III RESULTS AND DISCUSSION

A. Osmotic potential of cell sap :

In order to test the stress tolerance capacity of plant, osmotic potential (O.P.) of cell sap was measured in sorghum and groundnut leaves. The data is given in Table 1. In general, the O.P. of cell sap showed more negative value under stress condition. It is very clear from the table that the osmotic potential of cell sap was not much changed in control plant and in control sprayed with HICO-110R. However, it did change in sprayed and stressed plants. In fact this should show more negative value of osmotic potential than that of control because it is stressed one. However the situation is exactly reverse which indicates that HICO-110R facilitates the turgor maintenance of leaf tissue and thereby plant remain unwilted for some more days as compared to non sprayed stressed plants. From this observation it can be suggested that foliar application of HICO-110R may be suitable for protecting the field crops during shorter period of drought.

Water potential and turgor were found to be increased by abscisic acid (ABA) treatment in Lycopersicon esculentum (Bradford 1983). ABA decreased transpiration rate by causing stomatal closure and also increased the hydraulic conductance of sprayed plants.

Table 1 : Effect of HICO-110-R foliar application on Osmotic Potential (O.P.) of cell sap of Sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	Osmotic Potential of Cell Sap (bar)	
	Sorghum	Groundnut
Control	- 9.0	- 8.78
Sprayed control	- 8.9	- 8.22
Stressed	-11.4	- 9.54
Sprayed and stressed	- 7.5	- 6.91

The values are mean of three determinations.

B. Relative Water Content (R.W.C.) :

The rlative water content in control, sprayed control stressed and stressed and sprayed plants of sorghum and groundnut is given in Table 2. It was found that the R.W.C. of sprayed control plants was comparatively more than that of control plants (Table 2). This is possibly be due to partial closing of stomata influenced by HICO-110R foliar application and by retardation in transpiration rate. When we compared R.W.C. of stressed plants to those of sprayed and stressed plants, it was observed that the R.W.C. was maintained by HICO-110R foliar application, which indicates possibly this chemical helps in conservation of water under stress condition.

The increase as well as decrease in R.W.C., decrease in trans piration rate and adjustment of osmoticum under influence of anti-transpirants under low moisture regime is well known (Das et al. 1977, Mungse and Bhapkar 1983, Bradford 1983). Patil and De (1976a) have shown that water use efficiency increases at low soil moisture and by antitranspirant (PMA) treatment. Further, they have noticed that the relative water content was reduced by low soil moisture but was increased by the antitranspirants which relieved plant water stress. The data of present investigation on R.W.C. and O.P. also suggest that HICO-110R foliar application help the plant to withstand water stress by maintaining R.W.C. and O.P. of the cell sap.

Table 2 : Effect of HICO-110-R foliar application on Relative Water Content (RWC) of Sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	Relative Water Content (RWC,%)	
	Sorghum	Groundnut
Control	81.76	81.56
Sprayed control	83.49	84.50
Stressed	60.00	72.00
Sprayed and stressed	75.80	77.90

The values are mean of three determinations.

C. Organic Constituents :

1. Chlorophyll content :

Productivity of crop plant is linked with chlorophyll content which decides the solar energy harnessing ability of plant. Hence it has been analysed from HICO-110R sprayed leaves of sorghum and groundnut.

The chlorophyll content estimated from the leaves of sorghum and groundnut is given in Table 3. It is vividly clear from the table that HICO-110R spray stimulates the chlorophyll synthesis in sorghum as well as in groundnut under control condition. When we compared chlorophyll contents of stressed plants with those of stressed after spray, it was found that the chlorophyll content in stressed plant was more. This is obvious because plant has capacity to withstand drought by increasing chlorophyll stability index and the reason why chlorophyll content was more under stress condition both in sorghum and groundnut leaves. But if we compare chlorophyll content of control plants with those of sprayed and stressed plants, we found, chlorophyll level was more under sprayed and stressed plants. This situation clearly indicates that HICO-110R spray not only help the plants to withstand water scarcity but also protect photosynthetic apparatus to some extent.

In general, the chlorophyll 'a' content was more than 'chlorophyll b', and the chlorophyll a/b ratio was more or less same in control and control sprayed with HICO-110R in sorghum. However,

Table 3 : Effect of HICO-110 R foliar application on chlorophyll contents in sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	Total Chl. 'a'	Total Chl. 'b'	Chl. a/b ratio	Total chlorophyll
<u>Sorghum</u>				
Control	335.74	95.68	3.5	431.42
Sprayed control	339.66	95.67	3.55	435.33
Stressed	389.88	161.39	2.41	551.27
Sprayed and stressed	312.30	141.50	2.20	453.8
<u>Groundnut</u>				
Control	153.32	60.60	2.53	213.92
Sprayed control	210.26	69.33	3.03	279.59
stressed	300.04	101.85	2.94	401.89
Sprayed and stressed	285.34	101.31	2.81	386.65

The values are mean of three determinations and expressed as mg 100^{-1}g fresh tissue.

the chlorophyll a/b ratio was found to be decreased in stressed and sprayed and stressed plants of sorghum. In groundnut under stressed condition the chl a/b ratio was at higher level as compared to control whereas, it was at lower level in sprayed and stressed plants as compared to sprayed control.

In literature different effects on chlorophyll have been reported in different plants. Inhibition of chlorophyll synthesis by antitranspirants (Phosphon-D and CCC) has been reported in detached cotyledons of pumpkins (Knypl 1970, 1973). An increase in chlorophyll has been observed in cowpea leaves treated with Phosfhon-D (Adedipe et al. 1960). Higher grain matter and seed yield in Trifolium alexanderium has been also attributed to chlorophyll contents in leaves due to CCC and phosfhon-D application individually (Yadava et al. 1978). However, chlorophyll content was found to be almost similar to that of control plants when treated with antitranspirants such as phosfhon-D and CCC (Agarwal et al. 1986).

2. Chlorophyll stability index :

Chlorophylls are photosynthetic pigments which perform an important process of photo reaction during photosynthesis. Under extreme environmental conditions such as water scarcity, salt stress or aging, chlorophylls are degraded very fast affecting the process of photosynthesis. However, the degree of degradation of chlorophyll varies from plant to plant. Chlorophylls in certain plants such as drought resistant or salt tolerant plants are more stable under adverse

Table 4 : Effect of HICO-110-R foliar application on chlorophyll stability index of Sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	Chlorophyll stability index	
	Sorghum	Groundnut
Control	0.63	0.91
Sprayed control	0.67	0.80
Stressed	0.64	0.62
Sprayed and stressed	0.90	0.69

The values are mean of three determinations.

condition i.e. chlorophylls in such species show high chlorophyll stability index. Thus, chlorophyll stability index is the ability of plants to withstand the adverse condition. Under the circumstances it is essential to see whether any chemical has got a potentiality to maintain the chlorophyll stability index under extreme environment. The data depicted in Table 4 is the effect of HICO-110R foliar application on chlorophyll stability index of sorghum var. M-35-1 and groundnut var. JL-24. Looking to the data, one can safely say that HICO-110R has a potentiality to maintain the chlorophyll stability index both in sorghum and groundnut plants under control as well as under water stress condition.

