-d).

CONCLUSIONS

1. Mode of inheritance of the distribution of assimilates is specific for individual plant parts - lamina, petiole, stem, head, and seed. Not a single one of the examined elements was distributed uniformly in all plant parts (Tables 2 - 9).

2. Nitrogen uptake and distribution were inherited dominantly or superdominantly (-d or -h) from the parents with a lower uptake. Intermediacy was recorded only for the head of NS-H-27-RM.

3. Phosphorus uptake and distribution were mostly inherited dominantly (+d) from the parents with a higher uptake, with the exception of NS-H-62-RM in which the parent with a lower uptake was dominant (-d).

4. Potassium uptake and distribution in the lamina and the petiole were inherited dominantly from the parents with a lower uptake (-d) and the reverse situation was recorded for the stem.

5. Only regarding the uptake and distribution of calcium did there occur a positive heterosis, i.e., there occurred interallelic interactions of genes.

6. Manganese uptake and distribution were mostly inherited dominantly (-d) from the female parents with a lower uptake. The only exception was the distribution of manganes in the petiole.

7. The mode of inheritance of magnesium was opposite to that of manganese, i.e., there occurred dominance and superdominance (+d and +h). The distribution of magnesium in the stem followed a different pattern.

8. The mode of inheritance of iron uptake and distribution was similar to that for manganese.

9. The mode of inheritance of zinc uptake and distribution was similar to that for manganese.

TAB. 1 MODE OF INHERITANCE OF NUTRIENT UPTAKE IN SUNFLOWER HYBRIDS NS-H-26-RM, NS-H-27-RM, AND NS-H-62-RM

PLANT PART / HYBRID	N	P	K	Ca	Mn	Mg	Fe	Zn
LAMINA								
NS-H-26-RM	-h		-d ♂	+h	i	+h	-d ♀	i
NS-H-27-RM		+d ♂	-d ♂	+d ♂	i	+d ♂		+h
NS-H-62-RM	-d ♂			+d ♂	-d ♀	+d ♂	-h	
PETIOLE								
NS-H-26-RM		+d ♀	-d ♀	+h	+h	+h		+h
NS-H-27-RM		+h	-d ♀	+h	+h	+h		+h
NS-H-62-RM		-d ♀		+h	i	+d ♂	-d ♀	+d ♂
STEM								
NS-H-26-RM		+d ♀			-d ♀	i	-d ♀	
NS-H-27-RM			+d ♂	+d ♂	-d ♀	i	-d ♀	+h
NS-H-62-RM			+d ♂		-h	-h ♀		-h
HEAD								
NS-H-26-RM	-d ♀	-d ♀		+h	i	+d ♂		-d ♀
NS-H-27-RM	i	+d ♂		+d ♂	-d ♀	+d ♂		
NS-H-62-RM				+h	-d ♀	+h		-h
SEED								
NS-H-26-RM		-d ♀		+d ♂		+d ♂		
NS-H-27-RM		+d ♂		i	-d ♀	+d ♂	i	+d ♂
NS-H-62-RM	-d ♀	-d ♀		+d ♀	-h	-d ♀	+d ♂	

Tab. 2. Mode of inheritance of nitrogen content in sunflower plant parts at physiological maturity

