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Assessment Of Harvest Index And Plant Maturity In Linseed Plant In Saline Conditions

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Abstract

The term "harvest index" is used in agriculture to quantify the yield of a crop species versus the total amount of biomass that has been produced. The commercial yield can be grain, tuber or fruit. The present study deals with assessment of harvest index and maturity of plants under salinity conditions.

Introduction

Harvest index can apply equally well to the ratio of yield to total plant biomass (shoots plus roots) but above-ground biomass is more common because root mass is so difficult to obtain.The harvest index of the lupin plants was about 0.33. Potential values for the harvest index of various crop and horticultural species are studied by various researchers.Domesticated plants have been subjected to sustained selection pressures on reproductive development by humans and now reflect wide variation from tuber-forming species such as potato, where over 80% of plant biomass is harvested as storage organs, to high-value flower crops such as tulip where blooms might represent only 20% of the final biomass of whole plants. Mid-range are legumes, cereals and other grain crops where human selection for yield has led to a notable increase in HI. Wheat, for example, increased from between 0.30 and 0.35 to almost 0.55 over a century, while barley and rice have shown similar trends (Anonymous).Yield of a cereal crop such as wheat or rice depends on the numbers of seeds that mature on a plant, and their size. Carbon partitioning during vegetative development and before flowering influences the number of flowers that are formed on a plant, as the reproductive sink competes with growing tissue in leaves, stems and roots for carbon supply. Carbon partitioning after flowering influences the rate of seed growth and the final size of the seed.Major sources of variation in yield can be identified via a simple yield component model. Taking cereals as an example, final grain yield (g m^{-2}) is a product of grains per square metre and mass per grain.Planting density and fertilizer can further influence yield components, as *vide supra*. In cereals, lateral shoots are called "tillers", and the mature inflorescence that forms on a mature tiller an "ear". Ears m^{-2} is in turn an outcome of planting density (plants m^{-2}), tillers per plant and ears per tiller. Not all

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tillers produce an ear, especially if the density is high and the plants then limited by light as well as possibly by fertilizer or water.A major impetus to improve HI in cereals came from the introduction of dwarfing genes. In primitive wheats, and tall plants generally, reproductive structures have to compete with rapidly extending stems for photoassimilate, but dwarf cultivars alleviate such competition and enable a shift in carbon partitioning to ears. Early growth of ears and stems in two lines of a Mexican spring wheat illustrate this principle.

Methodology And Experimentation

The material for this experiment comprises 10 selected varieties of linseed *(Linumusitaissimum L.)* out of 50 varieties for their relative salinity tolerance. Seeds of 50 varieties of linseed were obtained from the coordinator, All India Co-ordinated Research Project (Linseed), Chandrashekhar Azad University of Agriculture and Technology, Kalyanpur, Kanpur. Preliminary screening of these varieties against various levels of salinity was done at R.B.S. College Agriculture Research Farm, Bichpuri, Agra and 10 varieties showing relative tolerance to salinity were selected for the present study during 2002-2003 crop season.

The seeds of 10 selected varieties namely Neelum, DPL-121, T-65, S-36, Hira, K-2, Gaurav, Subhra, Neela and LCM-926 were sown in well laid out plots at R.B.S. College Agriculture Research Farm, Bichpuri, Agraon during 2002-2003 crop season and 2003-04 crop season, in a “Split Plot Design” with three replications. The distances between row to row and plant to plant were kept 30 cm and 7 cm respectively. All possible reciprocal crosses were attempted amongst 10 varieties of linseed at best water and saline water conditions in 2002-03. Seventy one hybrids thus generated at best water and 66 hybrids under saline water were sown during 2003-04. The data were recorded from each plot on the randomly selected plants to study following characters during both crop seasons. Germination and Plant height was measured 15 days before harvest by taking vertical height starting from soil surface to the tallest shoot.

Experimental site, Climate and weather conditions: The experiment was conducted at R.B.S. College Agriculture Research Farm, Bichpuri, Agra for two consecutive rabi crop seasons. During both crop seasons, the experimental site remained the same. The depth of the ground water table remained around 14.00 meters from soil surface. The R.B.S. College Agriculture Research Farm is located at 28.3E longitudes and 169.5 m above mean sea level. The climate is semi-arid and sub-tropical with hot dry summers and severely cold winters. In summers, temperature goes upto46^{0}C with desiccating westernly wind and in winters it fallsupto1^{0}C with occasional ground frost. The average annual rainfall is about 650 mm of which 80 per cent in received during July and August.