3. Proline :

Proline accumulation in plant linked with water relations, nitrogen metabolism and energy metabolism (Stewart and Hanson 1980) In water relations proline is said to be osmotic substance (especially cytoplasmic osmoticum) during water stress (Boggess et al. 1976 a,b), and a desiccation protectant. In majority of plants under condition of water stress proline is synthesized and is known to play pivotal role. Although its role is not well defined, its ready appearance in the tissue under stress forestalls drought. Therefore, it is necessary to examine proline content under the influence of antitranspirant spray.

The proline level analysed in leaf tissue of sorghum and groundnut is given in Table 5. It is very clear from the table that

Table 5 : Effect of HICO-110-R foliar application on proline content in the leaves of Sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	PROLINE (mg 100^{-1}g dry wt)	
	Sorghum	Groundnut
Control	64	100
Sprayed control	80	170
Stressed	120	230
Sprayed and stressed	150	340

The values are mean of three determinations.

HICO-110R spray stimulate the proline synthesis both in sorghum and groundnut. The stimulation of proline was more pronounced in groundnut rather than in sorghum due to HICO-110R spray. The proline accumulation of stressed plants when compared with that of sprayed and stressed plants, it was found that the increase in proline content in sprayed and stressed plants was 23.10% in sorghum and 32.19% in groundnut. This clearly indicates that the HICO-110R stimulate the proline synthesis under stress condition in order to withstand the drought condition by adjusting osmoticum.

4. Polyphenols :

Polyphenols play an important role in disease resistance which has been field of active research for many years (Salem and Michail 1981). Contrary to this phenols and their oxidised products are known for inhibitory action on various enzyme systems. The best documented example is the inhibition of IAA-oxidase (Shekhawat *et al.* 1980). This is because formation of an active enzyme inhibitor complex (Zanobini *et al.* 1967). Therefore, it is essential to know the level of polyphenol content under influence of antitranspirant spray. As such some of the antitranspirants are also found to be effective in controlling fungal diseases (Kamp 1985). The effectiveness of HICO-110R foliar application under control and water stress condition was studied in sorghum and groundnut leaves and data is presented in Table 6.

When we compared phenolic contents influenced by HICO-110R application, it was found that polyphenol synthesis was stimulated both

Table 6 : Effect of HICO-110-R foliar application on polyphenol content in the leaves of Sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	POLYPHENOLS ($g\ 100^{-1} g$ dry wt)	
	Sorghum	Groundnut
Control	0.44	0.32
Sprayed control	0.57	0.34
Stressed	0.43	0.33
Sprayed and stressed	0.50	0.41

The values are mean of three determinations.

in sorghum and groundnut. This stimulation was 23.27% and 7.87% respectively in sorghum and groundnut. This indicates stimulation of polyphenol was more in sorghum rather than in groundnut. Under water stress condition the polyphenol level was gone down as compared to control plants. However, in those of sprayed and stressed plants the level of polyphenol was increased irrespective of water stress. This indicates that polyphenols are stimulated even under stress condition when sprayed with HICO-110R. The synthesis of polyphenols possibly be due to acceleration of schikimic acid pathway by utilizing carbohydrates or aminoacids (Pridham 1965). However, this require further investigation to link polyphenol synthesis with carbohydrate content and aminoacid pattern under influence of antitranspirants. At present we can only say that HICO-110R stimulate the polyphenol synthesis. How ? is not known which needs further investigation.

5. Nitrogen :

Nitrogen plays important role in crop plants as a single factor for it is linked to the productivity. All the breeding programmes of the recent years are oriented to the nitrogen geared productivity. Photosynthesis and nitrogen metabolism are often independent, for chloroplasts, should keep up their ability to harness the sun efficiently while, continuous infiltration of nitrogen take place. According to Hsiao (1973), reduction in nitrogen level due to water stress is common phenomenon. Similarly water stress reduces ratio of protein to amino acid or protein content of plant as a whole (Vaadia *et al.* 1961). In the recent years it has been shown that the plant produces or synthesizes special type of protein in response to water stress. However, no greater significance has been attached to such protein as its direct involvement could not be demonstrated to protect plants from many types of damage caused thereby. The use of antitranspirant on water stressed crop plants has been shown some promising results. However very little is known regarding the effect of antitranspirant on nitrogen metabolism. In this respect, it is essential to examine nitrogen status of water stressed crop under influence of antitranspirant spray.

The analytical data of nitrogen is presented in the Table 7. As usual water stress resulted decrease in nitrogen content both in sorghum and groundnut. This decrease was 34.34% and 6.20% in sorghum and groundnut respectively over control. HICO foliar application showed differential response of nitrogen content in sorghum and groundnut. In sorghum the nitrogen content was reduced whereas in groundnut it was increased when subjected to foliar application of HICO-110R under control condition. However, the reduction of nitrogen content in sorghum was negligible. The nitrogen content due to foliar application of HICO-110R in groundnut under control condition was increased by 21.13%. Similarly when we compared the nitrogen content of stressed plants to that of sprayed and stressed plants, it was found that the nitrogen content was increased by 46.86% and 29.82% respectively in sorghum and groundnut. This indicates that the foliar application HICO-110R helps in balancing nitrogen content of the plant.

Table 7 : Effect of HICO-110-R foliar application on nitrogen content in the leaves of Sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	NITROGEN ($g\ 100^{-1}g$ dry wt)	
	Sorghum	Groundnut
Control	3.17	4.43
Sprayed control	3.01	5.62
Stressed	2.08	4.15
Sprayed and stressed	3.92	5.92

The values are mean of three determinations.

There are reports to show that, in general, nitrogen content reduces due to water stress (Shaha and Loomis 1965, Hsiao 1973). According to Hsiao (1973) reduction in nitrogen level is common pheno menon. However, referring to the work of many others he pointed out that in response to the stress protein synthesis is reduced and the effect is at the translocation level and thereby the level of amino acid pool increases and protein to aminoacid ratio decreases.

