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Identification of Wheat Genotypes Under Drought Stress Conditions at Early Germination Stage

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ABSTRACT

Wheat (*Triticum aestivum*) is a staple crop of most of the irrigated as well as rainfed areas of the world including Pakistan. Thirty wheat genotypes were used to study the effect of low moisture stress by using Polyethylene Glycol (PEG-6000) under concentration (0%, 15% and 25%) of PEG-6000 at germination stage. Data was recorded for germination percentage, shoot length, root length, coleoptile length, shoot dry weight and root dry weight. The results of analysis were significant and positively Co-related among all parameters. About fourteen genotypes shows 100 % germination in both control as well as under 15% PEG-6000 conditions. Chakwal- 81, Punjab- 2011, AAS- 2011, Pirsabak- 2005, Pakistan- 2013, Chakwal- 50, Pisabak - 91 and Lasani- 2008 performance was better under control as well as 15 % PEG-6000 among all thirty genotypes. While AAUR-10 and Bhakkar-2002 showed no growth under all three concentrations because of fungal growth.

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INTRODUCTION

Wheat (*Triticum aestivum* L.) belongs to the family gramineae and serve as a staple food not only in Pakistan but in most parts of the world. It ranks third in providing daily calorie requirement of the world's population. Wheat serves as a major food item of more than 160 million people in Pakistan. It is grown from 240 ^{o}N to 370 ^{o}N, from 610 ^{o}E to 760 ^{o}E and from sea level to about 3000 m. However, main wheat growing areas fall in the Indus plains. Wheat is grown on irrigated as well as rainfed areas of the country.

The global wheat production was 739.9 million tons, nearly 3.3 million tons (0.4%) below expectations (FAO, 2017). In Pakistan Wheat contributes 9.6 % to value added in agriculture and 1.9 % in GDP. It is cultivated on an area of 9052 thousand hectares with production of 25750 thousand tonnes and yield 2845 Kg per hectare (Pakistan Economic Survey, 2016-17). Wheat occupies a prominent position in the cropping pattern of the country. Wheat is being important cereal food crop, 35 % of the world population depends upon it and its demand is increasing than any other cereal crop. The global demand and consumption of agricultural crop for food urges food security due to increase in population pressure (Edgerton, 2009). Given projection for global population to reach 9.3 Billion by 2050 (c, 2010), global food production will need to increase from 2005 levels by 66 to 70 % (Rosegrant and Agcaoili, 2010). The global Wheat production will need to boost up to 1.6 to 2.6 % annual yield with mean global yield to be shifted from 2.5 to 4 tons per hectare.

Baloch *et al*. (2011) concluded that water deficit is one of the major abiotic stresses, which adversely affects crop growth and yield. Drought is the foremost reason of low yield of crops. Drought is an unpredictable stress as it depends on many factors i.e., amount and distribution of rainfall, evaporative demand, and storage capacity of the soil. Kulkarni *et al*. (2008) reported that crop yield is

reduced by 70-80 % due to a drought condition.

Better understanding about drought resistance based on physiological and morphological traits concludes the germplasm potential to select drought resistance genotypes. The traits like coleoptile length and root length shows significant results for drought tolerance possessed by genotypes. So, these traits can be incorporated in others high yielding cultivars to get maximum plant population and yield under low moisture level in rainfed areas (Ahmed *et al*., 2013). Lisar *et al*. (2012) illustrated that the root-to-shoot ratio increases under water-stress conditions to facilitate water absorption and to maintain osmotic pressure, although the root dry weight and length decrease as reported in sugar beet and Populus.