Physio-Chemical characters of the Experimental soil before sowing.

S. No.	Particulars	
1.	Texture	Sandy loam
2.	Saturation (%)	26.25
3.	Hydraulic conductivity (cm/hr)	1.50
4.	Available N	79 Kg/ha
5.	Available P_2O_5	18.65 Kg/ha
6.	Available K_2O	456 Kg/ha
7.	pH	8.18
8.	EC (dS/m)	1.95
9.	Percentage of $CaCO_3$	0.51

During both crop seasons i.e. 2002-03 and 2003-04 three salt irrigations were applied. First irrigation was given before 8 days of sowing, second after 40 days and third after 80 days of sowing. The water for three irrigations was prepared by dissolving six salts viz. NaCl, Na_2SO_4, Na_2CO_3, $MgSO_4$, $MgCl_2$, $CaCl_2$in the canal water and different levels of EC (8, 10 and 12) were maintained through required quantity of salts.

Salinity with 4 levels :S_0 = best water, S_1 = EC – 8, S_2 = EC – 10, S_3 = EC – 12

Varieties :P_1 = Neelum, P_2 = DPL – 121, P_3 = T -65, P_4 = S -36, P_5 = Hira, P_6 = K -2, P_7 = Gaurav, P_8 = Subhra, P_9 = Neela, P_{10} = LCM – 926

1. **Days to 50 per cent maturity :** The number of days taken from the date of sowing to the maturity of 50 per cent capsule was recorded.

2. **Harvest index :** Harvest index was calculated with the help of a formula given below :

$$\text{Harvest Index} = \frac{\text{Seed wt/plant} \times 100}{\text{Seed wt./plant + straw wt./plant}}$$

***Statistical analysis*:** The experimental observations recorded on the characters mentioned earlier have been subjected to the following biometrical analysis in hybrid population of two consecutive years and F2 population of one year only in the present investigation.

Results And Discussion

Days to 50 per cent maturity:

Table No. 1 shows fluctuating trends of duration for 50 per cent maturity to the linseed germplasm. When compared with S_0, the duration for maturity increases significantly at S_2 and S_3 levels during 2003-04 late sown crop season. Maximum duration for 50 per cent maturity was recorded at S_3 level of salinity.

Table No. 1: Effect of various salinity levels on day to 50 per cent maturity in ten varieties of *Linseed* at two successive crop seasons.

Salinity Levels	Crop Season	
	2002-03	**2003-04**
S_0	104.00	103.06
S_1	105.30	105.40*
S_2	104.04	105.12
S_3	103.80	103.13
C.D. at 5%	2.81*	1.21*
C.D. at 1%	4.00**	1.72**

Table No. 2: Average days to 50 per cent maturity of each variety at salinity conditions (combined effect) S_1 to S_3.

Varieties	Crop Season	
	2002-03	**2003-04**
P_1	103.65	103.50
P_2	104.00	103.06
P_3	104.40**	104.50**
P_4	109.00**	108.38**
P_5	102.90	103.16
P_6	103.00*	103.60
P_7	104.10	103.95
P_8	102.83*	103.36
P_9	104.61**	104.66**
P_{10}	7.99**	7.71**
C.D. at 5%	0.61*	0.57*
C.D. at 1%	0.80**	0.76**

Table No. 2 shows the sensitivity of individual cultivar of linseed to the saline conditions with respect to duration of 50 per cent maturity. As compared to P1 a significant increase was noted in P3, P4 and P9 during both crop seasons.