Based on this, we may infer here that decreased level of nitrogen under stress condition can be corrected by the foliar application of HICO-110R which is seen in Table 7. Perhaps the increased protein level here may act as an osmoticum to withstand stress effect

D. Enzymes of nitrogen metabolism :

1. Nitrite reductase :

The efficiency of enzymes of nitrogen metabolism are mainly dependent upon availability of the reducing agents, which are generated during photosynthesis and respiration. Water stress often affects both nitrogen assimilation as well as nitrate reductase activity (Heuer et al. 1979). Therefore, it is essential to examine the effect of antitranspirant on nitrate and nitrite reductase activity under control and stressed conditions.

The activity of enzyme under control and stress condition as well as by spraying antitranspirant (HICO-110R) assayed in sorghum and groundnut and tabulated in Table 8.

Table 8 : Effect of HICO-110-R foliar application on the in vivo activity of enzyme Nitrite reductase in the leaves of Sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	NITRITE REDUCTASE (μg NO_2 reduced g^{-1} fresh wt h^{-1})	
	Sorghum	Groundnut
Control	8.54	5.38
Sprayed control	9.38	14.48
Stressed	4.82	2.20
Sprayed and stressed	8.62	0.96

The values are mean of three determinations.

It is very clear from Fig. 1 that there is a marked enhancement in the activity of enzyme nitrite reductase due to foliar application of HICO-110R over control. This increase was almost more than the double. However, under stress condition the activity is kept in lower ebb as compared to the control. The foliar application of HICO-110R not able to maintain the nitrite reductase activity under sprayed and stressed condition of groundnut.

In sorghum the activity of nitrite reductase was not much influenced due to foliar application of HICO-110R under control condition (Fig.1). However, HICO-110R is effective in maintaining the activity by stimulating it almost double than that of stressed plants in plants stressed after spray. The decrease in nitrite reductase activity under stress condition is attributed to protein synthesis (Gupta and Sheron 1983). The reduced rate of protein synthesis under water stress condition presumably lower the level of those enzymes such as nitrite reductase (Mirajkar, 1988). Similarly there are also report that the stability of enzyme under stress condition is responsible for the maintenance of the activity (Bradzik et al. 1971).

In our study with HICO-110R foliar application, enhanced activity of nitrite reductase was observed both in sorghum and groundnut under control conditions. However, when we compared activity of stressed plants to those of sprayed and stressed plants the enhancement of activity was found only in sorghum and not in groundnut.

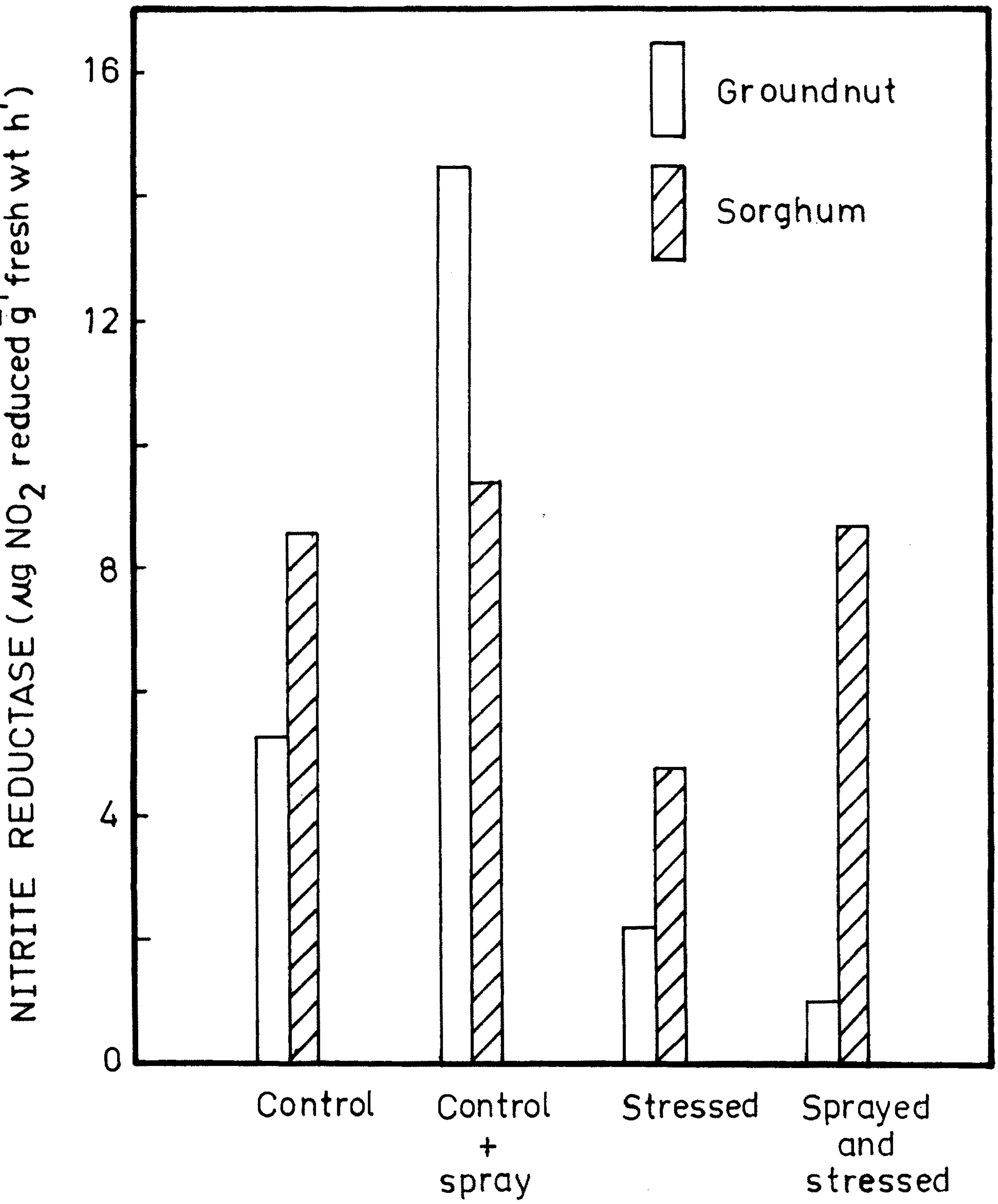

Groundnut
Sorghum
NITRITE REDUCTASE (μg NO2 reduced g-1 fresh wt h-1)
16
12
8
4
0
Control
Control + spray
Stressed
Sprayed and stressed

Fig. 1

2. Nitrate Reductase :

The activity of enzyme nitrate reductase was assayed only in the leaves of groundnut which were received foliar application of HICO-110R both grown under control and water stress condition. The data depicted in Table 9 and Fig. 2 reveals that the activity of nitrate reductase was drastically reduced under water stress condition than that of control. But when we assessed the activity of this enzyme in sprayed and stressed plants, it was found to be enhanced slightly. Possibly, this enhancement is due to foliar application of HICO-110R which also results in increased nitrogen content (Table 9).

