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CHANGES IN THE MORPHOLOGICAL BEHAVIOUR OF WHEAT PLANTS GROWN ON POLLUTED HABITATS (VARANASI, INDIA)

Modifications morphologiques de plantes de froment croissant sur des sites pollués (Varanasi, Inde)

B.D. TRIPATHI & R.S. AMBASHT*

RESUME

La présente recherche a été poursuivie dans quatre sites, dont les trois premiers (I, II et III) représentaient différents niveaux de pollution par les eaux résiduelles de l'usine de produits chimiques et d'engrais Sahu à Sahupuri, dans la banlieue de Bénarès en Inde. Le site IV, intact, a été pris comme témoin. Les effets de la pollution sur l'agro-écosystème ont été appréciés au moyen de paramètres morphologiques relatifs à la croissance du froment dans les quatre sites tels que la taille, la longueur et le développement latéral du système radiculaire, le nombre de feuilles par plante, le diamètre du second internoeud, la résistance à la rupture du chaume, le nombre de pousses par plante et la longueur de l'épi. Les observations ont été réalisées après respectivement 60, 80, 100 et 120 jours de croissance. Les observations établissent la corrélation étroite et inversément proportionnelle entre les paramètres de croissance et les niveaux de pollution. Bien que la longueur des pousses et leur nombre sont légèrement plus élevés pour le site légèrement pollué (III) que le témoin (IV), une réduction sévère de ces paramètres a été observée pour les sites fortement pollués (I et II). De même avec l'augmentation de la pollution s'observe une réduction du nombre de feuille, du diamètre de la tige, de la longueur de l'épi ainsi que de la résistance du chaume à la rupture.

La biomasse totale du froment montre des valeurs très basses sur les sites I et II, tandis que le site III est seulement légèrement inférieur au site témoin IV.

ABSTRACT

Present investigation was carried out on four sites of which site I, II and III are polluted by different levels of effluents of Sahu Chemicals and Fertilizers Factory at

* Centre of Advanced Study in Botany, Banaras Hindu University, Varanasi, 221005, India.

Sahupuri, Varanasi, India. Site IV was free from the pollutants and regarded as the control site. Effect of effluent pollution on the agro-ecosystem have been measured through the study of morphological growth parameters of wheat growing on these four sites such as shoot length, root length and lateral spread, number of leaves per plant, diameter of second internode, breaking strength, number of tillers per plant and length of ear. Each observation has been taken at the age of 60, 80, 100 and 120 days. Observations reveal the inversely proportional and significant relationship between the growth parameters and the level of pollution. Although the length of shoot and number of tillers on the least polluted habitat (site III) were slightly higher than on the control habitat (site IV), yet there was a sharp reduction in shoot length by 37 % and number of tillers by 39-60 % at moderate and highly polluted habitats (site II and site I) sites respectively. The number of leaves of wheat plant was reduced considerably at the polluted habitats. Stem diameter showed a reduction of 15 to 27 % at the polluted habitat over control one. The reproductive growth of the plant on polluted habitat was also poor. There was 35 to 45 % decrease in the average length of ears of heavily and moderately polluted habitats. The breaking strength of stems was tremendously reduced on site I and II.

The overall growth performance of plants on site I and II was very poor and on site III it was only some what less than the control plants of site IV.

INTRODUCTION

A Chemicals and Fertilizers Factory at Varanasi (83.1' E long and 25.18' N lat.), India, lets out huge quantity of untreated effluent through a brick channel upto some distance, beyond, which it spreads over to surrounding crop lands. Adverse effects of aforesaid effluent have been reported earlier by the author and some other workers on various aspects of soil pollution (TRIPATHI, 1978), phytosociological behaviour of uncultivated area (TRIPATHI, 1978), population dynamics of the soil mesofauna (SINGH & TRIPATHI, 1978, 1979), germination and mineral composition of wheat (TRIPATHI, 1978) and carbohydrate to sugar conversion during the time of germinating wheat seeds (TRIPATHI, 1979). In continuation of the same work present paper deals with the study on the growth performance of wheat in relation to different levels of soil pollution.

MATERIALS AND METHODS

For the present investigation in order to assess the effects of effluent on the growth performance of wheat crop 4 sampling sites were

