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INFLUENCE OF SIMULATED WHITEGRUB DAMAGE OF ROOTS ON WATER RELATION PARAMETERS IN GROUNDNUT

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SUMMARY

White grubs (larval scarbaeids) are important pest of groundnut in many parts of the world. These larvae damage the root system of the plants. A method of simulated whitegrub damage to plants was developed to assess influence of feeding activity of these insects on plant growth. Seeds of groundnut variety *Chitra* were sown in polythene bags and allowed to grow in a net house. One set was grown under normal water supply and the other set under water stress. Simulated whitegrub damage was created by cutting the roots of plants at 10, 20 and 30 cm from the top soil surface at 30 days after sowing in one set and at 60 days after sowing (DAS) in the other set under both the conditions. Plant leaves were taken at 5, 15 and 25 days after the root cut from both the sets for estimation of proline, peroxidase activity, transpiration rate and relative water content. Simulated whitegrub damage reduced relative water content as well as transpiration and the reduction was highest in plants with roots cut at 10 cm and the lowest in plants with roots cut at 30 cm. Proline content and peroxidase activity increased with the increase in the per cent root cut. The magnitude of increase in proline and peroxidase was almost 2-3 times of the control, in plants whose; roots were cut at 30 or 60 days after sowing. Seed yield was also reduced due to simulated whitegrub damage at both the stages. The roots damaged at 60 DAS reduced the seed yield to a greater extent than the roots damaged at 30 DAS.

Key words: **Proline, relative water content, transpiration, water stress, whitegrub**

INTRODUCTION

Plant water relation parameters like water potential, osmotic potential, turgor potential and transpiration are important indices for having an assessment of plant water status required for plant survival (Tanner and Sinclair 1983). Since whitegrub attacks the plant roots, it is likely that it causes water stress in the plant, thereby affecting water status of the plant (Wightman *et al.* 1994). There is little account of the relationship between the damage whitegrubs cause to roots and the interaction with above ground biomass and water status of the plant. Thus the importance of these features was realized so as to generate more information on the relationship between whitegrub activity, water and crop loss. It is not yet clear at what growth stage a plant can recover from root damage. The lack of information in this area is one of the reasons for initiating this study with the aim to develop technique that permit the root manipulation in simulated field condition. This will help in understanding the effect of whitegrub damage on yield loss and water relation parameters.

The experiment was planned to investigate the effect of root damage treatment at three depths and at two growth stages to simulate the root feeding activity of whitegrub. Proposed experiment was aimed at studying water status and related parameters like proline and

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peroxidase activity in response to simulated whitegrub damage. These parameters have been implicated as stress indicators (Kramer 1983). Natural tolerance of the plants to the water stress is likely to be affected by damage to root system; therefore water stress was included as one of the treatment.

MATERIALS AND METHODS

Seeds of groundnut variety chitra were sown in polythene bags filled with soil mixed with FYM (3:1). The height of polythene bags was 50 cm containing 5 kg soil leaving the space of 5 cm at the topsoil. Soil was saturated with water to field capacity and excess water drained. One set of plants were grown under normal water supply by irrigating them at every alternate day with 250 ml water per pot. This way the soil moisture was maintained at 10 to 10.5 per cent. The other set was grown under water stress conditions by irrigating them after every three days with 250 ml water per pot so as to maintain the soil moisture at 5 to 5.5 per cent. Simulated whitegrub damage was created by cutting the roots of plants from the lower side along with the bag at different depth of 10, 20, 30 cm from the topsoil surface at 30 days after sowing (DAS) in one set and 60 DAS in other set. After creating simulated whitegrub damage, the plants were grown in randomized block design. They were randomized after every 10 days. Each treatment had five replications and each replication consisted of three bags having one plant in each.

Plant leaf samples of different treatment were taken at 5, 15 and 25 days after the root cut at 30 and 60 days of sowing for estimating proline (Bates *et al.* 1973), peroxidase activity (Shannon *et al.* 1971), transpiration by quick weighing method (Srivastava and Kumar 1993) and relative water content (Weatherley 1950).