Chavan (1987) has reported that the foliar application of CCC Kinetin and GA (All in conc. of 100 ppm) stimulates the activity of enzyme nitrate reductase in groundnut. Among these three chemicals, GA found to be most effective, while CCC least in eliciting the response. Knypl (1970) has also observed enhanced nitrate reductase activity in cucumber cotyledons due to CCC pretreatments.

E Stomatal behaviour :

1. Effectiveness of HICO-110R spray on diffusive resistance for water vapour and transpiration rate :

Effect of HICO-110R spray (1 ml/lit) on stomatal regulation was studied in pot grown sorghum var. M-35-1 and groundnut var. JL-24 under control and water stress condition. The experimental results are presented in Table 10. It is very clear from the table that diffusive resistance was found to be increased in HICO-110R

Table 9 : Effect of HICO-110 R foliar application on the activity of enzyme nitrate reductase in the leaves of groundnut var. JL 24.

Treatment	Nitrate reductase μg NO_2 formed g^{-1} fresh wt. h^{-1}
Control	5.21
Sprayed control	8.04
Stressed	0.23
Sprayed and stressed	0.63

The values are mean of three determinations.

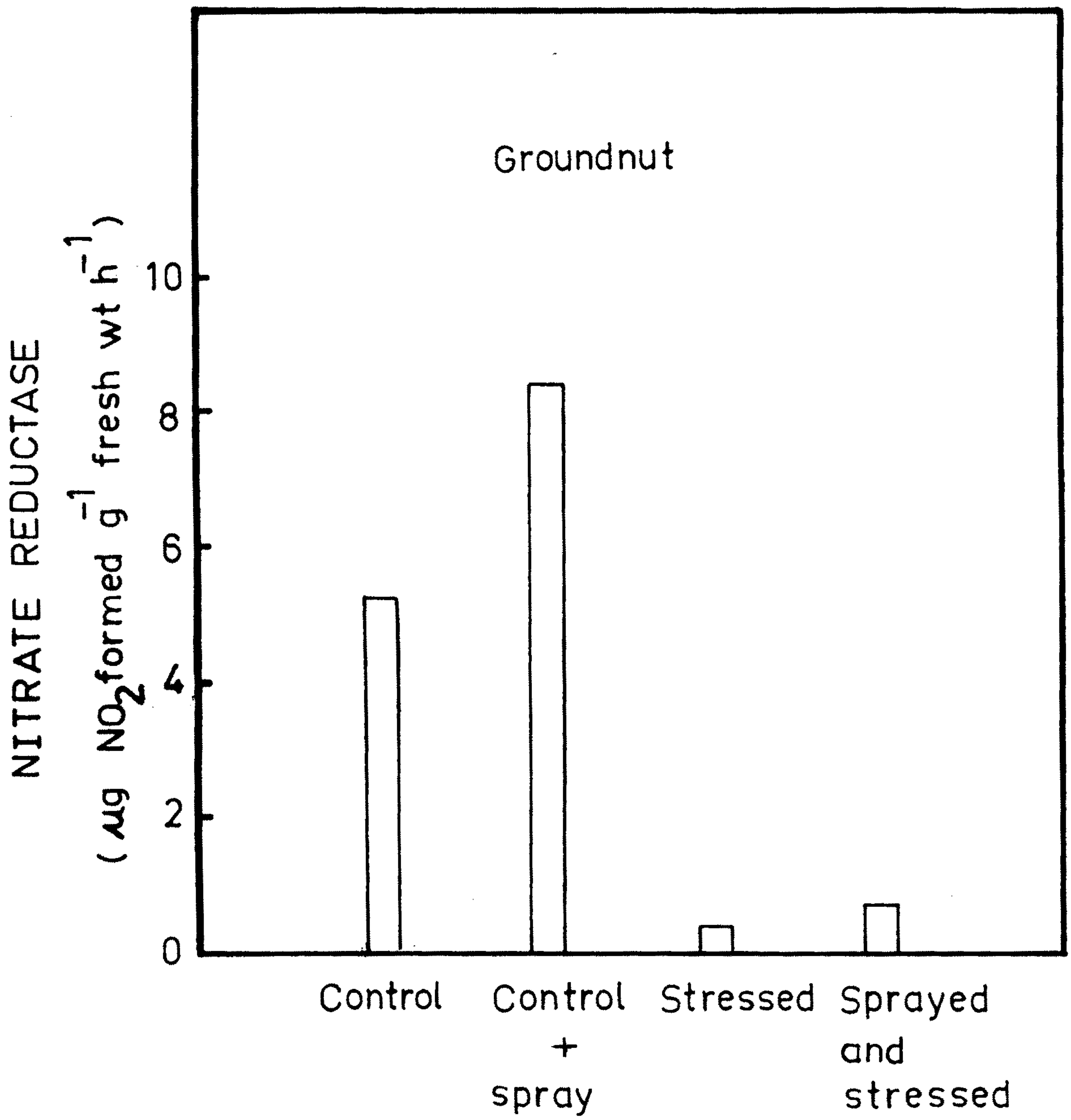

Groundnut
NITRATE REDUCTASE
(µg NO2 formed g-1 fresh wt h-1)
10
8
6
4
2
0
Control
Control + spray
Stressed
Sprayed and stressed

Fig. 2

sprayed plant and the transpiration rate in non stressed plants by increasing the diffusive resistance. But under sprayed and stressed condition the diffusive resistance of sorghum and groundnut leaves was not much affected relative to non sprayed stressed plants. This clearly indicates that the HICO-110R spray reduces transpiration loss under control condition and facilitates maintenance of cell turgor under stress condition and thereby helps in conserving the water inside the leaf tissue and protect the plant from desiccation to some extent.

The reduction in transpiratioin of potted plants with different types of antitranspirants was reported by several workers (Zelitch and Waggoner 1962, Slatyer and Bierhuizen 1964, Waggoner 1966, Davenpart 1967, Gale et al. 1966, Aboukhaled et al. 1970, Patil and De 1976).