Chachar *et al*. (2016) studied the wheat genotypes that are drought tolerant under water deficiency conditions. The work was done on six wheat genotypes and their response was checked at germination and seedling stage under different water stress treatments in controlled conditions. It is concluded that osmotic stress significantly decreases the seed germination, shoot/root length, fresh and dry weight. Chakwal- 86 and MT- 4/13 are the tolerant genotypes, whereas other 4 genotypes are the more sensitive genotypes. Tested genotypes should be used in future breeding programs. Drought affects plant throughout their life cycle and is harmful at all phonological stages of plants. Drought stress impact on plant in series of morphological, physiological, biochemical, and molecular changes, depending on the duration and severity of stress. Plants survive under the stress condition by adopting different mechanisms like escape, dehydration avoidance, resistance, desiccation tolerance. Polyethylene glycol used to induce drought stress in plants because high molecular weight PEG does not penetrate plant cells for any concentration, it will apply from the solution to the tissues an osmotic potential that deviates from colligative properties and depends on temperature. The objectives of this study were to compare the response of spring wheat genotypes to water stress at seedling stage and to study the Correlation between different seedling traits.

MATERIAL AND METHODS

The research done on the "Identification of wheat genotypes under drought stress conditions at early germination stage" was conducted in laboratory of Department of Plant Breeding and Genetics, University of Arid Agriculture, Rawalpindi, Pakistan. It was laid out according to the completely randomized design (CRD) with three repeats. Thirty wheat genotypes were used to study the effect of low moisture stress by using Polyethylene Glycol (PEG- 6000). List of the genotypes is given in table 1.

Table 1. List of 30 Wheat genotypes used in the Research study.

Sr. No.	Name of genotype	Sr. No.	Name of genotype	Sr. No.	Name of genotype
1	Pakistan- 2013	11	Lasani- 2008	21	Pasban- 90
2	Shakar- 2013	12	AAUR- 08	22	Bwp- 97
3	Anmol- 91	13	Pirsabak- 2005	23	Chakwal- 86
4	AARI- 2011	14	Bhakkar- 2002	24	Barani- 83
5	Punjab- 2011	15	Fakhre- sarhad	25	Sarhad- 82
6	AAS- 2011	16	Chakwal- 97	26	Pak- 81
7	Millet- 2011	17	Sariab- 92	27	SA- 75
8	NARC- 2009	18	Inqalab- 91	28	Lyp- 73
9	Chakwal- 50	19	Pirsabak- 91	29	Mexi pak
10	Pirsabak-2008	20	AAUR-10	30	LU- 26

Sodium hypochlorite (1 %) was used to avoid seeds from fungal attack. Wheat varieties were evaluated against different concentrations (0, 15, 25 %) of PEG-6000 at germination stage. Each treatment was replicated twice. Five seeds per replication were sown on petri plate. Data were recorded at different moisture levels on germination percentage, shoot length, root length, coleoptile length, shoot dry weight, root dry weight.

After ten days three germinated plants from each petri plate harvested and three parameters shoot length, Root length and Coleoptile length) measured. Roots and shoots from each plant packed and labelled into paper envelopes separately. Then these envelopes putted into hot air oven at 600 °C for 24 hours. After 24 hours data for Root Dry Weight and Shoot Dry Weight were taken with electronic weight balance. After entering all data in Excel sheet, we

apply statistix-8.1 software for Analysis of Variance and Correlation. The results of these analysis were significant and positively Co- related. About fourteen genotypes shows 100 % germination in both control as well as under 15% PEG- 6000 conditions.

RESULTS

Variation among all wheat varieties is presented in Figure 1. All the wheat varieties show more than 50 % germination in control as well as 15 %-PEG condition except V-12, but V-7 shows maximum growth at control, 15%-PEG and at 25%-PEG. Graph shows lowest growth at 25%-PEG. V-12 shows lowest germination % which is less than 30% in respective conditions due to fungal growth. In case of shoot length, all the tested whet genotypes showed promising increase in shoot length while minimum shoot length was observed in case of V-12 variety (Figure 2). All the tested whet genotypes showed an increase in root length while minimum root length was observed in case of V-12 variety (Figure 3). Coleoptile length and shoot dry weight was also recorded better and these parameters were recorded lower in case of V-12 wheat variety as presented in Figure 4-6.