Properties	Sampling Station			
	Station I	Station II	Station III	Well water
pH	9.5 (± 1.0)	9.3 (± 1.5)	8.1 (± 1.4)	7.2 (± 0.5)
Température °C	44.2 (± 4.0)	30.4 (± 5.0)	23.0 (± 2.0)	23.5 (± 2.0)
Carbonate mg/l	88.0 (± 6.4)	83.0 (± 5.5)	66.2 (± 2.8)	5.3 (± 1.5)
Bicarbonate mg/l	585.0 (± 10.2)	527.5 (± 12.0)	577.8 (± 8.6)	49.0 (± 2.0)
Sodium mg/l	290.9 (± 20.0)	285.7 (± 12.0)	282.7 (± 10.0)	7.3 (± 1.5)
Potassium mg/l	15.5 (± 2.8)	12.8 (± 2.6)	9.7 (± 1.5)	2.5 (± 0.5)
Calcium mg/l	120.2 (± 20.5)	118.6 (± 18.0)	115.4 (± 5.6)	95.0 (± 1.0)
Magnesium mg/l	25.2 (± 4.5)	95.0 (± 4.5)	24.5 (± 2.0)	24.3 (± 2.0)
Nitrate Nitrogen mg/l	12.6 (± 2.8)	10.5 (± 1.8)	8.5 (± 1.0)	0.24 (± 0.02)
Ammonium Nitrogen	64.1 (± 6.0)	55.5 (± 4.6)	42.6 (± 5.2)	0.04 (± 0.01)
Total Nitrogen mg/l	134.4 (± 25.0)	132.1 (± 22.5)	130.1 (± 20.0)	12.5 (± 1.5)
Residual Sodium Carbonate (RSC) mg/l	4.7 (± 1.2)	3.4 (± 1.0)	2.1 (± 0.2)	- -
Suspended solids mg/l	656.5 (± 98.0)	638.0 (± 105.0)	598.0 (± 80.0)	74.6 (± 5.2)
Dissolved solids mg/l	1266.4 (± 125.0)	1257.2 (± 98.0)	1237.7 (± 85.0)	32.8 (± 8.5)
Total solids mg/l	1926.0 (± 220.0)	1895.0 (± 180.5)	1836.0 (± 175.0)	107.5 (± 50.0)
Chloride mg/l	113.7 (± 13.0)	98.8 (± 10.5)	93.3 (± 10.0)	18.5 (± 2.0)

Tabl. I : Physico-chemical properties of effluent and well water (average of 13 months observation). Values in parentheses represent standard deviation.

chosen of which the first was highly affected area by the effluent, site second was moderately affected and site third was least affected receiving the effluents from station I, II and III respectively (Tab. I). These three sites were studied along the direction of flow of the effluent. The site fourth was situated on the opposite side of the factory, where the effluent did not reach. It was irrigated by the well water. This has been regarded as the control site.

To study the growth performance of wheat, some important morphological parameters such as shoot length, root length, lateral spread of roots, number of leaves per plant, diameter of second internode, breaking strength, number of tillers per plant, and length of ear have been taken into consideration. Twenty quadrats of one m^2 were laid at random on each study site and average of the aforesaid plant parameters were calculated. A monolith of soil around one plant was choosen randomly from each of the twenty quadrat and was dug up to 45 cm depth. Monolith samples were brought to the laboratory and washed with the water before the measurements of length and lateral spread of roots. Every observation was taken at the intervals of 60, 80, 100 and 120 days after sowing the seeds. For the determination of breaking strength wheat stem pieces (6 cm length) were cut out from the middle of the second internode from the base and a pan was suspended by means of thread of 10 cm length from the middle of the piece. Sand was poured in it till the breaking point. Breaking strength was calculated as follows :

Breaking strength of stem = Weight of pan + thread + sand in gm

RESULTS AND DISCUSSION

The morphological growth parameters of wheat plant growing on polluted and control sites are given in table II, and length of shoot and root in relation to exchangeable Sodium percentage (ESP), carbonate, pH and Chloride of the soil are shown in figure 1. The root length was maximum on site III at corresponding ages. The maximum height (102.2 cm) was observed at the age of 100 days. The plants growing on control soils however, had a maximum height of 83.6 cm only at 100 days. The height of the shoot gradually decreased at site II (58.4 cm). At all the sites, the height gradually increased from 60 days to 100 days, thereafter it somewhat falls at 120 days. In 60 days old wheat plants, root length varied from a minimum of 4.5 cm at site I to the maximum of 15 cm at control site. With increasing age the root length increased at all the

Growth parameter	Age in days	Site I	Site II	Site III	Control
Shoot length (cm)	60	20.0	40.5	75.4	65.5
	80	25.7	48.5	89.5	76.2
	100	32.5	52.4	102.2	83.6
	120	31.0	50.2	100.5	81.4
Root length (cm)	60	4.5	5.5	13.5	15.0
	80	5.0	6.0	19.0	20.5
	100	6.4	8.5	22.5	25.5
	120	6.4	8.5	22.5	25.5
Lateral spread of root (cm)	60	1.8	2.5	6.0	6.5
	80	2.5	3.5	6.2	7.2
	100	3.2	3.8	8.4	10.0
	120	3.2	3.8	8.4	10.0
N° of leaves/plant	60	4.5	16.5	22.5	22.4
	80	8.9	22.7	28.8	28.7
	100	10.5	28.4	32.5	34.7
	120	4.5	12.5	16.5	17.2
Diameter of II internode (cm)	60	0.25	0.28	0.30	0.31
	80	0.28	0.28	0.32	0.33
	100	0.28	0.29	0.33	0.33
	120	0.24	0.26	0.28	0.33
Breaking strength (g)	60	20.2	24.5	340.0	345.0
	80	20.5	28.5	402.0	408.0
	100	21.5	30.8	407.0	414.0
	120	18.4	28.4	370.0	380.0
Tillers/plant	100	6	9	16	15
Ear length (cm)	100	8.5	10.25	15.3	15.5