Table No. 3: Effect of three levels of salinity on ten varieties of Linseed for days to 50 per cent maturity during 2002-03

Varieties	**S_0**	**S_1**	**S_2**	**S_3**
P_1	103.66	103.45	104.10	104.01
P_2	103.00	105.33**	102.55	102.40*
P_3	105.16	105.00**	104.10	105.00
P_4	108.33**	109.00**	109.33**	108.01**
P_5	103.33	102.90	103.66	102.68
P_6	104.33	105.00	102.33**	102.33**
P_7	103.33	106.33**	104.66	103.40
P_8	101.66**	106.00**	102.67	101.66**
P_9	104.66	106.00**	104.68	105.00
P_{10}	102.00**	104.33	102.69	103.00
C.D. at 5%	1.50*			
CD at 1 %	1.97**			

When compared for interaction of various salinity levels to individual linseed variety, it was observed that P_4 showed significant increase for duration of 50 per cent maturity at all salinity levels during both crop seasons (table No. 3 and 4). Cultivar $P_8$and P_9 showed some significant fluctuating trends for increase or decrease in duration, during both crop seasons. Remaining varieties were found to have some changes occasionally only, during timely sown crop (Table No. 3).

Table No. 5: Effect of three levels of salinity on ten varieties of Linseed for days to 50 per cent maturity during 2003-04

Varieties	**S_0**	**S_1**	**S_2**	**S_3**
P_1	103.60	103.85	104.00	104.01
P_2	103.60	105.50*	102.33	102.40*
P_3	105.18*	105.90	105.00	105.00
P_4	109.00**	108.00**	108.50**	108.01**
P_5	103.15	104.83	103.01	102.68
P_6	105.16*	104.50	103.00	103.50
P_7	103.01	105.33**	104.68	104.40
P_8	101.68*	108.00*	102.83	103.18
P_9	104.50	106.50*	105.01	105.33**
P_{10}	101.83*	103.90	103.40	103.66
C.D. at 5%	1.44*			
CD at 1 %	1.87**			

Table No. 6 : Comparative effect of salinity on days to 50 per cent maturity in the hybrids of *Linseed* during 2003-04.

Crosses	S_0	S_1	Crosses	S_0	S_1
P_1 x P_2	+101.00	-105.00	**P_7x P_1**	-105.00	+104.00
x P_3	+101.00	-105.00	xP_2	+102.00	+103.00
x P_4	+101.00	+105.00	x P_3	+102.00	+103.00
x P_5	+100.00	-105.00	x P_4	+103.00	+104.00
x P_6	+103.00	+104.00	x P_5	+101.00	-
x P_7	+102.00	+103.00	x P_6	+104.00	+106.00
x P_8	+102.00	+103.00	x P_8	±103.00	+104.00
x P_9	+103.00	+104.00	x P_9	+103.00	+1`03.00
x P_{10}	+102.00	-105.00	x P_{10}	+102.00	+102.00
P_4 x P_1	+102.00	+104.00	**P_8 x P_1**	+103.00	+102.00
xP_2	+103.00	+102.00	xP_2	+103.00	+102.00
x P_3	+105.00	+104.00	x P_3	+102.00	+102.00
x P_5	+102.00	+104.00	x P_4	+104.00	+104.00
x P_6	+103.00	+107.00	x P_5	+101.00	+105.00
x P_7	+100.00	+103.00	x P_6	+102.00	-
x P_8	+103.00	+104.00	x P_7	-103.00	+104.00
x P_9	+105.00	+104.00	x P_9	+101.00	+104.00
x P_{10}	+103.00	+102.00	xP_{10}	+101.00	-
P_5 x P_1	-105.00	-	**P_9 x P_1**	-105.00	+105.00
xP_2	-105.00	-106.00	xP_2	-105.00	+104.00
x P_3	+103.00	+104.00	x P_3	-	+103.00
x P_4	-103.00	-104.00	x P_4	+106.00	-
x P_6	-102.00	-105.00	x P_6	+104.00	+104.00
x P_7	+100.00	+104.00	x P_7	-107.00	+103.00
x P_8	+103.00	+102,00	x P_8	+105.00	+103.00
x P_9	+104.00	-105.00	x P_9	+105.00	+103.00
x P_{10}	+100.00	-104.00	x P_{10}	-104.00	+103.00
P_6 x P_1	+103.00	+105.00	**P_{10} x P_1**	+102.00	+103.00
xP_2	-107.00	+102.00	xP_2	-103.00	+105.00
x P_3	+103.00	+104.00	x P_3	+105.00	+102.00
x P_4	+102.00	+103.00	x P_4	+106.00	+102.00
x P_5	-105.00	+100.00	x P_5	+104.00	+102.00
x P_7	+106.00	+103.00	x P_7	+104.00	+104.00
x P_8	+105.00	+102.00	x P_8	-104.00	-
x P_9	+103.00	+103.00	x P_9	-104.00	+103.00
x P_{10}	+103.00	+101.00	x P_{10}	+103.00	-104.00

