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EFFECT OF CYCOCEL AND SALINE IRRIGATION WATER ON GERMINATION, YIELD AND YIELD ATTRIBUTES IN DIFFERENT CULTIVARS OF BARLEY *(HORDEUM VULGARE L.)*

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Barley cultivar RD-2035 proved better with respect to number of effective tillers, leaf area, number of spikelets, straw yield, seed yield, test weight and harvest index as compared to BL-2, RD-2052 and RD-2516. Variety BL-2 had more germination percentage at 7 DAT and plant height at 30 and 60 DAS, while RD-2052 proved better in number of grains/ear and chlorophyll content as compared to the rest three varieties. Saline irrigation at EC_{12} dSm^{-1} decreased germination percentage, root length, leaf area, chlorophyll content, protein content, seed yield, straw yield and harvest index and test weight as compared to control. Soaking of seed in cycocel (500 and 1000 mgl^{-1}) increased water potential, chlorophyll content, protein content and seed yield significantly. The study revealed that soaking of the seed in cycocel for five hours at 1000 mgl^{-1} before sowing could ameliorate the adverse effect of saline irrigation in barley. The use of cycocel was also found economical. However no interaction was found significant.

Keywords : Barley; Cycocel; Saline irrigation; Yield.

Introduction

Barley (*Hordeum vulgare* L) is one of the most important cereals of the world. It is an important Rabi cereals occupying 8.41 lac hectares of area. It is also used to prepare malt for manufacturing beer, whisky, industrial alcohol and vinegar. Salt stress is a serious problem in crop production and about 7.01 million-hectare of land is affected by salinity and alkalinity problem in India[1]. Plant growth retardant have shown promises in amelioration of salt stress[2]. The investigation was, therefore, carried out aiming to evaluate performance of different cultivars of barley and improving its tolerance to salinity through cycocel.

Material and Methods

The seed of four barley varieties BL-2 (salinity tolerant),RD-2052,Rd-2516 and RD-2035 (salinity susceptible) ware soaked in cycocel solution at 0, 500 and 1000 mgl^{-1} for 5 hours. In the Petridishes (laboratory experiment), the different levels of salinity (EC_6 and EC_{12} dSm^{-1}) were maintained with the help of saline water. Germination % and seedling length were recorded at 7 DAT (Days After Treatment).

In an other set of experiment cycocel soaked seeds were sown in the pots irrigated with saline waters of (EC_6 and EC_{12} dSm^{-1}) besides control. The observations were recorded and analysis done at vegetative (30 DAS), pre anthesis (60 DAS) and harvesting stages.

Leaf area was measured using LI-3100 area meter. Chlorophyll content was estimated by the method of Arnon[3]. Protein was estimated according to the method described by Lowry *et al.*[4]. Water potential was measured by pressure chamber (PMS Instrument Co, USA).

Results and Discussion

Data regarding germination and seedling growth have bean presented inTable 1. In the laboratory experiment, a significant increase in germination percentage was registered higher in variety BL-2 over varieties RD-2516and at par with variety RD-2035 and 2052. The root as well as shoot length were also found significantly higher in variety Bl-2 than the three other varieties. A perusal of data in Table –1 further revealed that soaking of seeds with cycocel (500 and 1000 mgl^{-1}) significantly increased root length while reduced shoot length as compared to control. These findings, which might be due to stimulatory effect of CCC, are similar to the observation recorded by Emam *et al*[5]. in wheat. Seedling length (root and shoot) was found to be reduced signifiantly by saline irrigation of EC_6 and EC_{12} dSm^{-1} as compared to control. Decrease in seedling length might be due to accumulation of ions near root surface. Similar results were also obtained in wheat by earlier workers[6,7].

Soaking of seeds with cycocel (500 and 1000 mgl^{-1}) at 30 and 60 DAS (Table 2) decreased the plant height significantly as recorded earlier also[8,9]. Reduction in plant height might be due to dwarfing character induced by CCC in barley.Application of CCC (500 and 1000 mg^{-1}) as a seed treatment significantly increased number of effective tiller

Table 1. The effect of different varieties, levels of CCC and saline irrigation on Germination %, Root length and Shoot length at 7 days after treatment.