The seedlings of Capsicum annum CV Jupiter dipped in abscisic acid (100 µM and 1 mM) have shown increased leaf resistance and leaf water potential (Berkowitz and Rabin 1988). Based on this observatioin they have concluded that antitranspirant application can reduce transpirant shock and increase yield of bell paper. The treatment with an antitranspirant phenyl mercuric acetate (PMA) was more effective in reducing the transpiration rate of sunflower (Mungase and Bhapkar 1984).

According to Das et al. (1977) a single foliar application of the morphactin, EMD 7301 W at conc. of 5 and 10 mg per litre to seven weeks old cotton plants (Gossypium hirsutum L. var. Lakshimi) produced a significant decrease of stomatal conductance and rate

Table 10 : Effect of HICO-110 R foliar application on diffusive resistance and transpiration rate in sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	Sorghum				Groundnut			
	Lower surface		Upper Surface		Lower surface		Upper surface	
	DR	TR	DR	TR	DR	TR	DR	TR
Control	1.91	11.26	4.44	4.99	1.63	11.25	1.46	12.67
Sprayed control	2.96	9.78	6.37	3.76	3.39	6.55	3.52	5.89
Stressed	31.50	0.71	40.60	0.56	16.80	1.20	41.40	0.51
Sprayed & stressed	21.90	0.82	109.0	0.19	15.40	1.45	13.70	1.68

DR = diffusive resistance - S cm^{-1}

TR = Transpiration rate - $\mu g\ s^{-1}\ cm^{-2}$

The values are mean of three dedeterminations.

Average light quantum = 1500 $\mu E\ m^{-2}\ s^{-1}$

Relative humidity = 45 %

Leaf area = 1 cm^2

of transpiration after the chemical application. It is suggested that the morphactin thus seem to function effectively as an antitranspirant and because of its prolonged action may be suitable for protecting field crop during shorter period of drought.

2. Diffusive resistance and conductance for CO_2 :

The effect of HICO-110R on diffusive conductance and diffusive resistance for CO_2 is depicted in Table 11.

It is very clear from the result that there is decrease in stomatal conductance for CO_2 in HICO sprayed plants by 33.61% and 55.5% in sorghum and groundnut respectively under control condition. However, under stress condition sorghum do not exhibit maximum difference in stomatal conductance for CO_2 as far as stressed and sprayed and stressed plants are concerned. On the contrary, groundnut exhibit maximum difference in stomatal conductance for CO_2 when compared with non sprayed stressed plants to that of sprayed and stressed plants. Diffusive conductance for CO_2 is inversely proportional to diffusive resistance for CO_2 and highest diffusive resistance for CO_2 was observed in stressed plants while the HICO sprayed and stressed plants show less diffusive resistance for CO_2. This indicates that water stress brings constraints in the gases diffusion process. However, one thing is very clear that in the HICO sprayed and stressed plants the process of gases diffusion is superior to those of stressed plants. This suggests that HICO-110R help the plant to conserve water and for easy operation of gases diffusion. As such high

Table 11 : Effect of HICO-110 R foliar applicatioln on diffusive conductance and diffusive resistance for CO_2 in sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	Sorghum		Groundnut	
	Diffusive conductance for CO_2 cm s^{-1}	Diffusive resistance for CO_2 S cm^{-1}	Diffusive conductance for CO_2 cm s^{-1}	Diffusive resdistance for CO_2 S cm^{-1}
Control	1.19	0.84	2.07	0.48
Sprayed control	0.79	1.27	0.92	1.08
Stressed	0.086	11.62	0.13	7.57
Sprayed and stressed	0.088	11.32	0.22	4.60

Average : light quantum : 1500 $\mu E\ m^{-2}\ s^{-1}$, Humidity = 45%, leaf area = 1 cm^2

The values are mean of three determinations.

conductance of leaves due to application of abscisic acid results in a high intercellular CO_2 pressue which allows greater discrimination against $^{13}CO_2$ and thereby more negative $\delta^{13}C$ values (Bradford et al. 1983). Since the stomatal conductance and resistance for CO_2 under the influence of foliar application of HICO-110R was calculated by using the conversion formula suggested by Jarvis (1971), the picture will be more clear when we study the rate of CO_2 intake by plants subjected to foliar application of HICO-110R, which needs further investigation.

3. Stomatal regulation :

Plants are able to regulate internal water potential into two ways (1) by continuous pumping of water through its root system; and (2) by stomatal regulation. Under water stress condition, if the root system is not efficient in tapping the available water from the soil, stomata close down to conserve water. Thus, stomata play pivotal role in controlling the balance between assimilation and transpiration. Hence the response of diffusive resistance and transpiration rate in the leaves of sorghum var. M-35-1 and groundnut var. JL-24 sprayed with HICO-110R were studied.

In this experiment, in order to create identical situation of soil moisture two plants of sorghum were retained per pot. One group of two plants per pot was treated as a control and the other group was treated as stressed. From the control and stressed group : one plant was sprayed with HICO-110R (1 ml/lit) and the other one was sprayed with equal volume of distilled water to run off point Control plants were received the water as per their requirement while from stressed group water was withheld for 8 days. On the 8th day of stress both sorghum and groundnut plants were analysed for stomatal regulation and parameters like diffusive resistance, transpiration rate and leaf temperature were studied with the help of steady state porometer. The per cent soil moisture from the soil of control pots and stressed pots of sorghum and groundnut was analysed and the data is presented in Tables 12 and 13.

It is very clear from the Table 12 that when we compare the diffusive resistance of control plants of sorghum var. M-351 to those of sprayed control, it was observed that in HICO-110R spfayed plants the diffusive resistance was increased by reducing the transpiration rate and increasing the leaf temperature by not more than $1^{o}C$. However, the reduction in transpiration rate was not more as compared to control plants. Increase in diffusive resistance under stress condition is natural phenomenon. However, with the same soil moisture further increase in diffusive resistance in sprayed and stressed plants definitely the effect of HICO-110R spray (Table 12).

Another interesting point observed here that there was no much difference in the leaf temperaure though the sprayed and stressed plant showed higher diffusive resistance under stress conditions. This is clear indication that HICO-110R has additive effect of conserving the water in plant under stress conditions by maintaining the osmotic pool and keeping the leaf temperature at desired level.

Table 12 : Effect of HICO-110 R foliar application on diffusive resistance, transpiration rate and leaf temperature of sorghum var. M-35-1.