Harvest Index : Use of saline water in irrigation reduced the harvest index of linseed significantly at 1 per cent probability, at all the concentrations used in this experiment, during both crop seasons (Table No. 7). The reduction in harvest index (H.I.) was more pronounced at S_2 (10 dS/m) and above.

Table No. 7: Effect of various salinity levels on Harvest Index (H.I.) in ten varieties of *Linseed* at two successive crop seasons.

Salinity Levels	Crop Season	
	2002-03	**2003-04**
S_0	43.00	25.65
S_1	37.60**	36.95**
S_2	31.75**	31.50**
S_3	27.65**	26.60**
C.D. at 5%	1.05*	1.20*
C.D. at 1%	1.50**	1.72**

Table No. 8: Average seed size of Harvest Index of each variety at salinity conditions (combined effect) S_1 to S_3.

Varieties	Crop Season	
	2002-03	**2003-04**
P_1	26.55	25.65
P_2	37.60**	36.95**
P_3	38.90**	37.95**
P_4	41.00**	39.42**
P_5	31.60**	30.45**
P_6	40.20**	39.29**
P_7	35.03**	34.22**
P_8	37.15**	36.45**
P_9	37.98**	38.15**
P_{10}	36.90**	36.35**
C.D. at 5%	8.71*	1.55*
C.D. at 1%	1.14**	2.04**

Table No. 8 shows the effect of individual variety on harvest indeed in salinity conditions. A significantly consistent increase (at 1 per cent probability) in the harvest index was observed in all varieties when compared with P_1 during both crop seasons. Maximum increase was, however, noted in P_4, P_6, P_3 and P_9 during both crop seasons.

Table No. 9: Effect of three levels of salinity on ten varieties of Linseed for Harvest Index during 2002-03

Varieties	**S_0**	**S_1**	**S_2**	**S_3**
P_1	36.90	28.50	18.50	15.30
P_2	43.90**	35.75**	38.15**	33.25**
P_3	43.40**	37.35**	36.70**	32.40**
P_4	43.15**	39.25**	41.50**	36.60*
P_5	43.50**	30.90*	21.39**	17.75*
P_6	44.40**	41.00**	40.82**	34.80**
P_7	46.08**	32.95**	30.48**	25.80**
P_8	40.15**	41.40**	33.60**	29.15**
P_9	44.15**	41.50**	28.80**	27.40**
P_{10}	44.00**	42.65**	27.85**	23.84**
C.D. at 5%	2.12*			
CD at 1 %	2.80**			

When compared for interaction of various salinity levels to individual linseed variety against P_1, it is observed that significant increase for harvest index for different varieties at all salinity levels was consistant (Table No. 9 and 10) during both crop seasons.

Table No. 10: Effect of three levels of salinity on ten varieties of Linseed for Harvest Index during 2003-04

Varieties	**S_0**	**S_1**	**S_2**	**S_3**
P_1	35.50	27.60	17.35	41.40
P_2	41.80**	36.00**	37.73**	31.60**
P_3	40.90**	36.65**	36.17**	31.18**
P_4	40.80**	38.90**	41.08**	35.20**
P_5	41.02**	38.09**	20.50	16.72
P_6	43.30**	40.18**	40.40**	33.85**
P_7	45.50**	32.20**	29.83**	24.65**
P_8	38.75	41.15**	33.09**	28.35**
P_9	43.92**	41.25**	31.61**	26.45**
P_{10}	43.77**	42.30**	27.82**	23.00**
C.D. at 5%	3.80*			
CD at 1 %	4.95**			

Table No. 11 : Comparative effect of salinity on Harvest Index in the hybrids of *Linseed* during 2003-04.