RESULTS AND DISCUSSION

Effect of simulated whitegrub damage on relative water content of groundnut under relatively non-stress and stress condition is shown in Table 1. The fall in relative water content due to root cut at 30, 20, 10 cm depth was more under water-stress than under non-stress in both the sets subjected to simulated whitegrub damage either at 30 DAS or 60 DAS. Relative water content (RWC) decreased with the increase in severity of root damage under moisture stress and non-stress. The RWC decreased to greater extent in plants with roots cut at 10 cm than those with roots cut at 20 cm under non-stress as well as under water stress. The per cent decrease in RWC due to roots cut at 10 cm at 30 DAS was 11.54 % under non-stress and 22.33 % under water

Table 1. Effect of simulated whitegrub damage on relative water content at different days after root cut at 30 and 60 days after sowing (DAS) in groundnut.

Treatment	Root cut depth (cm)	30 DAS			60 DAS		
		Days after root cut treatment					
		5	15	25	5	15	25
Non Stress	Control	88.59	89.84	86.94	80.60	80.83	84.58
	30	86.66	86.05	82.15	80.33	78.60	82.36
	20	84.04	84.73	80.10	78.72	73.73	74.41
	10	78.33	79.12	73.26	64.82	62.26	63.09
Water Stress	Control	86.10	84.44	84.64	78.43	79.00	74.86
	30	81.45	82.12	80.40	77.00	76.29	74.61
	20	72.68	78.87	74.04	76.59	72.59	70.68
	10	67.73	70.14	69.15	55.26	56.26	52.88
			CD (0.05)			CD (0.05)	
Days			1.115			1.009	
Treatment			1.620			1.649	
Days x Treatment			3.153			2.856	

stress while it was 19.58 % and 29.54 % respectively due to 10 cm roots cut at 60 DAS.

Influence of simulated whitegrub damage on transpiration of groundnut revealed that due to water stress the transpiration decreased as compared to non-stress in all the treatments of simulated whitegrub damage (Table 2). Simulated whitegrub damage also decreased the rate of transpiration as compared to the control (without root cut) under non-stress as well as water stress. Plants having simulated whitegrub damage (10 cm root cut) at 30 DAS had 53.19% fall in transpiration rate compared to control under water stress and 51.22 % under non-stress. However, it was 34.81% under water-stress and 34.67% under non-stress due to whitegrub damage simulated at 60 DAS. Due to simulated whitegrub damage, the fall in relative water content and transpiration in plants was greater under water stress than under non-stress conditions. Wightman *et al.* (1994) have also reported similar observation.

Effect of simulated whitegrub damage at 30 as well as 60 DAS revealed over production of proline than the control under non-stress as well as water-stress. The maximum increase (428.12 %) was recorded in 10 cm root cut under water stress when whitegrub damage was simulated at 30 DAS. It seems, there is some linkage between the stress created as a results of simulated whitegrub damage and water stress *vis-a-vis* proline accumulation. It is known that proline helps in stress tolerance (Koti *et al*. 1994) either by rehydration of protoplasm or by providing energy for recovery of plants (Manjula *et al.* 2003). The effect of simulated whitegrub damage of groundnut at 30 DAS showed that peroxidase activity in the leaves initially increased up to 15 days after root cut and then declined under non-stress as well as water stress (Table 4). In case of simulated whitegrub damage at 60 DAS, it increased gradually till 25 days after root cut in all the treatments under water stress as well as non-stress. The increase in peroxidase activity was more when whitegrub damage was simulated at 30 DAS than at 60 DAS.

Survival of plants also affected due to simulated whitegrub damage (Table 5). The loss of plants was more due to whitegrub damage simulated at 30 DAS than at 60 DAS. However the damage was more under water stress than non-stress due to simulated whitegrub damage. Simulated whitegrub damage both at 30 DAS and 60 DAS also reduced the yield compared to their respective controls under non-stress as well as water stress. The maximum loss in seed yield was witnessed in 10 cm root cut plants when whitegrub damage was simulated at 30 DAS. With this treatment, very few

Table 2. Effect of simulated whitegrub damage on transpiration rate (mg g^{-1} fw min^{-1}) at different days after root cut at 30 and 60 DAS in groundnut

Treatment	Root cut depth (cm)	30 DAS			60 DAS		
		Days after root cut treatment					
		5	15	25	5	15	25
Non Stress	Control	1.232	2.567	4.047	2.163	1.918	2.091
	30	1.331	2.651	4.043	1.932	1.891	1.812
	20	0.874	2.580	3.555	1.963	1.762	1.695
	10	0.704	2.345	2.466	1.413	1.403	1.323
Water Stress	Control	1.130	2.411	3.690	1.847	1.661	1.612
	30	1.130	2.219	3.840	1.775	1.291	1.271
	20	0.639	2.158	2.186	1.667	1.270	1.192
	10	0.529	2.080	2.029	1.204	1.174	1.094
			CD (0.05)			CD (0.05)	
Day			0.171			0.071	
Treatment			0.279			0.117	
Days x Treatment			0.483			0.202	

Table 3. Effect of simulated whitegrub damage on proline content in (µg g^{-1} fw) at different days after root cut at 30 and 60 DAS in groundnut.