Treatments	Germination (%)	Root length (cm)	Shoot length (cm)
Varieties			
BL-2	83.5	9.64	9.09
RD-2516	80.7	9.31	8.63
RD-2052	81.8	9.35	8.67
RD-2035	82.7	9.22	8.65
SEm±	0.73	0.13	0.09
CD at 0.05%	2.04	0.37	0.24
Salinity(dSm^{-1})			
Control (BAW)	88.4	10.31	8.98
EC_6	85.6	9.40	8.73
EC_{12}	72.4	8.45	8.59
SEm±	0.63	0.11	0.07
CD at 0.05%	1.76	0.32	0.21
CCC(mg^{-1})			
Control	75.2	8.36	9.35
500	82.9	9.29	8.72
1000	88.4	10.50	8.21
SEm±	0.63	0.11	0.07
CD at 0.05%	1.76	0.32	0.21
Interactions			
VxS			
SEm±	1.27	0.23	0.15
CD at 0.05%	NS	NS	NS
VxC			
SEm±	1.27	0.23	0.15
CD at 0.05%	NS	NS	NS
SxC			
SEm±	1.10	0.20	0.13
CD at 0.05%	NS	NS	NS
VxSxC			
SEm±	2.21	0.41	0.27
CD at 0.05%	NS	NS	NS

Table 2. The effect of different varieties, levels of CCC and saline irrigation on Plant height (cm) and number of effective tillers per plant at different growth stages.

Treatments	Vegetative stage (30 DAS)	Pre-anthesis stage (60 DAS)	Effective tillers per plant (80 DAS)
Varieties			
BL-2	21.7	42.2	5.07
RD-2516	21.2	41.2	5.00
RD-2052	21.4	41.4	5.44
RD-2035	21.4	40.7	5.89
SEm±	0.07	0.33	0.07
CD at 0.05%	0.20	0.93	0.18
Salinity(dSm^{-1})			
Control (BAW)	22.1	44.7	5.75
EC_6	21.5	41.7	5.33
EC_{12}	20.7	37.8	4.97
SEm±	0.06	0.29	0.06
CD at 0.05%	0.17	0.81	0.16

Contd

Treatments	Vegetative stage (30 DAS)	Pre-anthesis stage (60 DAS)	Effective tillers per plant (80 DAS)
CCC (mg^{-1})			
Control	21.7	42.8	5.00
500	21.4	41.3	5.36
1000	21.2	40.0	5.69
SEm±	0.06	0.29	0.05
CD at 0.05%	0.17	0.81	0.16
Interactions			
VxS			
SEm±	0.12	0.58	0.11
CD at 0.05%	NS	NS	NS
VxC			
SEm±	0.12	0.58	0.11
CD at 0.05%	NS	NS	NS
SxC			
SEm±	0.10	0.50	0.10
CD at 0.05%	NS	NS	NS
VxSxC			
SEm±	0.21	1.01	0.20
CD at 0.05%	NS	NS	NS

Table 3. The effect of different varieties, levels of CCC and saline irrigation on leaf area per plant and leaf area index (LAI).

Treatment	Leaf area per plant (cm^2)		Leaf area index (LAI)	
	Vegetative stage(30 DAS)	Pre Harvest stage (60DAS)	Vegetative stage(30 DAS)	Pre Harvest stage (60DAS)
Varieties				
BL-2	52.2	143	0.474	1.30
RD-2516	50.9	143	0.469	1.31
RD-2052	53.8	148	0.491	1.35
RD-2035	54.9	149	0.502	1.36
SEm±	0.44	0.68	0.004	0.013
CD at 0.05%	1.23	1.89	0.012	0.037
Salinity(dSm^{-1})				
Control (BAW)	58.9	160	0.538	1.46
EC_6	53.7	142	0.425	1.37
EC_{12}	44.7	124	0.419	1.15
SEm±	0.38	0.7	0.004	0.011
CD at 0.05%	1.06	1.8	0.011	0.032
CCC (mg^{-1})				
Control	50.7	140	0.463	1.27
500	53.1	146	0.486	1.33
1000	55.1	151	0.503	1.38
SEm±	0.38	0.7	0.004	0.011
CD at 0.05%	1.06	1.8	0.011	0.032

Contd.