Analysis of variance of six parameters of wheat genotypes is presented in Table 2 while the correlation is presented in Table 7. The germination percentage showed positive and highly significant correlation with shoot length, root length, coleoptile length and dry weight of root and shoot in both treatments. Shoot length showed positive and significant correlation with germination percentage, root length, coleoptiles length, shoot dry length and root dry weight in both treatments. Root length showed positive and significant correlation with germination percentage and shoot length, coleoptiles length, root dry weight and shoot dry length in both treatments. Dry shoot weight showed positive and significant correlation with germination percentage, root length, shoot length, coleoptiles length, root dry weight in both treatments. Dry root weight showed positive and significant correlation with germination percentage, root length, shoot length, coleoptiles length, shoot dry length in both treatments. The varieties Chakwal- 81, AAS- 2011, Punjab- 2011, Pirsabak- 2005, Chakwal- 50, Pakistan-2013, Pisabak- 91, and Lasani- 2008 performed well under control as well as under 15 % PEG- 6000 from all thirty varieties and these varieties can be used in breeding program for good yield and productivity. While Bhakkar- 2002 and AAUR- 10 did not germinate under control and 15 % PEG- 6000.The reason for no growth is fungal growth.

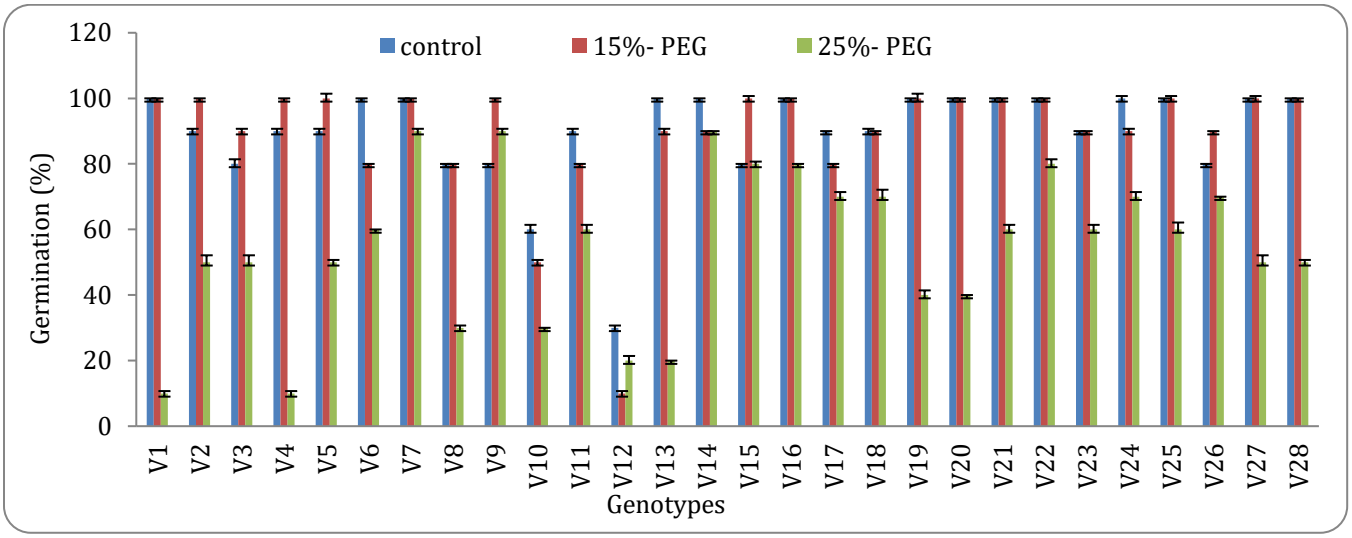

Figure 1. Germination Percentage of Wheat genotypes used at three different levels.