Treatment	Root cut depth (cm)	30 DAS			60 DAS		
		Days after root cut treatment					
		5	15	25	5	15	25
Non Stress	Control	0.09	2.50	23.00	6.02	1.41	1.38
	30	0.09	3.50	23.80	7.06	1.61	1.82
	20	0.20	3.50	37.00	10.86	2.01	2.00
	10	0.22	22.50	87.50	16.82	3.01	4.11
Water Stress	Control	0.32	60.20	14.20	10.18	5.21	3.00
	30	0.83	61.75	15.00	13.19	6.08	3.11
	20	1.06	75.50	16.50	14.00	7.01	4.82
	10	1.69	132.50	33.00	18.39	10.05	6.12
			CD (0.05)			CD (0.05	
Day			0.581			0.212	
Treatment			0.948			0.347	
Days x Treatment			1.643			0.600	

Table 4. Effect of simulated whitegrub damage on peroxidase activity (Enzyme unit* x 100) at different days after root cut at 30 and 60 DAS in groundnut

Treatment	Root cut depth (cm)	30 DAS			60 DAS		
		Days after root cut treatment					
		5	15	25	5	15	25
Non Stress	Control	3.82	3.96	1.97	2.02	2.16	3.68
	30	5.02	5.82	2.37	2.73	2.84	3.83
	20	6.00	6.15	3.56	2.91	3.55	4.14
	10	7.02	7.38	3.83	3.64	3.63	5.62
Water Stress	Control	4.08	5.01	2.98	2.35	2.43	3.82
	30	5.83	5.87	3.07	2.91	3.95	4.22
	20	6.69	7.17	3.83	3.50	4.31	5.08
	10	7.66	7.78	4.42	3.68	4.33	6.39
			CD (0.05)			CD (0.05)	
Days			0.429			0.439	
Treatment			0.702			0.716	
Days x Treatment			1.215			1.241	

* One enzyme unit is defined as that quantity of enzyme which causes an increase in absorbance of 0.01 OD per min per g fw

plants survived under non-stress while none survived under water stress till harvest. The yield losses were more under water stress than under normal soil moisture due to whitegrub root damage simulated either at 30 or 60 DAS. Simulated whitegrub damage at 30 DAS was more detrimental that resulted in 80% loss in plant number under normal moisture. Data also suggest that the growth stage of the plant at which whitegrub attacks was of immense importance than depth of root cutting. One of the reasons for higher reduction in relative water content at different days after root cut (5, 15 and 25) seems to be due to loss of water through enhanced

Table 5. Effect of simulated whitegrub damage on seed yield of groundnut when root cut treatment was given at 30 and 60 DAS

Treatment	Root cut depth (cm)	Number of plants survived from sub-treatment at		Yield (g/ plant) from the plants cut at	
		30 DAS	**60 DAS**	**30 DAS**	**60 DAS**
Non-stress	Control	15.00	15.00	0.85	0.94
	30	9.00	12.00	0.79	0.86
	20	6.00	12.00	0.39	0.70
	10	3.00	6.00	0.35	0.23
Water-stress	Control	6.00	9.00	0.73	0.88
	30	3.00	9.00	0.56	0.83
	20	3.00	6.00	0.34	0.33
	10	NIL	6.00	NIL	0.10
	CD (P=0.05)	1.61	2.28	0.06	0.05

transpiration by the plant. Over production of proline under water stress and simulated whitegrub damage as compared to their respective control shows that stress is manifested by proline accumulation. Higher change in relative water content and transpiration in the plants growing under water stress (5% moisture) than under simulated whitegrub damage indicates that moisture stress is more critical. The simulated white grub damage and the root damage caused by feeding of *H. consanguinea* larvae (Yadav and Yadav 2004), although appear to mirror closely the effects of water stress, their exists some differences among the three stresses. Taking into consideration our earlier results (Yadav and Yadav 2000), it can be concluded that depth of root cutting would have little influence on the yield in groundnut as whitegrub is generally active in 10-20 cm root zone. Present study also showed the maximum reduction in seed yield due to simulated whitegrub damage by cutting roots at 10 cm from topsoil.

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