Treatment	Leaf area per plant (cm^2)		Leaf area index (LAI)	
	Vegetative stage(30 DAS)	Pre Harvest stage (60DAS)	Vegetative stage(30 DAS)	Pre Harvest stage (60DAS)
Interactions				
VxS				
SEm±	0.77	1.30	0.008	0.023
CD at 0.05%	N.S	N.S	N.S	N.S
VxC				
SEm±	0.77	01.12	0.008	0.020
CD at 0.05%	N.S	N.S	N.S	N.S
SxC				
SEm±	0.67	1.12	0.007	0.020
CD at 0.05%	N.S	N.S	N.S	N.S
VxSxC				
SEm±	1.34	2.25	0.013	0.040
CD at 0.05%	N.S	N.S	N.S	N.S

Table 4. The effect of different varieties, levels of CCC and saline irrigation on seed yield , straw yield/plant and harvest index.

Treatments	Seed yield/plant(gm)	Straw yield/plant(gm)	Harvest index(%)
Varieties			
BL-2	9.10	14.7	38.2
RD-2516	9.64	14.9	39.2
RD-2052	8.82	14.1	38.4
RD-2035	10.3	15.1	40.3
SEm±	0.12	0.10	0.15
CD at 0.05%	0.35	0.28	0.42
Salinity(dSm^{-1})			
Control (BAW)	10.8	15.3	41.3
EC_6	9.38	15.0	38.56
EC_{12}	8.31	13.8	37.23
SEm±	0.11	0.09	0.13
CD at 0.05%	0.30	0.24	0.36
CCC (mg^{-1})			
Control	8.74	14.5	37.4
500	9.52	14.7	39.1
1000	10.2	15.0	40.6
SEm±	0.11	0.09	0.13
CD at 0.05%.	0.30	0.24	0.36
Interactions			
VxS			
SEm±	0.22	0.17	0.26
CD at 0.05%	NS	NS	NS
VxC			
SEm±	0.22	0.17	0.26
CD at 0.05%	NS	NS	NS
SxC			
SEm±	0.19	0.15	0.22
CD at 0.05%	NS	NS	NS
VxSxC			
SEm±	0.38	0.30	0.45
CD at 0.05%	NS	NS	NS

Table 5. The effect of different varieties, levels of CCC and saline irrigation on chlorophyll and protein content (mg/g Fr. Wt.).

Treatment	Chlorophyll content (mg/g Fr. Wt.)		Protein content (mg/g Fr. Wt.)	
	Vegetative stage(30 DAS)	Pre Harvest stage (60DAS)	Vegetative stage(30 DAS)	Pre Harvest stage (60DAS)
Varieties				
BL-2	3.61	3.64	17.2	20.5
RD-2516	4.27	4.25	17.2	20.4
RD-2052	3.60	3.66	19.9	20.0
RD-2035	3.61	3.67	17.0	20.1
SEm ±	0.10	0.10	0.11	0.20
CD at 0.05%	0.30	0.28	NS	NS
Salinity(dSm^{-1})				
Control (BAW)	4.41	4.43	18.1	22.2
EC_6				
EC_{12}	3.64	3.70	16.8	20.3
SEm ±	3.26	3.27	16.2	18.3
CD at 0.05%	0.09	0.08	0.10	0.18
	0.26	0.24	0.27	0.50
CCC (mg^{-1})				
Control	3.22	3.24	16.3	19.1
500	3.88	3.91	17.1	20.4
1000	4.21	4.25	17.8	21.3
SEm ±	0.09	0.08	0.10	0.18
CD at 0.05%	0.26	0.24	0.27	0.50
Interactions				
VxS				
SEm±	0.18	0.17	0.19	0.36
CD at 0.05%	N.S	N.S	N.S	N.S
VxC				
SEm±	0.18	0.17	0.19	0.36
CD at 0.05%	N.S	N.S	N.S	N.S
SxC				
SEm±	0.16	0.15	0.17	0.31
CD at 0.05%	N.S	N.S	N.S	N.S
VxSxC				0.63
SEm±	0.32	0.30	0.34	N.S
CD at 0.05%	N.S	N.S	N.S	N.S

Table 6. The effect of different varieties, levels of CCC and saline irrigation on Leaf water potential (bar) and effect of Cycocel on net profit (Rs/ ha).