Tab. II : Growth behaviour of wheat plant growing on effluent affected and normal soils near fertilizer factory.

sites upto 100 days. At this age also the plants growing on control site had longer roots (25.5 cm) than those at site III (22.5 cm), site II (8.5 cm) and site I (6.4 cm).

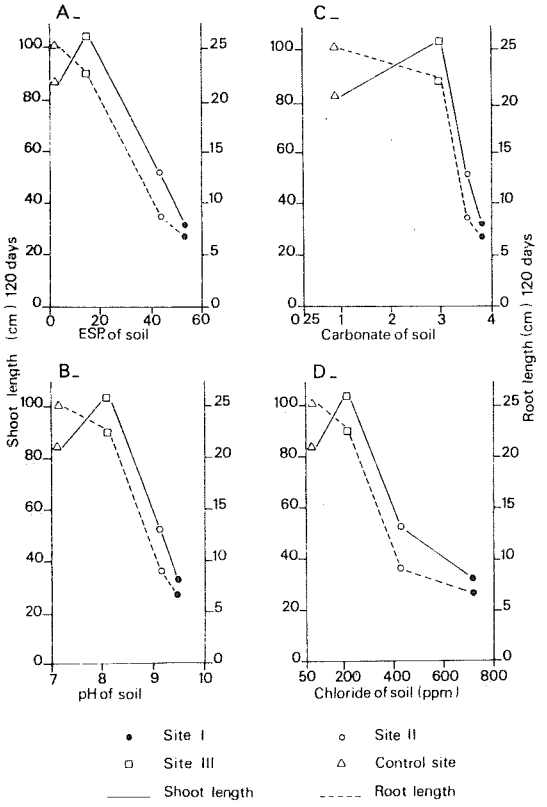

Fig. 1.

Besides lateral spread of the roots was also reduced. The maximum lateral spread of roots on all the four sites were observed at 100 days. It also decreased with the increase in pollution level from 10.0 cm at control site to 8.4 cm at site III to 3.8 cm at site II and to 3.2 cm at site I.

Number of leaves per plant increased with the age upto 100 days, and then it decreased at 120 days. This trend was found on all the four sites. The maximum average number of leaves (34.7/plant) was recorded on control site at the age of 100 days. The corresponding values for site III, II and I were 32.5 leaves/plant, 28.4 leaves/plant and 10.5 leaves/plant in the sampling of 100 days old plant. Diameter of second

internode of wheat plant (from the shoot base) showed a very minor decreasing trend from control to site III, II and I.

Breaking strength of the stem was maximum at the age of 100 days on all the four sites. At this age its value ranged from 414 g in control site plants to as low as 21.5 g in plants of site I. The breaking strength of stem gradually increased on all the sites upto 100 days after which it decreased. The average number of tillers per plant counted at the age of 100 days varied from a minimum of 6 tillers in site I to a maximum of 16 tillers at site III. Control plants showed 15 tillers per plant. Similarly the length of ear was the least in highly polluted site I (8.5 cm) and maximum in plants of control site (15.5 cm). However, a number of growth parameters were studied for the wheat crop on the polluted and control sites. Most of these growth parameters are negatively affected as soil pollution level increases from site III to I. Although the length of shoot and number of tillers at site III are slightly higher than on the control site, may be due to better nitrogen and less sodium content of the soil, yet there is a sharp reduction in shoot length by 37 % and number of tillers 39 to 60 % at polluted sites as compared to those of of control site. Similarly BAJWA, BHUMBLA and CHAUDHARY (1975) have reported that high levels of ESP, although the sodium tolerance of plants is increased to some extent by application of nitrogen, yet the crop growth and responses to the fertilizer nitrogen were severely inhibited by the direct adverse effects of sodium saturation. Reduction in the root length and root spread is less than 20 % at site III but more than 60 % in site II and I as compared to the control site. The number of leaves of control plants is reduced to 4-73 % at polluted sites. Stem diameter also showed a reduction of 15 to 27 % at polluted sites over control one. Plants growing on polluted soils were considerably weak. Breaking strength of their stem was reduced to almost half. Thus present investigation supports the findings of PERSON and BERSTEIN (1958), SOWELL and ROUSE (1958) and DIXIT & LAL (1971) that the high concentration of salts in general and sodium in particular presumbly creates a very unfavourable soil condition which reduces or supresses the growth of plants.

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