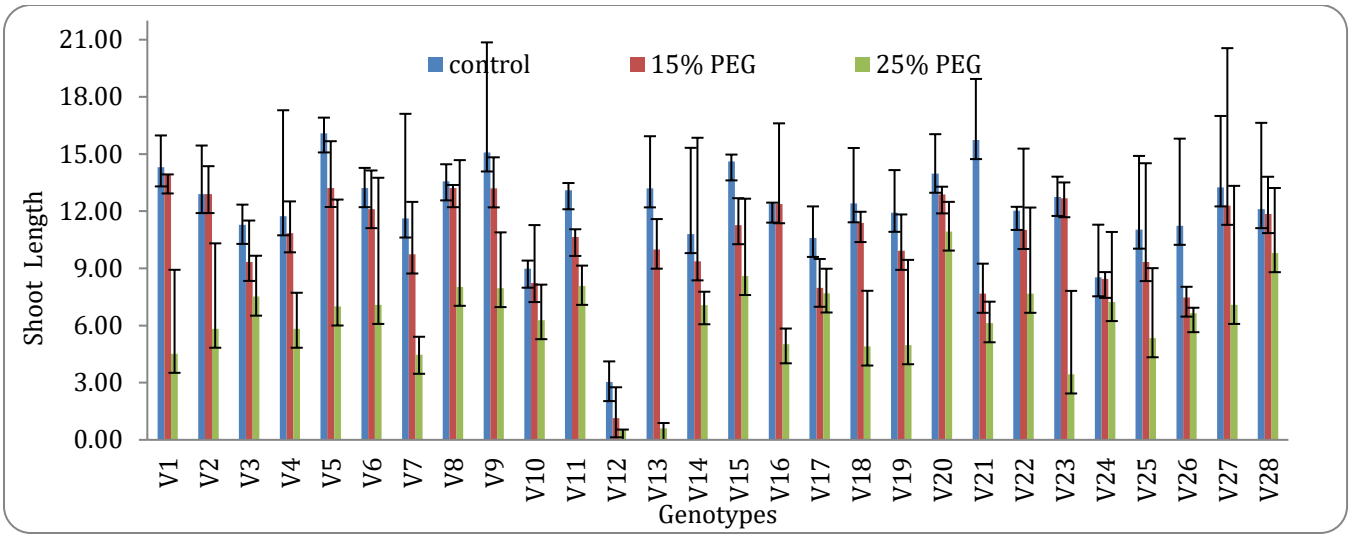

Figure 2. Shoot Length of Wheat genotypes used at three different levels.

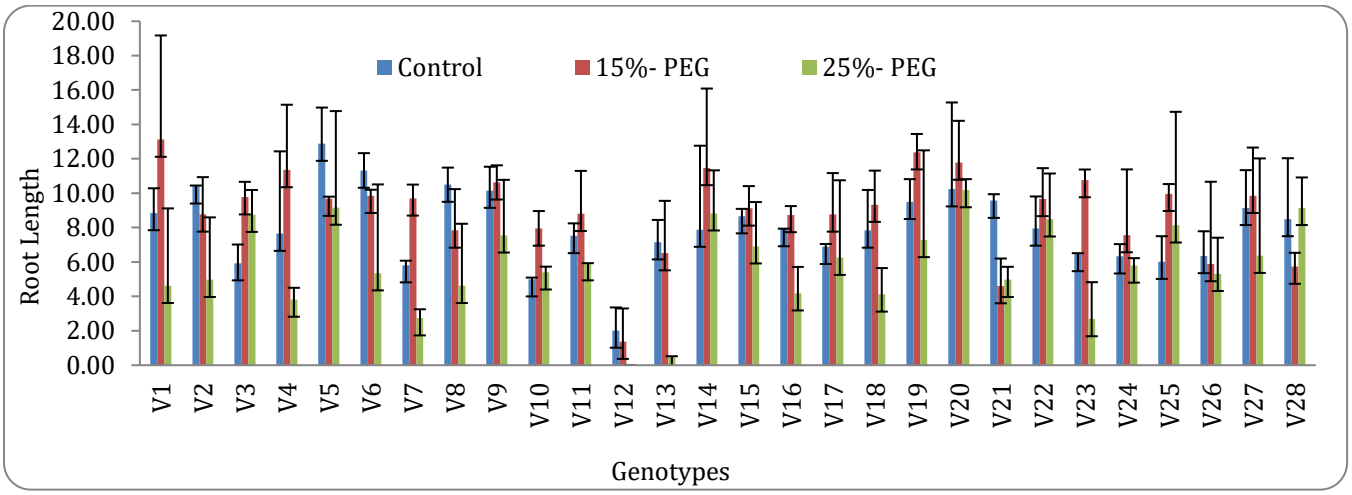

Figure 3. Root Length of Wheat genotypes used at three different levels.

