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EFFECT OF CRYOPROTECTANTS ON YIELD AND YIELD ATTRIBUTES OF GRAM *(CICER ARIETINUM* L.)

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ABSTRACT

A field experiment was conducted for two consecutive years i.e 1974-75 and 1975-76 to study the effect of cryoprotectants on productivity of gram. Foliar spray of cryoprotectant DMSO (10^{-3} moles) was most effective, followed by H_2SO_4 (0.1%), $ZnSO_4$ (0.1%) and Urea (1%). The other chemicals, glucose (1%), chloromequat (10^{-3} moles) and terbutryn (10^{-3} moles) were found less effective in the order named. The increase in grain yield was found associated with increase in number of branches/plant and pods/plant. Further, the schedule of two sprays, one at 50% flowering and the other 10 days thereafter, was found significantly better than one spray at either of the stages.

Low temperature stress greatly limits the productivity of winter season crops like gram in the southern Rajasthan. Large scale plant mortality under freezing temperatures and floral sterility under sub-freezing temperatures cause low grain production in gram. Efforts were, therefore, made to explore the efficiency of some chemicals known to have cold protecting properties, viz., sulphuric acid (Pareek, 1976), zinc sulphate (Dycus, 1969), sugars (Goisa et. al., 1975) and urea (Ashahina, 1962) on yield and yield attributes of gram.

MATERIAL AND METHODS

The experiment was conducted for two consecutive rabi crop seasons (1974-75 and 1975-76) at the Agronomy Farm of College of Agriculture, Udaipur. The soils of the experimental site, sampled from a depth of 0-15 cm, were clay loam in texture with 18.3% coarse sand, 24.3% fine sand, 25.3% silt and 32.2% clay. The soils were medium in organic carbon (0.75%), available phosphorus (16.8 kg P/ha) and available potassium (175.00 kg K/ha) contents.

Udaipur has a typical sub-tropical climate with mild winter and mild summer. The weather during the winter months is often unpredictable. Days of low temperature ($<4°C$) during the crop growth period were December 15, 25, 31; January 4, 14, 24; and February 3, 13, 23 in the year 1974-75. In 1975-76, however, low temperature (4-5°C) continued from December 15 to the end of January with little fluctuations in the intervening period.

The treatments consisted of seven different chemicals viz. DMSO (Dimethyl sulfoxide 10^{-3} moles), CCC (2- chloroethyl trimethyl ammonium chloride or chlorocholine-chloride, 10^{-3} moles) Terbutryn [2- (ter-butylamino)- 4-(ethylamino)-6-(methylthio) -s-triazine, 10^{-3}moles] and sulphuric acid (0.1%). The choice of concentrations for the trial was based largely on the works of earlier workers and after Bhanwer Lal (1975) and Pareek (1976). All the chemicals were applied as aqueous foliar sprays (1000 l ha^{-1}), making three spray schedules, viz., spray at 50% flowering, ten days thereafter and a combination of the two. Twenty one treatment combinations alongwith one control were replicated four times in a Randomized Block Design in plots 5mx 4m. Data on the effects of individual cryoprotectants were averaged over spray schedules, and those for the three spray schedules were averaged over the different chemicals, while subjecting them to statistical analysis and inferences.

Seeds of gram, variety RS -10, were drilled on 20 October in both years at the rate of 75 kg/ha, 4-5 cm deep in furrows 30 cm apart. Application of 18 kg nitrogen and 46 kg phosphorus (P_2O_5) per hectare was made through diammonium phosphate in all the plots uniformly by placement at the time of sowing. The crop was irrigated once after 60 days of sowing in both years, besides ensuring proper soil moisture for sowing.

RESULTS AND DISCUSSION

Foliar treatments of cryoprotectants significantly increased number of branches/plant, pods/plant and grains/pod (Table 1). The effects on grains/pod were, however, significant only in one year. When compared with control, increases in these parameters were 6.40, 25.56 and 9.1%, respectively. Seed index remained uninfluenced in both the years of study. Use of DMSO was most effective in improving all the yield attributes studied. This was followed by H_2SO_4 except for the number of pods/plant. While the effects of H_2SO_4 were comparable with some chemicals for one or the other yield attribute, the effects of DMSO were significantly better than those of all other chemicals.

Foliar treatments of cryoprotectants significantly increased the grain yield by 23.57 – 70.09 per cent and 14.67 – 69.33 per cent in 1974-75 and 1975-76, respectively over control. (Table 2). Mean effects over the rwo years were also found significant in comparison to control. Further, significantly highest mean grain yield of 18.12 q/ha was obtained with DMSO followed by H_2SO_4, ZnSO4 and urea, giving mean yield of 15.94, 15.36 and 15.30 q/ha, respectively. Significant improvement in harvest index of the crop was also observed with the foliar treatments and DMSO, H_2SO_4 and $ZnSO_4$ were on a par.