Crosses	S_0	S_1	Crosses	S_0	S_1
P_1 x P_2	-41.25	-22.50	**P_7x P_1**	+48.50	-26.00
x P_3	+45.50	-30.51	xP_2	-45.20	+36.09
x P_4	-40.65	-21.04	x P_3	+52.65	-22.60
x P_5	+49.00	-21.24	x P_4	-43.30	-25.20
x P_6	+44.40	-31.42	x P_5	-45.25	-
x P_7	-44.50	-24.70	x P_6	-39.25	-21.19
x P_8	+44.00	-18.05	x P_8	-45.50	-27.15
x P_9	-43.65	-16.80	x P_9	-44.65	-27.00
x P_{10}	-42.90	-21.30	x P_{10}	-42.57	-30.85
P_4 x P_1	-39.00	-23.06	**P_8 x P_1**	-22.30	-20.90
xP_2	-36.75	-28.00	xP_2	+48.00	-15.60
x P_3	-36.45	-36.50	x P_3	+41.90	-20.40
x P_5	+42.25	-34.40	x P_4	-40.50	-21.35
x P_6	-35.15	-28.50	x P_5	+46.80	-14.03
x P_7	-43.20	+39.60	x P_6	-42.20	-
x P_8	+41.60	-28.48	x P_7	+46.78	+41.37
x P_9	-39.88	-28.70	x P_9	-42.65	-20.14
x P_{10}	+47.34	-22.00	xP_{10}	+48.00	-
P_5 x P_1	+49.25	-	**P_9 x P_1**	-38.06	-21.50
xP_2	-40.60	-16.50	xP_2	-40.40	-22.65
x P_3	+51.40	-21.20	x P_3	-	-17.15
x P_4	-40.20	-15.75	x P_4	-35.30	-
x P_6	-39.60	-25.25	x P_6	+46.70	-16.20
x P_7	-45.30	-20.40	x P_7	-35.60	-30.00
x P_8	+41.40	-20.01	x P_8	-36.09	-26.60
x P_9	-42.70	-17.61	x P_9	+44.80	-11.30
x P_{10}	+56.88	-23.68	x P_{10}	+51.90	-20.65
P_6 x P_1	-38.40	-18.90	**P_{10} x P_1**	-39.30	-14.00
xP_2	-38.09	-19.50	xP_2	+48.35	-15.00
x P_3	+46.62	-13.98	x P_3	-35.08	-17.30
x P_4	-36.50	-20.04	x P_4	-42.60	-15.04
x P_5	-37.40	-16.40	x P_5	+44.86	-18.80
x P_7	-42.95	-20.02	x P_7	+44.70	-17.40
x P_8	+45.30	-21.15	x P_8	-44.20	-
x P_9	+44.92	-25.15	x P_9	-44.10	-14.54
x P_{10}	+47.80	-14.39	x P_{10}	+46.15	-21.65

The performance of hybrids obtained from reciprocal crosses of ten cultivars of linseed was studied for harvest index under best water and saline water (dS/m) conditions. The data recorded are presented in the table 11. It is seen that harvest index have increased in 25 hybrids over their best parent in best water conditions and in 3 hybrids under saline conditions. The maximum harvest index was observed in the hybrid involving the parent P_5 x P_{10} under best water conditions followed by P_7 x P_3 and P_9 x P_{10}. On the other hand, although salinity reduced harvest index in general, a positive heterosis for this character was noted among 3 hybrids of which P_8 x P_7 had maximum value followed by P_4 x P_7.

The effect of salinity on duration for 50 per cent maturity revealed fluctuating trends at various salinity levels and the difference in most of the cases, remained insignificant. When compared for individual cultivars variety S-36 took about 110 days from the date of sowing to 50 per cent maturity and Subhra took 105 days. In most of the varieties, the longest duration was recorded at 8 dS/m sanility. Among the hybrids a general tendency of delayed maturity was observed in best water as well as in saline water irrigated plots. In general, the harvest index of late sown crop was lesser than that of timely sown crop and higher salinity reduced it significantly during both crop seasons. When compared with Neelum the value of harvest index was significantly greater in all other varieties. Variety S-36 had highest average value of this parameter at all salinity levels followed by K-2. However, Garima in best water and Neela at dS/m excelled all other. Among the hybrids maximum harvest index was observed in the cross combination Hira x LCM-926 in best water and Subhra x Gaurav in 10 dS/m salinity.

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