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Dry Matter Partitioning into Root and Shoot of Wheat Genotypes Sown at Different Depths and Dates under Rainfed Conditions

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ABSTRACT

An experiment was conducted to study the partitioning of dry matter at vegetative stage into root and shoot of three wheat cultivars sown at two different depths on different dates. Relative Growth Rate (RGR) of roots of wheat planted on Oct. 27 to Dec. 11 was about the same in the first and 3rd fortnight after sowing. RGR of roots of Chakwal 86 was the highest in the last fortnight of the vegetative growth followed by Barani 83. RGRs of roots of wheat seeded deeper was higher than shallow seeded wheat throughout the vegetative growth stages. Similarly, RGRs of wheat shoots was higher than that of later seeded plants. Barani 83 had slightly higher shoot RGR at initial stages while Pak–81 had slightly higher RGR in the later stages. Deeper sowing slightly had higher RGRs than sowing at shallow depth at later stages of growth. Late planting increased absolute growth rate (AGR) of roots. Depth of sowing had real effect on root AGR and it was higher in the roots of the crop planted at a depth of 5 cm, throughout the vegetative growth. Shoot AGRs of wheat planted on different dates were about the same in early and later part of the vegetative growth. Shoot AGR was higher in plants sown at 5 cm. depth. The allometry showed a significantly higher root–shoot ratio in crop planted on Nov. 11 and Dec. 11. Chakwal 86 had slightly higher root–shoot ratio than other cultivars. Similarly, deeper sowing resulted in higher root–shoot ratio which is very important for rainfed area to impart drought tolerance.

Key Words: Sowing depth; Dry matter partitioning; Wheat

INTRODUCTION

Seeding depth is very important especially under low rainfall conditions to make use of the soil moisture available at the lower surface for seed germination. Under rainfed conditions, germination of seed is often influenced by low supply of soil moisture at the upper surface of the soil. Hence to get normal germination, seed should be place at a deeper depth where soil moisture is available in adequate amount to support seed germination.

According to Shahbaz *et al.* (1988) wheat sown under limited soil moisture produced significantly better yield at 10 cm depth than that seeded at 5 cm. While, Stickler (1962) observed that 6.25 cm seeding depth gave yield significantly higher than 3.75 cm depth. Keeping in view these controversial statements the present study was planned to determine the effect of different depths and dates of sowing on dry matter accumulation in the roots and shoots of various wheat genotypes under rainfed conditions.

MATERIALS AND METHODS

The present study was conducted at Barani Agricultural Research Institute, Chakwal. Three varieties *viz.* Pak 81, Chakwal 86 and Barani 83 were sown at two different depths i.e. 10 and 5 cm on four different dates (October 10, November 11. 28 and December 11) in split–plot arrangement. The treatments were replicated 4 times. Dates of sowing were kept in main plots while varieties and sowing depths were randomized in sub–plots each measuring 4.0 x 2.7 m. A basal dose of 100–60 kg NP ha^{-1} was applied uniformly to all plots. The full amount of phosphorus and half of nitrogen was applied at sowing while the remaining half of nitrogen was applied at the jointing stage. In order to control the weeds, two weedicides i.e. Buctri–M40EC and Tribunil (WP 60) were applied at the rate of 800 ml ha^{-1}. A uniform seed rate of 135 g per subplot was used. Wheat plants were sampled periodically and roots and shoots were separated. The plant samples were dried in an oven and then weighed. The ratios of AGR's and RGR's at different plant parts were used as criteria for assimilates partitioning and dry matter accumulation patterns. The observations regarding seedling emergence, plant population per unit area, RGR and AGR of roots and shoots and allometry were recorded using standard procedures.