Plant part	Genotype	X̄	Sx	S	cv	t-test Female	t-test Male	M.I.
Lamina	Female	1.477	0.093	0.293	19			
	Male	1.892	0.039	0.124	6			
	NS-H-26 (F1)	1.081	0.041	0.130	11	3.90**	14.28**	-h
	Male	1.404	0.036	0.114	8			
	NS-H-27 (F1)	1.270	0.082	0.259	20	1.67	1.49	
	Male	1.225	0.035	0.110	8			
	NS-H-62 (F1)	1.132	0.050	0.157	13	3.28**	1.53	-d♂
Petiole	Female	0.637	0.052	0.166	26			
	Male	0.590	0.023	0.073	12			
	NS-H-26 (F1)	0.567	0.036	0.115	20	1.09	0.55	
	Male	0.619	0.029	0.091	14			
	NS-H-27 (F1)	0.735	0.079	0.250	34	1.03	1.37	
	Male	0.716	0.037	0.117	16			
	NS-H-62 (F1)	0.524	0.026	0.083	15	1.92	4.23**	
Stem	Female	0.494	0.035	0.112	22			
	Male	0.545	0.035	0.110	20			
	NS-H-26 (F1)	0.502	0.036	0.115	22	0.15	0.86	
	Male	0.546	0.049	0.157	28			
	NS-H-27 (F1)	0.692	0.069	0.218	31	2.55*	1.72	
	Male	0.560	0.047	0.148	26			
	NS-H-62 (F1)	0.428	0.023	0.074	17	1.57	2.53*	
Head	Female	1.066	0.054	0.170	15			
	Male	1.415	0.032	0.101	7			
	NS-H-26 (F1)	1.043	0.052	0.164	15	0.30	6.11**	-d♀
	Male	1.489	0.042	0.132	8			
	NS-H-27 (F1)	1.293	0.081	0.255	19	2.34*	2.15	i
	Male	1.150	0.075	0.237	20			
	NS-H-62 (F1)	0.972	0.015	0.047	4	1.68	2.31*	
Seed	Female	2.474	0.109	0.343	13			
	Male	2.564	0.052	0.163	6			
	NS-H-26 (F1)	2.317	0.096	0.303	13	1.08	2.27*	
	Male	2.564	0.080	0.253	9			
	NS-H-27 (F1)	2.430	0.067	0.213	8	0.34	1.27	
	Male	3.011	0.139	0.438	14			
	NS-H-62 (F1)	2.316	0.097	0.305	13	1.09	4.11**	-d♀

T tab for 18 df and 1 % = 2.88, and 5 % = 2.10

Tab. 3. Mode of inheritance of phosphorus content in sunflower plant parts at physiological maturity

Plant part	Genotype	X	Sx	S	cv	t-test Female	t-test Male	M.I.
Lamina	Female	0.175	0.015	0.047	27			
	Male	0.157	0.004	0.013	8			
	NS-H-26 (F1)	0.200	0.023	0.073	36	0.88	1.81	
	Male	0.218	0.011	0.034	15			
	NS-H-27 (F1)	0.256	0.023	0.073	28	2.94*	1.50	+d♂
	Male	0.175	0.013	0.043	24			
	NS-H-62 (F1)	0.194	0.016	0.050	26	0.83	0.88	
Petiole	Female	0.095	0.009	0.028	28			
	Male	0.067	0.003	0.010	14			
	NS-H-26 (F1)	0.106	0.007	0.022	20	0.95	5.24**	+d♀
	Male	0.089	0.004	0.011	12			
	NS-H-27 (F1)	0.154	0.012	0.039	25	3.90**	5.03**	+h
	Male	0.128	0.009	0.030	23			
	NS-H-62 (F1)	0.100	0.006	0.019	19	0.44	2.46*	-d♀
Stem	Female	0.062	0.006	0.019	30			
	Male	0.038	0.005	0.015	39			
	NS-H-26 (F1)	0.070	0.010	0.031	44	0.68	2.92*	+d♀
	Male	0.055	0.004	0.011	20			
	NS-H-27 (F1)	0.107	0.017	0.055	51	2.42*	2.90*	
	Male	0.079	0.013	0.040	49			
	NS-H-62 (F1)	0.059	0.006	0.019	32	0.33	1.44	
Head	Female	0.193	0.010	0.033	16			
	Male	0.333	0.010	0.032	9			
	NS-H-26 (F1)	0.238	0.019	0.060	25	2.08	4.40**	-d♀
	Male	0.314	0.012	0.039	12			
	NS-H-27 (F1)	0.285	0.018	0.058	20	4.36**	1.34	+do
	Male	0.211	0.029	0.092	43			
	NS-H-62 (F1)	0.172	0.008	0.026	15	1.55	1.29	
Seed	Female	0.628	0.010	0.031	4			
	Male	0.707	0.010	0.031	4			
	NS-H-26 (F1)	0.626	0.012	0.039	6	0.09	5.14**	-d♀
	Male	0.690	0.019	0.059	8			
	NS-H-27 (F1)	0.657	0.009	0.027	4	2.27*	1.61	+d♂
	Male	0.710	0.023	0.072	10			
	NS-H-62 (F1)	0.610	0.017	0.055	8	0.89	3.50**	-d♀

T tab for 18 df and 1 % = 2.88, and 5 % = 2.10

Tab. 4. Mode of inheritance of potassium content in sunflower plant parts at physiological maturity

