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Rooting Pattern as a Selection Parameter of Wheat Varieties Under Moisture Stress

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ABSTRACT

Sixteen wheat varieties were studied under rainfed condition in heavy black soil with a view to evaluate their yield potential on the basis of root growth pattern in moisture stress condition. Varieties viz., C 306, Hy 633, Hy 11, Hy 65, PKD 14, HD 1625 with greater number, deep vertical penetration and a more horizontal spread of seminal roots proved to be drought escaping and high yielding. Earlier initiation of crown roots coupled with their more number and greater length was found to be of great significance for an additional moisture and nutrient absorption and substantial vigour which ultimately result in higher productivity.

INTRODUCTION

Wheat possesses like other graminaceous plants seminal and crown root systems. The former type has a greater capacity for uptake of water and nutrients from deeper zones of soil as compared to that of crown roots (Boat Wright and Ferguson, 1967). The seminal roots serve the main culm where as the crown roots serve the tillers. Since the main culms constitute bulk of the population under water stress, the seminal roots predominate, and their number and degree of vertical penetration form an important selection index of wheat plant type suitable for drought adaptation. (Asana, 1969).

Deeper crown-nodes and shorter sub-crown-inter nodes in a plant are desirable characteristics for drought adaptation since they place the region of crown root initiation nearer to moister soil zone. The time and growth rate of crown roots are also important in selecting drought adaptable varieties. An earlier and faster development may have a distinct advantage under stress conditions.

MATERIALS AND METHODS

The root systems of sixteen improved varieties of wheat were studied during in 1969-70 with regard to growth, productivity and adaptability to rainfed conditions in heavy black soil in a simple randomised block design with a basal dose of 30:30 kg Nitrogen and phosphate per ha. Sowing was done on 7th November 1969 and the samples were taken on 3rd

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TABLE 1. Seminal root system and its growth pattern under rainfed cultivation

Variety	No. of seminal roots/plants	Length of Seminal roots at different growth stages (in)				Vertical penetration of semi roots (in)	Horizontal spread of seminal roots (in)
		Tillering stage	Root stage	Ear stage	Matured stage		
Hy 65	5.25	11.33	13.85	17.60	27.42	24.42	29.52
Kalyansona	4.20	11.14	12.70	15.05	23.07	23.30	28.00
HD 1467	4.30	9.22	12.95	15.37	25.50	21.42	22.46
HD 1460	4.75	11.55	14.25	15.02	23.75	21.35	21.56
HD 1625	4.65	11.47	14.30	15.25	23.95	20.00	24.30
DA 491–5	4.85	10.64	14.10	16.30	26.72	23.62	29.85
NP 404	5.65	12.07	14.42	15.72	25.85	21.80	31.25
S 307	4.50	12.62	13.92	15.75	25.42	22.75	32.60
C 306	5.58	12.04	13.00	19.92	29.67	27.85	38.52
HI 6–23	4.55	11.89	13.87	16.75	22.67	21.00	30.20
Hy 11	5.15	13.90	14.67	16.27	26.77	25.00	35.25
Hy 633	5.35	11.77	13.87	18.87	30.15	28.25	34.37
PKD–14	5.55	13.07	14.00	18.20	27.15	26.65	40 00
PKD–4	4 80	13.51	14.00	17.17	24.47	22.05	28.24
K 68	4.25	12.34	12.87	16.40	24.17	21.82	25.52
K 65	4.67	12.32	13.65	16.60	22.12	19.85	23.62
S. E.	0.3322	N. S.	0.54	0.61	0.6843	0.6557	2.5808
C. D. at 5%	0.6712	—	1.09	1.24	1.3824	1.3245	5.2132
C. D. at 1%	0.8938	—	1.46	1.65	1.84	1.7638	6.9423

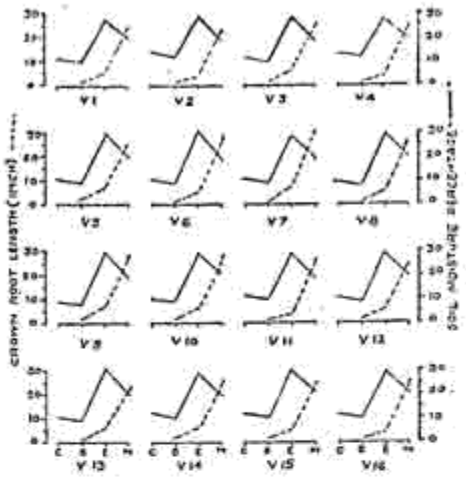

Fig. 1. Relationship between soil Moisture and Crown Root Length.
C. Crown root stage, B. Boot stage, E. Ear stage, M. Matured stage

December 1969, 6th January and 21st January 1970 and 6th March 1970. The plot size was 2.5 × 1.5 m. The length, number and vertical as well as horizontal spread of seminal roots was noted at different growth stages of the crop while in case of crown roots, time of initiation, total and effective number per plant and vertical and horizontal spread were noted. The length of sub-crown-internode was also noted. Monolith sampling method was used (Fox and Lipps, 1955).