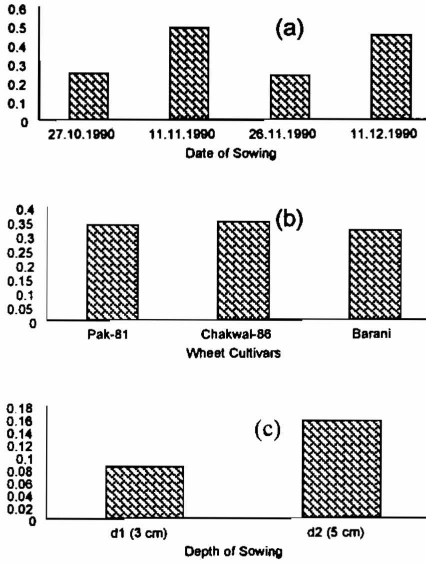
The data so obtained were statistically analysed by using Fisher's analysis of variance technique and LSD test at 0.05 to compare the significance of treatment means (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

The data on relevant parameters contributing to the accumulation of dry matter are reported in Table I. Depth of sowing significantly affected the germination Wheat planted at shallow depth gave 73.17% germination which was significantly higher than that planted at deeper depth (57.45%). Dates of sowing also had a significant effect on germination. This might be attributed to an environment conducive for seedling emergence as a result of favourable planting depth and time. Increased germination at shallow (3 cm) depth might also be due to more retention and conservation of moisture. All the three genotypes had no significant effect on the germination capacity that varied from 64.15 to 67.33%. It might be due to equally healthy and vigorous seed of the test varieties. Different dates and depths of sowing significantly affected the plant population m^{-2}. However, varietal effects were non–significant. The minimum plant population m^{-2} was recorded in plots seeded on 11th of December that was on a par with that seeded on 11th of November. As regards seeding depth, shallow seeding gave significantly more plant population density m^{-2} than deep seeding. This might be attributed to relatively more favourable date of sowing and more retentive and soil moisture conservation capacity of soil at 3 cm depth. It is further documented that initial germination per unit area ensures final plant population density irrespective to water stress and genotypes.

Relative growth rate (RGR). It is a better criterion for plant growth because it takes into account the

Fig. 1. Root shoot ratio as affected by (a) date of sowing, (b) cultivar and (c) depth of sowing



photosynthetic material involved during the growth period. In functional growth analysis it is calculated as the derivative of the function fitted to the plant growth data after taking the natural logarithm of the plant mass recorded at different times. The derivative of the function gives instantaneous values of RGR of whole or part of plant. In classical growth analysis mean RGR is obtained for an interval of plant growth period by the use of following formula:

RGR = (LnW2 – LnW1) / T2–T1

Table I. Dry matter partitioning into roots and shoots of wheat genotypes planted at different dates and depths

Treatments			Absolute Growth Rate		Relative Growth Rate	
1. Sowing dates	**Germination (%)**	**Plant population (m^{-2})**	**Root (g plant^{-1})**	**Shoot (day^{-1})**	**Root (g plant^{-1})**	**Shoot (day^{-1})**
27-10-90	68.50 A	229.17 A	0.0959	0.3152	0.0306	0.1073
11-11-90	62.53 AB	208.48 AB	0.1100	0.1764	0.0488	0.0853
28-11-90	78.95 A	261.49 A	0.1011	0.2189	0.0294	0.1027
11-12-90	51.25 B	173.88 B	0.1145	0.1638	0.0456	0.0875
2. Genotypes						
Pak-81 V_1)	67.33	224.42	0.1583	0.2021	0.1171	0.0751
Chakwal-86 V_2)	64.15	213.42	0.1660	0.1870	0.1261	0.0704
Barani-83 (V_3)	64.44	213.87	0.1631	0.1753	0.1181	0.0687
3. Depth of sowing						
3 cm (d_1)	73.17 A	243.48 A	0.0972	0.2838	0.0295	0.1298
5 cm (d_2)	57.45 B	193.04 B	0.1287	0.3058	0.0461	0.1522

* Means in a vertical columns not sharing a letter differ significantly at 0.05 P.

Where RGR is mean relative growth rate for the period from T1 to T2.

LnW1 is natural log of weight at T1

LnW2 is natural log of weight at T2

T1 is the beginning of time interval

T2 is the end of time interval

RGR of roots of wheat. RGR's of wheat roots are given in Table 1. RGR's of roots of wheat planted on October 27 to December 11 was about the same in the first and 3rd fortnight after sowing. During the period of 15 to 30 days after sowing, RGR's of the roots of wheat planted on November 11 and December 11 were higher than RGR's of roots of wheat planted on October 27 and December 26. During the last half of 2nd month and first half of 3rd month after sowing RGR of roots of wheat planted on December 11 was the highest followed by the RGR of roots of wheat planted on November 11.