Plant part	Genotype	X	Sx	S	cv	t-test Female	t-test Male	M.I.
Lamina	Female	2.187	0.106	0.337	15			
	Male	1.714	0.089	0.283	16			
	NS-H-26 (F1)	1.662	0.078	0.247	14	3.96**	0.44	-d♂
	Male	1.719	0.111	0.350	20			
	NS-H-27 (F1)	1.650	0.106	0.334	20	3.57**	0.45	-d♂
	Male	2.353	0.148	0.468	19			
	NS-H-62 (F1)	2.000	0.122	0.385	19	1.15	1.84	
Petiole	Female	1.888	0.135	0.427	22			
	Male	2.560	0.221	0.700	27			
	NS-H-26 (F1)	1.555	0.131	0.415	26	1.77	3.90**	-d♀
	Male	3.086	0.222	0.701	22			
	NS-H-27 (F1)	1.848	0.118	0.374	20	0.22	4.92**	-d♀
	Male	2.297	0.148	0.467	20			
	NS-H-62 (F1)	2.482	0.248	0.784	31	2.10	0.64	
Stem	Female	2.143	0.192	0.606	28			
	Male	2.867	0.255	0.807	28			
	NS-H-26 (F1)	2.528	0.225	0.710	28	1.30	0.99	
	Male	3.331	0.216	0.682	20			
	NS-H-27 (F1)	3.252	0.210	0.665	20	3.90**	0.26	+d♂
	Male	2.625	0.140	0.443	16			
	NS-H-62 (F1)	3.117	0.211	0.666	21	3.42**	1.94	+d♂
Head	Female	4.026	0.348	1.101	27			
	Male	4.222	0.140	0.444	10			
	NS-H-26 (F1)	4.467	0.362	1.144	25	0.87	0.63	
	Male	4.051	0.175	0.555	13			
	NS-H-27 (F1)	4.927	0.246	0.778	15	2.11	2.89*	
	Male	4.241	0.403	1.273	30			
	NS-H-62 (F1)	5.602	0.269	0.850	15	3.58**	2.81*	
Seed	Female	0.917	0.025	0.078	8			
	Male	0.762	0.010	0.031	4			
	NS-H-26 (F1)	0.861	0.057	0.182	21	0.90	1.69	
	Male	0.863	0.021	0.066	7			
	NS-H-27 (F1)	1.007	0.055	0.173	17	1.50	2.47*	
	Male	0.929	0.023	0.074	7			
	NS-H-62 (F1)	0.793	0.022	0.068	8	3.79**	4.27**	

T tab for 18 df and 1 % = 2.88, and 5 % = 2.10

Tab. 5. Mode of inheritance of calcium content in sunflower plant parts at physiological maturity

Plant part	Genotype	X	Sx	S	cv	t-test Female	t-test Male	M.I.
Lamina	Female	4.900	0.150	0.475	9			
	Male	5.702	0.217	0.685	12			
	NS-H-26 (F1)	6.717	0.150	0.473	7	8.56**	3.85**	+h
	Male	7.406	0.210	0.665	8			
	NS-H-27 (F1)	7.902	0.200	0.633	8	11.99**	1.70	+d♂
	Male	7.236	0.221	0.700	9			
	NS-H-62 (F1)	7.330	0.192	0.607	8	9.97**	0.32	+d♂
Petiole	Female	2.642	0.051	0.160	6			
	Male	2.147	0.140	0.443	20			
	NS-H-26 (F1)	3.577	0.121	0.382	10	7.13**	7.73**	+h
	Male	1.629	0.144	0.455	27			
	NS-H-27 (F1)	3.373	0.094	0.299	8	6.81**	10.12**	+H
	Male	2.064	0.056	0.178	8			
	NS-H-62 (F1)	3.352	0.087	0.277	8	7.01**	12.38**	+h
Stem	Female	1.140	0.063	0.199	17			
	Male	1.229	0.042	0.133	10			
	NS-H-26 (F1)	1.264	0.045	0.142	11	1.59	0.55	
	Male	1.319	0.045	0.142	10			
	NS-H-27 (F1)	1.306	0.035	0.112	8	2.29*	0.22	+d♂
	Male	1.070	0.068	0.214	19			
	NS-H-62 (F1)	0.924	0.026	0.082	8	3.17*	2.01	
Head	Female	1.041	0.022	0.070	6			
	Male	1.494	0.038	0.121	8			
	NS-H-26 (F1)	1.734	0.049	0.155	8	12.89**	3.85**	+h
	Male	1.388	0.051	0.161	11			
	NS-H-27 (F1)	1.388	0.079	0.251	18	4.21**	0.00	+d♂
	Male	1.218	0.047	0.149	12			
	NS-H-62 (F1)	1.594	0.031	0.099	6	14.43**	6.64**	+h
Seed	Female	0.189	0.005	0.017	9			
	Male	0.227	0.007	0.021	9			
	NS-H-26 (F1)	0.210	0.005	0.016	7	2.81*	2.00	+d♂
	Male	0.259	0.008	0.025	9			
	NS-H-27 (F1)	0.218	0.009	0.029	13	2.65*	3.38**	i
	Male	0.153	0.006	0.019	12			
	NS-H-62 (F1)	0.177	0.005	0.014	8	1.67	3.19*	+d♀