RESULTS AND DISCUSSION

(a) **Seminal root System:** The number of seminal roots was significantly higher in NP 404 (5.65) followed by C 306, PKD-14 and Hy 633 (Table 1) at the final growth stage. An average length of 26 to 30 in was recorded in Hy 633, C 306, Hy 65, PKD-14 and Hy 11 but in case of the former three varieties the maximum of 45 in was noted. Shorter roots (21-25 in) were observed in K 65, HI 6-23 HD 1460 and Kalyansona under rainfed conditions. As K 65 and Kalyansona possess a lesser number of shorter seminal roots they are poorly adopted for rainfed cultivation. Roy and Murty (1968) found a poor seminal root growth in relatively lighter soils.

The horizontal spread of the seminal roots although of less consequence has grater significance when coupled with a deeper root penetration under soil moisture stress. Irrespective of the root length, maximum horizontal spread (31-40 in) was found in PKD-14, C 306, Hy 11, Hy 633, S 307 and Hy 65.

The varieties, although genetically different, did not exhibit any marked variability in the growth rate and pattern of development of the seminal roots during early growth stages of the seedling. However, marked variations in rooting pattern were obvious at the later stages of the plant growth, indicating morpho-physiological adaptability of particular varieties to drought conditions.

(b) **The Crown root system:** The development of crown roots has been considered to be a varietal characteristic in wheat. The initiation and growth rate of these roots is also largely dependent on the soil moisture content.

HD 1625, Hy 633, C 306, DA 491-5 and Hy 65 (Table 2) had an earlier initiation of the crown roots at the tillering stage which continued to grow, though slowly under low soil moisture. In other varieties the development of crown root was almost ineffective in spite of the presence of crown root primordia, indicating the significance of time of initiation and the speed of

TABLE 2. Crown root system and its growth pattern under rainfed condition

Variety	No. of days required for crown root initiation	No. of crown roots initiated plant	No. of effective crown roots/plant	Length of crown roots at different stages (in)			Length of sub-crown internode (in)	Grain weight culm (g)	Yield (Q/ha)
				Boot stage	Ear stage	Matured stage			
Hy 65	35.55	11.55	4.92	0 89	4.85	24.50	0.85	1,57	20.77
Kalyansona	37 35	9.30	3.40	1.28	4.32	22.00	0.65	1.19	13.88
HD 1467	40.50	7.20	3.25	1.36	5.52	25.25	1 20	1.268	16.86
HD 1460	38.00	9.29	3.47	0 63	4.05	24.00	1.00	1.31	19.82
HD 1625	32.00	13.90	4.00	2.35	7.07	20.50	0.52	1.611	20.55
DA 491 - 5	35.65	8 90	4.80	0.66	3.85	27.50	0.68	1.45	18.11
NP 404	38.25	10.55	5.35	0.95	7.17	29.65	0.47	1.34	17.78
S 307	42.00	11.15	3.55	0.57	5.65	26.00	0.82	1.30	19.60
C 306	33.50	12 80	6.85	1.24	7.02	28.57	0.45	1.73	24.12
HI 6 – 23	37.65	8.65	6.75	1.45	6.20	27.00	1.25	1.30	14.74
Hy 11	40.75	10 25	5 60	0.82	3.65	25.40	1.07	1.72	23.82
Hy 633	33.25	13.05	4.65	1.52	5.15	24.50	0.72	1.64	23.36
PKD – 14	41.75	11.30	6.95	0.65	6.35	22.25	0.65	1.44	17.07
KD – 4	36.00	12.35	5.30	1.27	5.50	25.57	0.95	1.30	18.30
K 68	38 25	9.35	5.30	1.37	4.12	24 35	1.25	1.24	16.18
K 65	42 50	10.50	4.45	1.17	3.75	24 82	1·42	1.10	17.14
S. E.	1.73	1.9513	0.44	0.2828	1.466	0.7396	0.36	0.0940	1.03
C. D. 5%	3.51	3.94	1.83	0.5712	2'94	1.4939	0.73	0.1899	2 08
C. D. 1%	4.67	5.24	1.62	0.7607	3.91	1.9895	0.97	0.2529	2.77