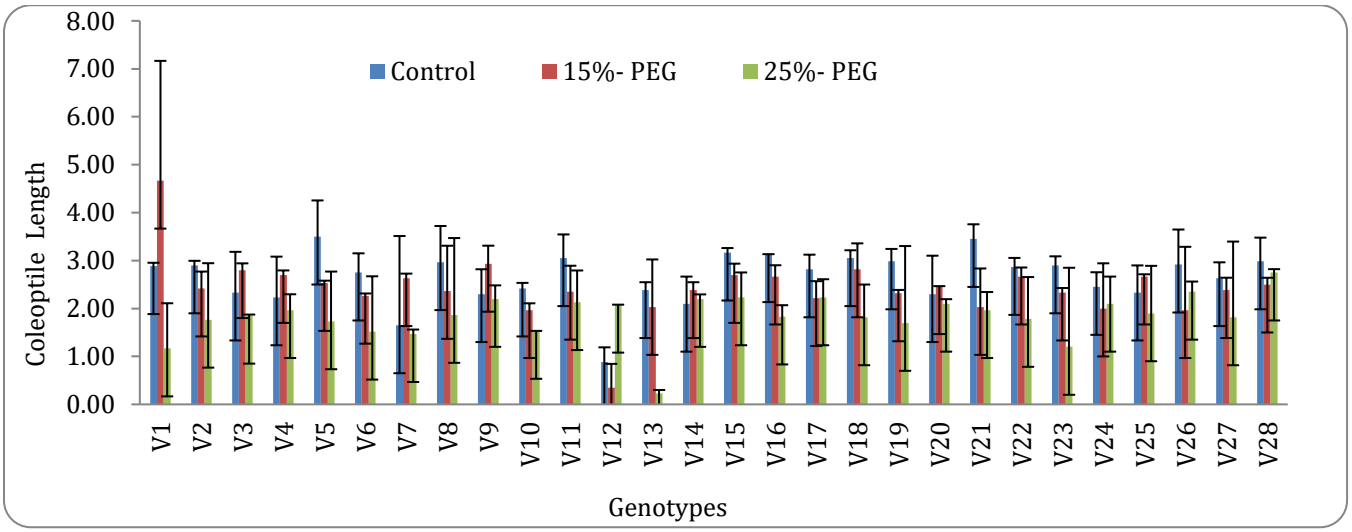

Figure 4. Coleoptile Length of Wheat genotypes used at three different levels.