T tab for 18 df and 1 % = 2.88, and 5 % = 2.10

Tab. 6. Mode of inheritance of manganese content in sunflower plant parts at physiological maturity

Plant part	Genotype	X	Sx	S	cv	t-test Female	t-test Male	M.I.
Lamina	Female	107.150	3.123	9.874	9			
	Male	218.900	5.464	17.280	7			
	NS-H-26 (F1)	139.500	4.581	14.486	10	5.83**	11.13**	i
	Male	178.400	3.918	12.389	6			
	NS-H-27 (F1)	152.750	2.707	8.561	5	11.03**	5.38**	i
	Male	175.650	3.769	11.919	6			
	NS-H-62 (F1)	111.000	2.363	7.472	6	0.98	14.53**	-d♀
Petiole	Female	48.050	1.893	5.987	12			
	Male	68.230	2.043	6.462	9			
	NS-H-26 (F1)	89.060	2.726	8.621	9	12.35**	6.11**	+h
	Male	64.820	3.366	10.643	16			
	NS-H-27 (F1)	80.340	1.503	4.752	5	13.35**	4.21**	+H
	Male	83.090	3.445	10.895	13			
	NS-H-62 (F1)	64.650	2.138	6.762	10	5.81**	4.54**	i
Stem	Female	19.920	0.623	1.971	9			
	Male	22.750	0.741	2.344	10			
	NS-H-26 (F1)	20.120	0.712	2.253	11	0.21	2.55*	-d♀
	Male	34.030	1.213	3.835	11			
	NS-H-27 (F1)	18.840	0.866	2.739	14	1.01	10.19**	-d♀
	Male	24.540	0.807	2.552	10			
	NS-H-62 (F1)	15.170	0.402	1.271	8	6.40**	10.39**	-h
Head	Female	14.150	0.675	2.135	15			
	Male	29.100	0.763	2.413	8			
	NS-H-26 (F1)	21.000	0.799	2.528	12	6.54**	7.33**	i
	Male	22.850	1.116	3.528	15			
	NS-H-27 (F1)	15.444	0.589	1.863	12	1.44	5.87**	-d♀
	Male	19.100	1.178	3.725	19			
	NS-H-62 (F1)	14.050	0.411	1.301	9	0.12	4.04**	-d♀
Seed	Female	19.500	0.558	1.764	9			
	Male	19.685	0.389	1.230	6			
	NS-H-26 (F1)	20.825	0.565	1.786	8	1.66	1.66	
	Male	26.615	0.586	1.853	6			
	NS-H-27 (F1)	21.060	0.505	1.597	7	2.07	7.18**	-d♀
	Male	25.700	1.317	4.165	16			
	NS-H-62 (F1)	16.510	0.584	1.847	11	3.70**	6.37**	-h

T tab for 18 df and 1 % = 2.88, and 5 % = 2.10

Tab. 7. Mode of inheritance of magnesium content in sunflower plant parts at physiological maturity