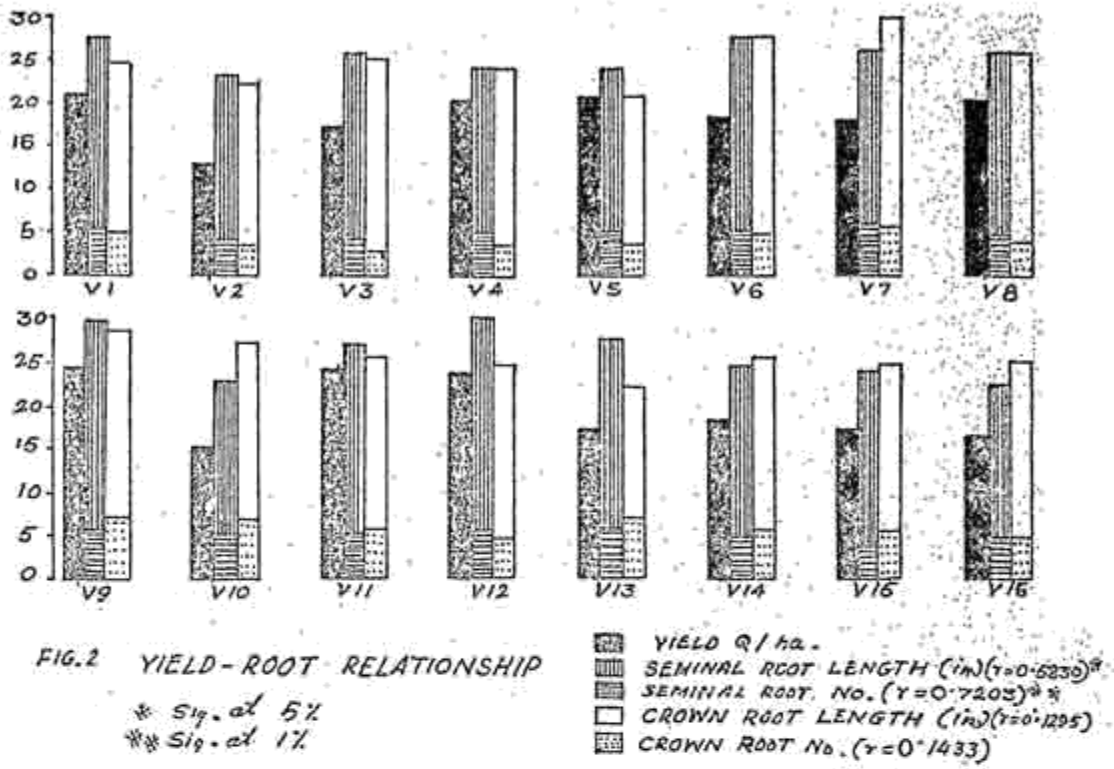

FIG. 2 YIELD - ROOT RELATIONSHIP

* Sig. at 5%
** Sig. at 1%

growth of crown roots in evaluating the adaptability of a variety to escape drought. The variety producing effective crown roots at an early stage of growth is more suitable for rainfed cultivation. With increase in soil moisture content, the primordia are activated and the rate of growth is accelarated. The development of crown roots is obviously dependent on seasonal precipitation. The varieties also differ significantly with regard to the number of crown roots per plant in relation to soil moisture. It was interesting to note that although HD 1625, Hy 633, C 306, and PKD-14, produced a greater number of crown roots primordia, the number of longer and effective crown roots was larger in PKD—14, C 306, HI 6—23 and Hy 11, indicating a bette adaptibility to rainfed conditions in the latter varieties.

The length of crown internode appears to be directly correlated with the number of effective crown roots. The shorter the internode, larger is the number of functional crown roots as noted in case of NP 404, HD 1625, C 306, and PKD—14. Crown internode length is negatively correlated with the grain yield ($r = -0.3293$).

Moreover, the grain yield per plant and per hectare are also directly correlated with the number and length of the seminal and crown roots C 306, Hy Hy 11, 633, Hy 65, HD 1460, and HD 1625 had higher yield as they possessed a larger number of longer roots of both the types.

The contribution of seminal roots to plant growth and yield seems to be greater than that of crown roots as

indicated by the relationships of HI 6–23 and Hy 633, also reported by Boat Wright and Ferguson (1967) and Sellans (1942).

This contribution is largely due to greater test weight of grain produced on the main culm, mainly served by the seminal roots which seems to suffer to a comparatively lesser extent than the tillers served by the crown roots.

On the basis of this screening the varieties C 306, Hy 633, Hy 11, PKD–14, HD 1625 and Hy 65 proved to be suitable for rainfed cultivation.

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