Treatments	Vegetative stage (30 DAS)	Pre Harvest stage (60 DAS)	Net Profit Rs/ha
Varieties			
BL-2	-17.4	-23.7	------
RD-2516	-17.6	-23.9	------
RD-2052	-17.5	-24.0	------
RD-2035	-17.6	-23.9	------
SEm ±	0.13	0.14	------
CD at 0.05%	NS	NS	------
Salinity(dSm^{-1})			
Control (BAW)	-16.4	-22.3	------
EC_6	-17.3	-23.9	------
EC_{12}	-18.9	-25.3	------
SEm ±	0.10	0.12	------
CD at 0.05%	0.27	0.35	------
CCC (mg^{-1})			
Control	-18.2	-24.5	29058
500	-17.51	-23.9	29937
1000	-16.97	-23.2	31566
SEm ±	0.10	0.12	44.8
CD at 0.05%.	0.27	0.35	109.8
Interactions			
VxS			
SEm±	0.22	0.25	------
CD at 0.05%	N.S.	N.S.	------
VxC			
SEm±	0.22	0.25	------
CD at 0.05%	N.S.	N.S.	------
SxC			
SEm±	0.19	0.21	------
CD at 0.05%	N.S.	N.S.	------
VxSxC			
SEm±	0.38	0.43	------
CD at 0.05%	N.S.	N.S.	------

per plant (Table 2), leaf area and LAI at 30 and 60 DAS (Table 3). The results of study are similar to findings of Smith[9] and Nayler and Saleh[10]. Saline irrigation at EC_6 and EC_{12} dSm^{-1} significantly reduced the plant, number of effective tiller per plant (Table 2), leaf area and LAI at all growth stages (Table 3). Saline water irrigation might lead to osmotic inhibition and toxic effect of ions and nutritional imbalance of elements and finally culminates in decreased growth[11]. The results are also in conformation with findings of Asana and Kale[12] in wheat.

Cycocel (soaking at 500 and 1000 mgl^{-1}) significantly increased the seed yield, straw yield and harvest index significantly as compared to control (Table 4). Similar results have bean reported in wheat[13]. The decline in seed yield due to salinity might be due to delay in flowering and reduction in number of seeds per ear.

Results on chlorophyll content (Table 5) showed that the variety RD-2052 was having significantly higher chlorophyll content as compared to untreated seeds. However the application of saline water (EC_6 and EC_{12} dSm^{-1}) reduced the chlorophyll content significantly as compared to control (Table 5). Similar results have bean recorded earlier in guar[14]. The reduction in chlorophyll under high salinity might be destroyed due to loosened binding between chlorophyll and chloroplast protein.

Cycocel treatment (500 and 1000 mgl^{-1}) increased the leaf protein content significantly at 30 and 60 DAS while the salinity at both levels reduced the protein content under saline water is perhaps due to decrease in amino acid content and other metabolites[15].

Perusal of data in Table 6 revealed that soaking of seeds with CCC at 500 and 1000 mgl^{-1} significantly increased the water potential over control at both growing stages (30and 60 DAS). This is perhaps due to stimulatory effect of cycocel in increasing the water potential. There was a significant decline in water potential as in both growth stages with increasing levels of salinity (EC_6 and EC_{12} dSm^{-1}) over control.

The economics of cycocel was worked out (Table 6). The data revealed that there was an increase in net profit of Rs. 704 and 2086 / ha with cycocel treatment of seeds with 500 and 1000 mg^{-1} respectively as compared to control. Therefore, the use of cycocel (1000 mgl^{-1}) seems to be more economical to the farmers for increasing the yield and net profit.

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