Plant part	Genotype	X	Sx	S	cv	t-test Female	t-test Male	M.I.
Lamina	Female	Ø.953	Ø.Ø37	Ø.117	12			
	Male	1.Ø87	Ø.Ø53	Ø.167	15			
	NS-H-26 (F1)	1.369	Ø.Ø44	Ø.139	1Ø	7.25**	4.11**	+h
	Male	1.422	Ø.Ø48	Ø.151	1Ø			
	NS-H-27 (F1)	1.421	Ø.Ø25	Ø.Ø79	5	1Ø.48**	Ø.Ø1	+d♂
	Male	1.449	Ø.Ø57	Ø.18Ø	12			
	NS-H-62 (F1)	1.562	Ø.Ø62	Ø.197	12	8.39**	1.34	+d♂
Petiole	Female	1.469	Ø.Ø69	Ø.218	14			
	Male	Ø.9Ø7	Ø.Ø29	Ø.Ø91	1Ø			
	NS-H-26 (F1)	1.824	Ø.Ø39	Ø.125	6	4.46**	18.78**	+h
	Male	1.Ø37	Ø.Ø67	Ø.211	2Ø			
	NS-H-27 (F1)	1.652	Ø.Ø32	Ø.1Ø1	6	2.4Ø*	8.31**	+h
	Male	1.753	Ø.Ø49	Ø.155	8			
	NS-H-62 (F1)	1.672	Ø.Ø72	Ø.228	13	2.Ø3*	Ø.93	+d♂
Stem	Female	Ø.391	Ø.Ø17	Ø.Ø54	13			
	Male	Ø.958	Ø.Ø37	Ø.117	12			
	NS-H-26 (F1)	Ø.748	Ø.Ø26	Ø.Ø82	11	11.45**	4.62**	i
	Male	Ø.96Ø	Ø.Ø27	Ø.Ø85	8			
	NS-H-27 (F1)	Ø.661	Ø.Ø18	Ø.Ø57	8	1Ø.86**	9.26**	i
	Male	Ø.54Ø	Ø.Ø27	Ø.Ø87	16			
	NS-H-62 (F1)	Ø.424	Ø.Ø23	Ø.Ø72	16	1.16	3.27**	-d♀
Head	Female	Ø.162	Ø.ØØ9	Ø.Ø28	17			
	Male	Ø.45Ø	Ø.Ø19	Ø.Ø59	13			
	NS-H-26 (F1)	Ø.478	Ø.Ø16	Ø.Ø5Ø	1Ø	17.25**	1.14	+d♂
	Male	Ø.343	Ø.Ø13	Ø.Ø43	12			
	NS-H-27 (F1)	Ø.342	Ø.Ø14	Ø.Ø45	13	1Ø.7Ø**	Ø.Ø5	+d♂
	Male	Ø.216	Ø.ØØ9	Ø.Ø29	13			
	NS-H-62 (F1)	Ø.372	Ø.ØØ8	Ø.Ø26	7	17.28**	12.76**	+h
Seed	Female	Ø.3Ø6	Ø.ØØ7	Ø.Ø21	6			
	Male	Ø.386	Ø.ØØ7	Ø.Ø21	5			
	NS-H-26 (F1)	Ø.372	Ø.ØØ6	Ø.Ø19	5	7.34**	1.56	+d♂
	Male	Ø.347	Ø.Ø11	Ø.Ø33	9			
	NS-H-27 (F1)	Ø.357	Ø.ØØ4	Ø.Ø13	3	6.51**	Ø.9Ø	+d♂
	Male	Ø.345	Ø.Ø1Ø	Ø.Ø3Ø	8			
	NS-H-62 (F1)	Ø.292	Ø.ØØ8	Ø.Ø24	8	1.37	4.32**	-d♀

T tab for 18 df and 1 % = 2.88, and 5 % = 2.1Ø

Tab. 8. Mode of inheritance of iron content in sunflower plant parts at physiological maturity