Treatment	Soil moisture %	Leaf surface	Diffusive resistance s cm^{-1}	Transpiration rate $\mu g\ s^{-1} cm^{-2}$	Leaf temperature ^{o}C
Control	12.2	Lower	2.36	11.60	33.45
		Upper	3.53	9.21	33.75
Sprayed control	12.2	Lower	3.31	10.03	34.14
		Upper	4.98	6.79	34.28
Stressed	2.01	Lower	32.5	1.04	36.9
		Upper	41.7	0.85	37.8
Sprayed and stressed	2.01	Lower	48.2	0.70	36.5
		Upper	66.0	0.22	37.2

Average : Light quantum : 1500 $\mu E\ m^{-2} s^{-1}$, Humidity : 45%, leaf area : 1 cm^2

The values are mean of three determinations.

Table 13 : Effect of HICO-110 R foliar application on diffusive resistance, transpiration rate and leaf temperature of groundnut var. JL-24.

Treatment	Soil moisture %	Leaf surface	Diffusive resistance $s\ cm^{-1}$	Transpiration rate $\mu g\ s^{-1} cm^{-2}$	Leaf temperature ^{o}C
Control	20.14	Lower	1.75	16.86	34.41
		Upper	1.34	17.07	34.07
Sprayed control	20.14	Lower	1.32	16.85	33.87
		Upper	1.34	16.17	33.76
Stressed	5.11	Lower	29.2	1.29	38.0
		Upper	11.4	3.25	38.5
Sprayed and stressed	5.11	Lower	51.0	0.79	38.0
		Upper	41.0	1.04	37.5

Average : Light quantum : 1500 $\mu E\ m^{-2} s^{-1}$, Humidity : 45%, leaf area : 1 cm^2

The values are mean of three determinations.

The situation in groundnut var. JL-24 is more or less the same as that in sorghum var. M-35-1 (Table 13). However, the stomatal regulation in control and control sprayed with HICO 110R has no much difference as far as diffusive resistance, transpiration rate and leaf temperature are concerned.

Increase in leaf temperature due to decrease in transpiration rate by an antitranspirants is well known. Raschke (1960) has reviewed the heat balance of plant leaves under field conditions. Williamson (1963) observed that tobacco leaf temperature increased by 1.7°C as a result of an antitranspirant treatment which reduced the transpiration 60 to 80 per cent. Tanner (1963) found that an antitranspirant raised leaf temperature 1°C and calculated from this that under prevailing field conditions transpiration was depressed about 10 per cent. Gale and Poljakoff Mayber (1965) measured leaf temperature of a number of species treated with an antitranspirants which reduced transpiration by about 30 per cent. They found little difference between treated leaves, untreated leaves and air temperature.

In the present investigation, however, no much difference was observed in leaf temperature of groundnut sprayed with HICO-110R. While in sorghum there was increase in leaf temperature by 0.5°C in control plants sprayed with HICO-110R. Similarly under stress condition the plants which do not received foliar application of HICO-110R showed increase in leaf temperature by 0.6°C over the HICO-110R sprayed and stressed sorghum plants.

The reduction in the transpiration rate is obvious under stress condition. When we compare control plants with those of stressed one, the reduction in the transpiration rate of upper leaf surface in sorghum was 90 per cent, while 84 per cent through lower leaf surface Similarly the comparison between stressed plants with those of sprayed and stressed plants clearly indicated that the reduction in the transpiration rate is more in sprayed and stressed plants. This situation is more or less same in groundnut also, but the reduction in the transpiration rate, leaf temperature was not much hampered. However, it needs further investigation.

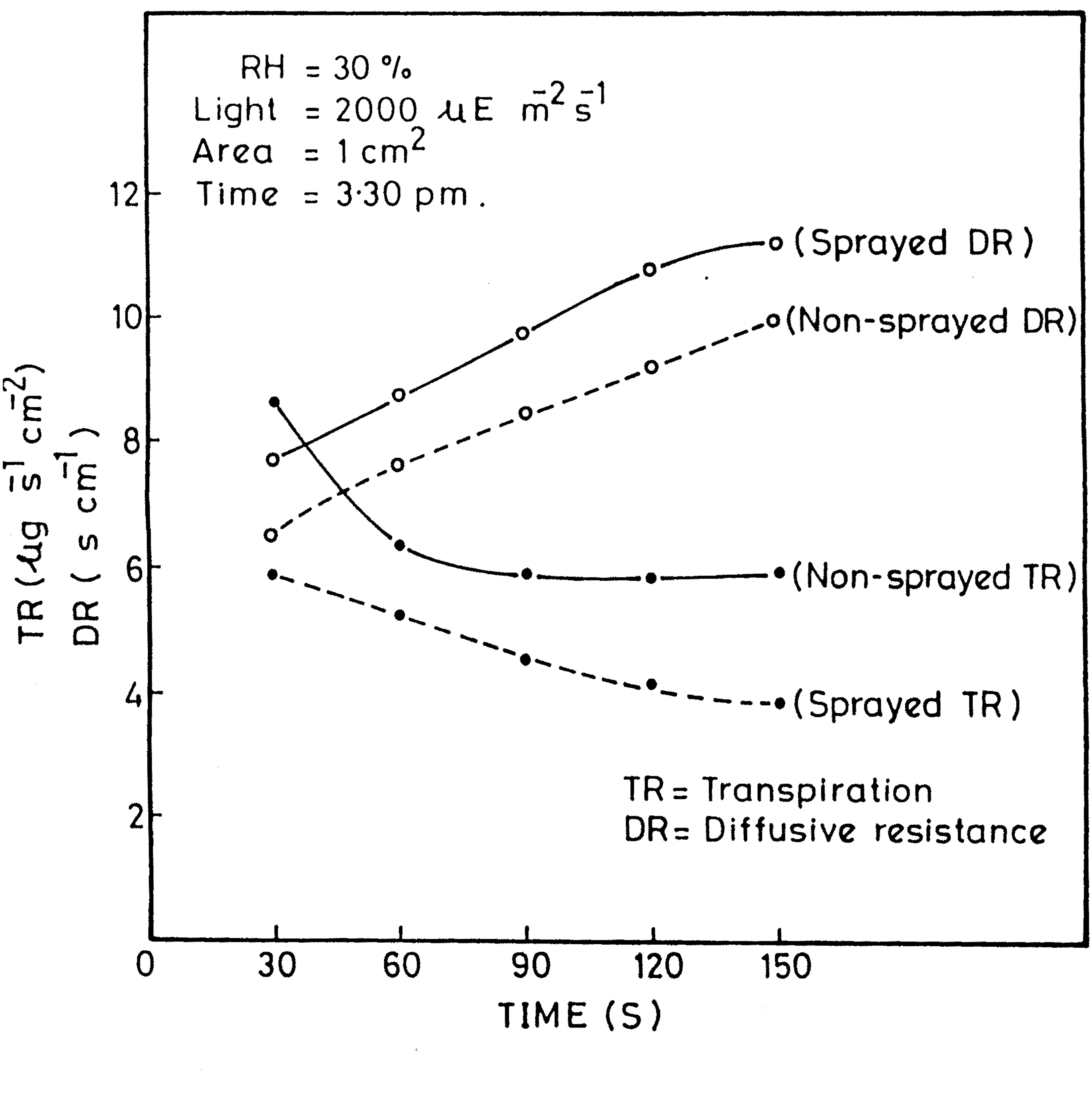
4. Stomatal regulation in field grown groundnut (UF-7-103) :

The experimental procedure, spray schedule and type of spray is mentioned in materials and methods.