Porwal et al. (1986) concluded that in gram increases in water soluble carbohydrates, protein contents and activity of oxidative enzymes (catalase and peroxidase)

Table 1 Effect of cryoprotectants on number of branches per plant, grains per pod and pods per plant in chickpea

Treatments	Branches/plant			Pods per plant			Grains/pod		
	1974-75	1975-76	Mean	1974-75	1975-76	Mean	1974-75	1975-76	Mean
DMSO	19.75	17.85	18.80	104 45	107 55	106 00	1 24	1 34	1 29
Chloromequat	16.80	16.85	16.82	88 06	91 43	89 74	1 09	1 29	1 15
Terbutryn	16 74	16 40	16 74	83 26	88.45	85.85	1.08	1.23	1.15
H_2SO_4	17.85	17 14	17.49	95.85	94 18	95.15	1 24	1.32	1.28
$ZnSO_4$	17 59	16 82	17.27	105.65	101.61	103.63	1.11	1.25	1.18
Glucose	17.95	17.01	17 48	98.16	96.51	92.83	1.15	1.30	1.22
Urea	17.91	17.05	17.48	97.11	101 08	99 09	1.07	1 25	1.16
Control	16.72	16.82	16.67	72.90	80 20	76 55	1.00	1.20	1.10
Overall treatment mean	17.79	17 02	17 44	96.08	97 25	96 04	1.14	1.27	1.20
SEm ±	0.22	0 12	—	1.88	2.47	—	0 04	0.05	—
CD at 5%	0.61	0.33	—	5.32	6 99	—	0.11	NS	—

Table 2. Effect of cryoprotectants on grain yield and harvest index of chick pea

Treatment	Grain yield (q/ha)			Harvest index		
	1974-75	1975-76	Mean	1974-75	1975-76	Mean
DMSO	17.15	19.05	18.12	0.27	0.27	0,27
Chloromoquat	15.35	13.20	13.28	0.25	0.27	0.26
Terbutryn	11.90	12.90	12.42	0.23	0.25	0.24
H_2SO_4	16.60	15.20	15.94	0.26	0.29	0.27
$ZnSO_4$	15.75	14.95	15.36	0.28	0.27	0.27
Glucose	13.65	15.20	14.24	0.25	0.28	0.26
Urea	15.80	14.75	15.30	0.24	0.25	0.24
Control	9.63	11.25	10.40	0.22	0.23	0.22
Overall treatment mean	15.17	15.03	14.95	0.25	0.26	0.25
SEm±	0.53	0.45	0.47	0.01	0.004	—
CD at 5%	1.50	1.30	1.40	0.03	0.01	—

formed the metabolic basis of chemical cryoprotection, which also decreased plant mortality. The beneficial effects of the cryoprotectants, when assessed in terms of grain yield of gram, appear to be a cumulative effect of significant increase in the number of branches/plant and pods/plant. There was also significant positive correlation. Correlation co-efficients obtained between grain yield and pods/plant for 1974-75 and 1975-76 were 0.92 and 0.86, respectively and those for grain yield and plant mortality were 0 – 0.51 and 0 – 0.63 in the order named. The spray schedule had noticeable effects in influencing the grain yield and harvest index (Table 3) but not on the yield attributes of the crop. The two spray schedules, first spray at 50% flowering and second 10 days after the first spray, significantly increased grain yield and harvest index in both the years. Similar results have also been reported by Bhanwer Lal (1975) and Pareek (1976) in potato and opium poppy, respectively.

Table 3 : Mean effects of spray schedule on gprain yield and harvest index of chick pea

Spray Schedule	Grain yield (q/ha)			Harvest index		
	1974-75	1975-76	Mean	1974-751	975-76	Mean
Single spray at 50% flowering	14.88	14.35	14 63	0.25	0.27	0.26
Single spray at 10 days after 50% flowering	14 11	15.05	14.51	0.25	0.27	0.26
Two sprays, first at 50% flowering, second 10 days later	15 71	15.70	15.70	0.27	0 28	0.27
SEm±	0.35	0.30	0.31	0.007	0.0003	-
CD at 5%	0.99	0.87	0.92	0.020	0.009	-

REFERENCES

Ashahina, E. 1962. A mechanism to prevent the seeding of intracellular ice from outside in freezing living cells. Low Temperature Science Series. 20: 45-56 (cf. Botanical Review. 37: 37-142, 1971).

Bhanwer Lal. 1975. Effect of different methods of planting with and without mulching and use of chemicals to mitigate cold injury on potato production. M. Sc. Ag. thesis. Department of Agronomy, University of Udaipur, Udaipur.

Dycus, A. M. 1969. Frost and chilling injury in growing plants. Advances in Agronomy. 22: 203-234.

Goisa, N. I., Gatsenko, R. B. and Kovtub, I. I. 1975. Kinetics of sugar in plant of winter wheat during the autumn-winter period in relation to temperature and radiation conditions for over-wintering. (cf. Field Crop Abstracts. 29: 3441).

Kuiper, P. J. C. 1967. Surface active chemicals as regulators of plant growth, membrane permeability and resistance to freezing. Laboratory Plant Physiological Research, Agricultural University, Wageningen, Netherlands. 23: 253.

Pareek, B.L. 1976. Effect of select chemicals in mitigating cold liability of opium poppy M.Sc. Ag. Thesis, Deptt. of Agronomy, Sukhadia University, Udaipur.

Porwal, B.L., Singh, H G. and Mathur, P.N. 1986. Metabolic changes associated with chemical cryoprotection in gram (*Cicer arietinum* L.) Biochemie und. Physiologie der Pflanzen. 181: 659-664.

Sycheva, Z. F., Balagurova, N. I. and Vasyukova, V. A. 1975. The effect of chlorocholine chloride on respiration and frost resistance of potato plant. Fiziologiya Rastenil. 22: 176-180. (cf. Field Crop Abstracts 8: 4803).