Plant part	Genotype	X	Sx	S	cv	t-test Female	t-test Male	M.I.
Lamina	Female	555.300	30.833	97.502	17			
	Male	899.450	26.385	83.438	9			
	NS-H-26 (F1)	476.550	21.496	67.976	14	2.09	12.42**	-d♀
	Male	467.940	34.273	108.382	23			
	NS-H-27 (F1)	617.550	31.460	99.485	16	1.41	3.21*	
	Male	714.800	22.409	70.863	9			
	NS-H-62 (F1)	380.500	12.646	39.990	10	5.24**	12.99**	-h
Petiole	Female	141.080	6.198	19.599	13			
	Male	177.560	6.886	21.776	12			
	NS-H-26 (F1)	167.280	15.308	48.407	28	1.58	0.61	
	Male	137.570	7.794	24.647	17			
	NS-H-27 (F1)	163.760	13.655	43.181	26	1.51	1.66	
	Male	223.075	12.173	38.494	17			
	NS-H-62 (F1)	138.010	8.401	26.566	19	0.29	5.75**	-d♀
Stem	Female	165.960	8.161	25.808	15			
	Male	188.800	5.552	17.557	9			
	NS-H-26 (F1)	147.750	7.980	25.236	17	1.59	4.22**	-d♀
	Male	192.730	7.777	24.594	12			
	NS-H-27 (F1)	153.355	8.511	26.916	17	1.06	3.41**	-d♀
	Male	161.860	12.169	38.482	23			
	NS-H-62 (F1)	132.833	7.627	24.119	18	2.96*	2.02	
Head	Female	132.300	4.895	15.478	11			
	Male	157.650	3.856	12.195	7			
	NS-H-26 (F1)	151.850	9.394	29.706	19	1.84	0.57	
	Male	130.850	2.168	6.856	5			
	NS-H-27 (F1)	131.500	4.873	15.409	11	0.11	0.12	
	Male	132.950	3.953	12.500	9			
	NS-H-62 (F1)	134.450	6.408	20.264	15	0.26	0.19	
Seed	Female	77.050	2.097	6.631	8			
	Male	73.570	2.013	6.365	8			
	NS-H-26 (F1)	73.770	4.391	13.884	18	0.67	0.04	
	Male	52.350	1.913	6.049	11			
	NS-H-27 (F1)	64.600	1.807	5.714	8	4.49**	4.65**	i
	Male	91.900	3.391	10.723	11			
	NS-H-62 (F1)	91.690	3.111	9.837	10	3.90**	0.04	+d♂

T tab for 18 df and 1 % = 2.88, and 5 % = 2.10

Tab. 9. Mode of inheritance of zinc content in sunflower plant parts at physiological maturity

Plant part	Genotype	X	Sx	S	cv	t-test Female	t-test Male	M.I.
Lamina	Female	53.650	3.110	9.834	18			
	Male	90.225	5.796	18.329	20			
	NS-H-26 (F1)	65.967	3.674	11.619	17	2.55*	3.53**	i
	Male	41.194	2.247	7.106	17			
	NS-H-27 (F1)	72.675	3.957	12.513	17	3.78**	6.91**	+h
	Male	47.600	2.341	7.403	15			
	NS-H-62 (F1)	67.944	2.038	6.445	9	3.84**	6.55**	
Petiole	Female	30.433	1.752	5.540	18			
	Male	19.905	1.142	3.612	18			
	NS-H-26 (F1)	40.970	2.048	6.476	15	3.91**	8.98**	+h
	Male	19.995	1.423	4.499	22			
	NS-H-27 (F1)	42.495	2.102	6.649	15	4.40**	8.86**	+h
	Male	35.010	1.736	5.490	15			
	NS-H-62 (F1)	38.560	1.775	5.612	14	3.25**	1.43	+d♂
Stem	Female	30.920	1.537	4.860	15			
	Male	21.555	1.122	3.549	16			
	NS-H-26 (F1)	25.160	2.926	9.253	36	1.74	1.15	
	Male	22.250	1.360	4.301	19			
	NS-H-27 (F1)	40.077	1.532	4.846	12	4.21**	8.70**	+h
	Male	28.560	1.938	6.128	21			
	NS-H-62 (F1)	19.060	0.850	2.687	14	6.75**	4.49**	-h
Head	Female	22.800	1.031	3.259	14			
	Male	34.138	1.054	3.331	9			
	NS-H-26 (F1)	25.950	1.728	5.464	21	1.56	4.04**	-d♀
	Male	25.875	1.321	4.177	16			
	NS-H-27 (F1)	25.833	1.133	3.582	13	1.98	0.02	
	Male	25.650	1.057	3.342	13			
	NS-H-62 (F1)	18.500	1.052	3.327	17	2.92*	4.79**	-h
Seed	Female	57.220	1.286	4.066	7			
	Male	55.461	3.290	10.403	18			
	NS-H-26 (F1)	68.830	2.072	6.552	9	4.76**	3.43**	
	Male	61.935	1.674	5.292	8			
	NS-H-27 (F1)	63.835	1.402	4.434	6	3.47**	0.87	+d♂
	Male	60.250	1.369	4.330	7			
	NS-H-62 (F1)	47.845	3.275	10.356	21	2.66*	3.49**	

T tab for 18 df and 1 % = 2.88, and 5 % = 2.10