Continuous monitoring of stomatal regulation for diffusive resistance and transpiration rate performed with the help of Steady State Porometer at 50% field capacity is presented in Fig. 3. Figure clearly indicates that HICO-110R spray reduces transpiration rate by increasing diffusive resistance of leaf, however, there is every possibility of altering the situation under condition of stress when field capacity goes down below 50%. This needs further confirmation by studying stomatal regulation at different field capacity.

F. Growth :

The leaf moisture, leaf area and plant height was analysed in HICO-110R sprayed and non-sprayed sorghum and groundnut plants.


RH = 30 %
Light = 2000 µE m⁻² s⁻¹
Area = 1 cm²
Time = 3·30 pm.
(Sprayed DR)
(Non-sprayed DR)
(Non-sprayed TR)
(Sprayed TR)
TR = Transpiration
DR = Diffusive resistance
TR (µg s⁻¹ cm⁻²)
DR (s cm⁻¹)
TIME (S)
0
30
60
90
120
150
2
4
6
8
10
12

In this experiment the plants were received three consecutive sprays of HICO-110R (1 ml/lit) at an interval of 15 days and after every spray the plants from a set stressed, sprayed and stressed were received water stress of eight days. Control and sprayed control were received water everyday (2 lit/pot). The stressed plants were then rewatered and analysed for the leaf area and plant height. The leaf moisture content from all the set was analysed prior to rewatering the plants after stress period of 8 days. The data is presented in Table 14.

From day to day observation one thing was clear that the recovery in sprayed and stressed plants was very fast relative to that in stressed plants. This clearly indicates that HICO-110R spray protects the plants from wilting. The moisture content in leaf though is less in stressed; sprayed and stressed plants compared to control and sprayed control plants the leaves of sprayed and stressed plants show significantly better moisture balance.

The highest leaf area observed in HICO-110R sprayed plants is a good sign of increasing photosynthetic assimilatory area. From this, we can speculate that HICO-110R possibly acting as a growth promoting substance because of which there was increase in internodal length and leaf area.

The growth contributory character such as height, number of leaves, number of branches, spread of plants and dry matter per plant have been shown to be increased due to foliar application of

Table 14 : Effect of HICO-110 R foliar application on leaf moisture, leaf area and plant height in sorghum var. M-35-1 and groundnut var. JL-24.

Treatment	Sorghum			Groundnut		
	Leaf moisture %	Leaf area cm^2	Height cm	Leaf moisture %	Leaf area cm^2	Height cm
Control	75.39	394.4	117.5	70.36	10.0	-
Sprayed control	78.97	440.0	134.0	71.53	12.5	-
Stressed	60.93	-	89.25	51.90	-	-
Sprayed and stressed	67.14	-	125.5	65.05	-	-

The values are mean of three determinations.

PLATE - 2

Effect of HICO-110 R foliar application on growth of groundnut var. JL-24 under control and water stressed condition.

A : 1 = Control

2 = Sprayed control

B : 1 = Stressed

2 = Sprayed and stressed

PLATE - 3

Leaf area expansion influenced by

foliar application of HICO-110 R

<u>PLATE - 4</u>

Effect of HICO-110 R foliar application on growth of sorghum var. M 35-1 under control condition.

1 = Control

2 = Sprayed control

PLATE - 5

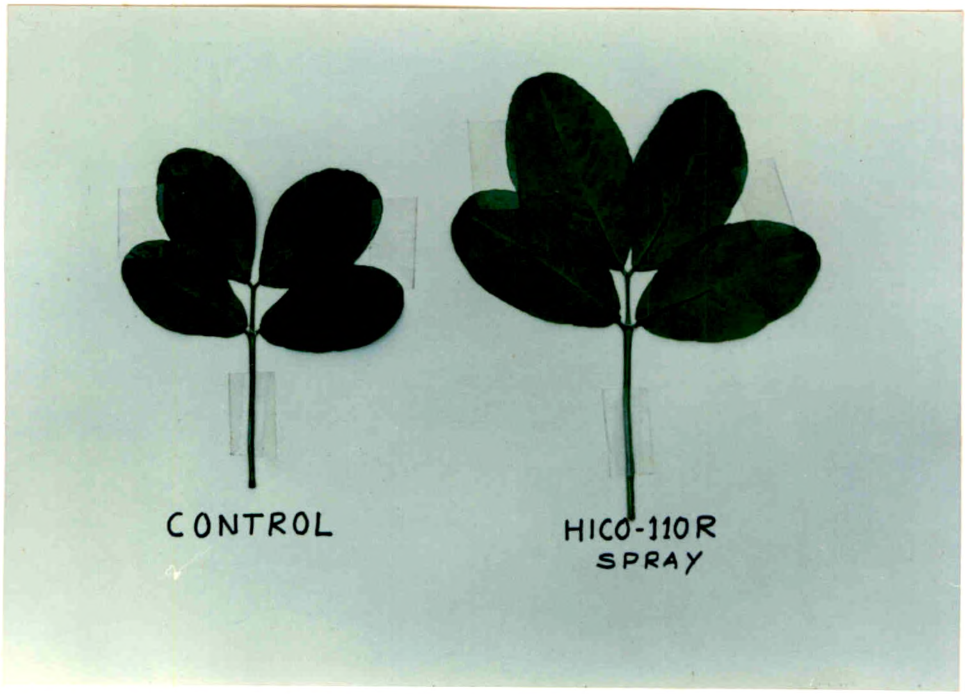
Effect of HICO-110 R foliar application on growth of sorghum var. M 35-1 under water stressed condition.