RGR's of the roots of the three cultivars was about the same in the first month after sowing. During the 2nd month after sowing RGR of the roots of Pak–81 was slightly lower than RGR's of roots of the other two varieties. In the last fortnight of the vegetative growth of wheat varieties, RGR of roots of variety Chakwal 86 was the highest followed by that of Barani 83. Depth of sowing had a pronounced effect on RGR of wheat roots. RGR of the roots of wheat sown deeper was higher than RGR of the wheat roots sown shallower throughout the vegetative growing stages.

RGR of wheat shoots. RGR's of shoots planted on different dates were different from one another throughout the crop growing season of wheat. Early planted crop grew faster because of higher RGR than that of later planted wheat. Shoots RGR of the three cultivars was about the same throughout the vegetative growth stages of wheat. Barani 83 had slightly higher shoot RGR in the second half of the first month after sowing while Pak–81 had slightly higher shoot RGR's during period from 30–90 days after sowing. Depth of sowing had no effect on RGR's of shoot of wheat within the first month after sowing. During the later vegetative growth stages, plants with deeper planting had slightly higher RGR than plants with shallower planting.

Absolute growth rate. Absolute growth rate (AGR) is one of the quantitative description of plant growth. In classical growth analysis, it is calculated as w/t and is unit change in weight per unit change in time. Total biomass is a function of AGR because biomass equals AGR. Plant AGR can be partitioned into plant parts.

AGR of roots. AGR of roots of wheat planted on October 27 and November 26 was lower than that recorded in plants sown on November 11 and December 11 throughout the crop growing season. Generally, AGR of roots increased during vegetative growth of wheat and reached the maximum of 0.08 during the period from 75–90 days after sowing in plots sown on November 11 and December 11. During the same period AGR's of plant roots sown on November 26 and October 27 were about 0.62. AGR of roots of the three cultivars was about the same in the first fortnight after sowing (Fig. 1a). However, during the later period of vegetative growth of wheat AGR's of roots of Chakwal 86 were higher than that Pak–81. AGR of the roots of wheat sown at a depth of 5 cm was higher throughout the vegetative growth of wheat than the AGR of the roots of wheat sown at a depth of 3 cm.

AGR of shoots. Absolute growth rates of wheat shoots of plots planted on different dates was almost the same both in the early and late part of the vegetative growth of the crop. During the period from 15 to 45 days after sowing the AGR's of shoots of wheat planted on different dates were different. During this middle vegetative period, AGR's of wheat shoots were higher in plots planted on October 27 and November 26 than the AGR's shoots in plots sown on November 11 and December 11. AGR's of shoots of three wheat cultivars was almost the same for about the first 2 months of the vegetative growth of the coop. AGR of the shoots of Pak–81 was slightly higher than Chakwal 86 and Barani–83 during the 3rd month after sowing. The AGR of wheat shoot was affected by depth of sowing (Fig. 1c). Plants with deeper sowing grew faster than plants with shallower sowing. The AGR of wheat shoots emerging from a depth of 5 cm was higher than that emerging from a depth of 3 cm. The results are in line with those of Ecochard (1953), Stickler (1962) and Shahbaz (1988).

Allometry. The root shoot ratios of wheat planted on different dates are shown in Figure 1(a). The allometric relationships of the root and shoot growth revealed that date of sowing had significant effect on root–shoot ratio. November 11 and December 11 sown wheat plants had higher root–shoot ratios than that planted on October 27 and November 28. There were minor differences in root–shoot ratio of different cultivars (Fig. 1(b). Chakwal 86 had slightly higher root–shoot ratio than other cultivars. Barani 83 had the lowest root–shoot ratio.

The allometric relationships of root growth to shoot growth as expressed by root–shoot ratio of wheat planted at the two different depths are given in Figure 1(c). Deeper sowing resulted in higher root–shoot ratio than shallower sowing. This pattern of root–shoot ratio is important for rainfed areas because higher root–shoot ratio induces drought tolerance in crop plants.

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