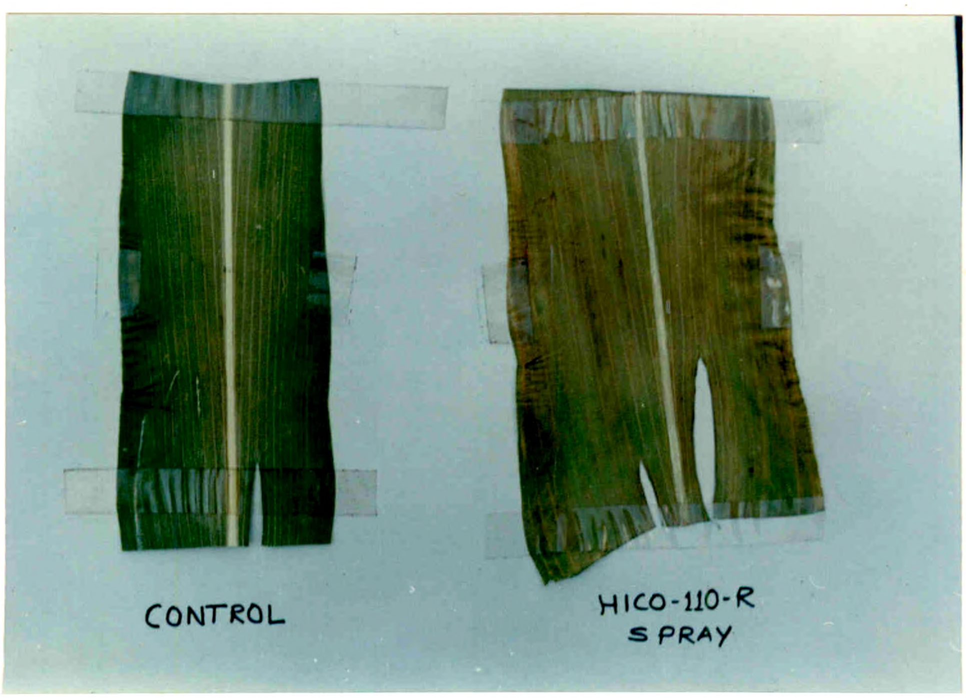
1 = Stressed

2 = Sprayed and stressed


A
1
2


B
1
2


CONTROL
HICO-110R
SPRAY


CONTROL
HICO-110-R
SPRAY


1
2


1
2

antitranspirants viz. PMA and Atrazine (Sable and Khuspe 1986) in groundnut plants. Thus we can say that antitranspirants to some extent protect the plant from water stress and also acts as a growth regulator.

G. Leaf anatomy :

This experiment was performed after analysing leaf moisture and leaf area. The general tendency of the chloroplasts under stress condition is either they reduce their number or increase the size. To test this, the sprayed and non-sprayed leaves of groundnut were examined in transverse section under light microscope. The number of chloroplasts per palisade tissue was counted and size was measured with the help of occular and stage micrometer.

The data is presented in Table 15. It is very clear from the table that number of chloroplasts per palisade was more in HICO-110R sprayed leaves under both control and stressed condition. Similarly same was the case of palisade size and chloroplast diameter. The increase in chloroplast size is certainly a beneficial event under stressed condition which was possibly attained by the plants due to HICO-110R spray. However, it needs confirmation.

H. Yield :

Above mentioned growth experiment was traced upto yield and it has been observed that there was increase in biomass production of above ground parts of groundnut by 23% and underground part by

Table 15 : Effect of HICO-110 R foliar application on leaf anatomy of groundnut var. JL-24

Treatment	Chloroplast No./palisade tissue	Palisade size (μ) Length x Breadth	Chloroplast diameter (μ)
Control	24.1	210 x 50	13.0
Sprayed control	24.9	218 x 40.8	14.5
Stressed	17.5	142 x 65.0	15.0
Sprayed and stressed	18.5	17.8 x 62.0	17.5

4% over control due to HICO-110R spray. Similarly in sprayed and stressed plants there was 3% increase in above ground part and 5% increase in underground parts of groundnut over stressed plants. As such antitranspirants such as a PMA and Atrazine at 5 ppm concentration were found to be effective in enhancing dry pod yield of summer groundnut (Sable and Khuspe 1986).

The effect of HICO-110R foliar application on an ear head weight of sorghum and biomass production and nut weight of groundnut was also studied.

The yield data given in Table 16 clearly indicate that sorghum ear-head weight increased in the plants sprayed with HICO-110R. Similarly the ear-head weight in the plants subjected to water stress condition was decreased. However, this decrease was less in the plants which were sprayed and stressed. The 100 grain test weight of sorghum was also increased in sprayed control and sprayed and stressed plants as compared to that of control and stressed plants respectively (Table 17).

The foliage yield in groundnut was also stimulated by HICO-110R under control conditions. However, it is interesting to note that the foliage yield was still more in the plants which were stressed after spray. The yield of groundnut was more or less same in control and control sprayed with HICO-110R, whereas it was stimulated in the plants which were sprayed and stressed.

Table 16 : Effect of HICO-110 R foliar application on yield of sorghum var. M-35-1 and groundnut JL-24.

Treatment	Sorghum ear head wt. g	Groundnut	
		Foliage wt./plant g	Pod wt./plant g
Control	49.5	24.44	7.56
Sprayed control	68.8	43.43	7.57
Stressed	19.0	17.98	4.11
Sprayed and stressed	30.0	40.32	9.68

The values are mean of three determinations.

Table 17 : Effect of HICO-110 R foliar application on grain wt. of sorghum var. M-35-1.

Treatment	100 grain wt. g
Control	4.04
Sprayed control	4.34
Stressed	3.75
Sprayed and stressed	3.92

The values are mean of three determinations.

PLATE - 6

Ear-head development of sorghum var. M 35-1 influenced by HICO-110 R foliar application under control and water stressed condition.

1. Stressed
2. Sprayed and stressed
3. Control
4. Sprayed control

PLATE - 7

Growth and pod yield in groundnut var. JL-24 influenced by HICO-110 R foliar application

1 : Sprayed control

2 : Sprayed, stressed and recovered.


1
2


1
2
3
4

In general, groundnut is a rainfed crop and as such frequent irigations are not essential for this crop to get more yield. Possibly this may be the reason for getting less yield under control condition as compared to sprayed and stressed plants. Further, maintenance of water balance in stressed plants due to HICO-110R might be enough to yield more under stress condition. From this it is very clear that HICO-110R stimulates the yield potentiality of both the crops and also helps in maintaining turgor of the cell under stress condition.