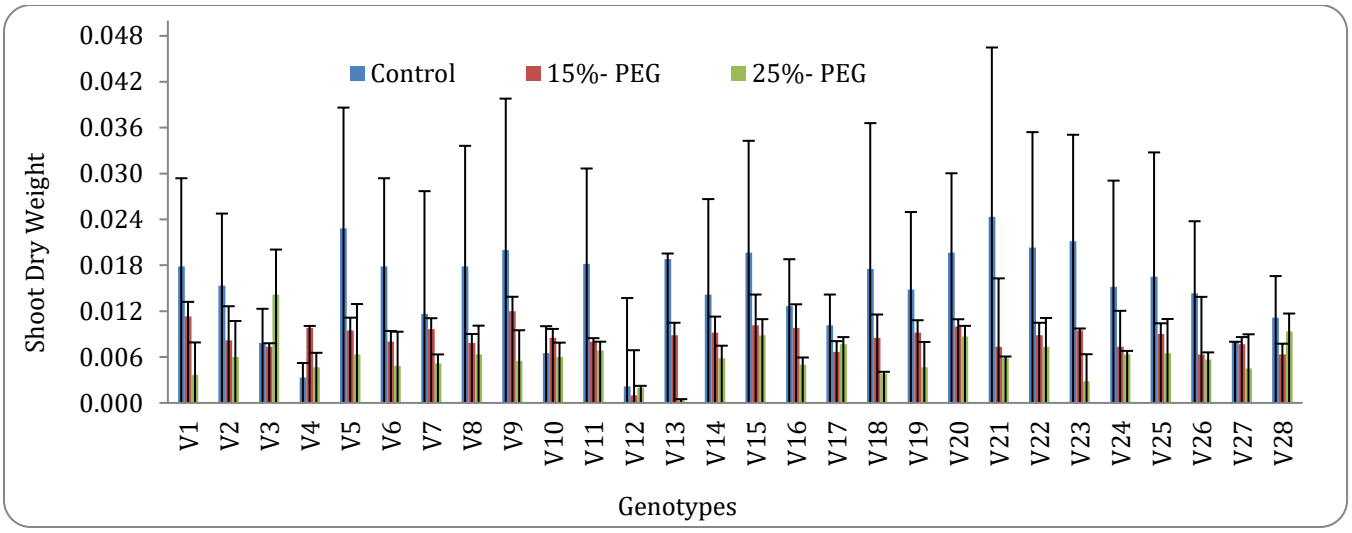

Figure 5. Shoot Dry Weight of Wheat genotypes used at three different levels.

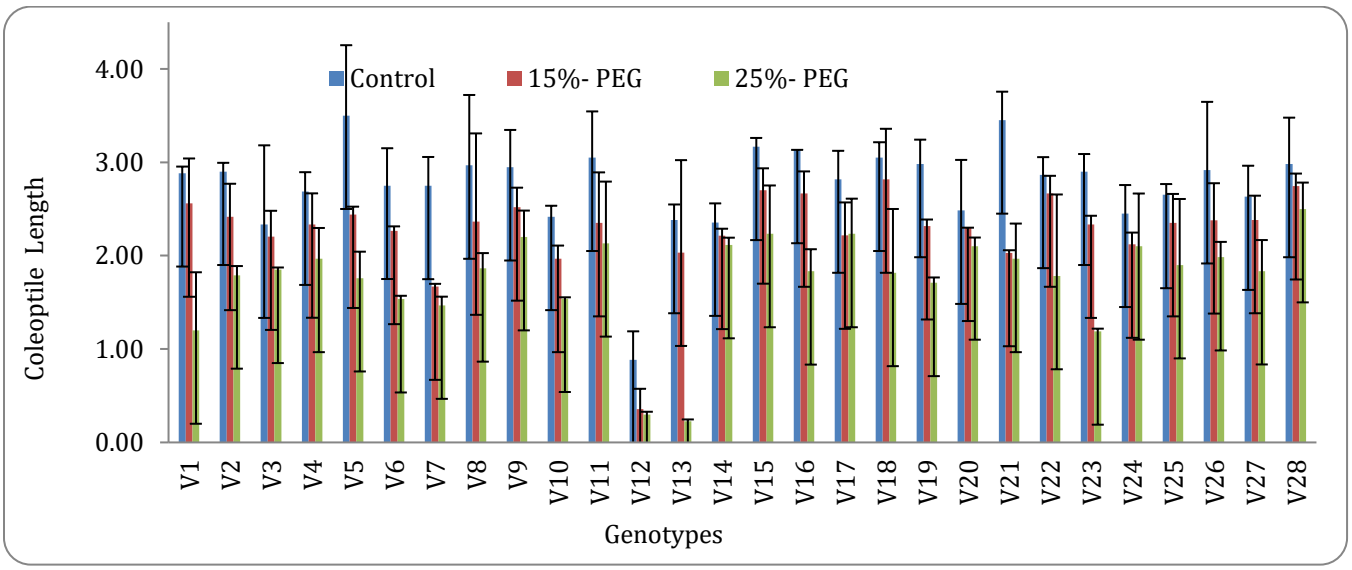

Figure 6. Root Dry Weight of Wheat genotypes used at three different levels.

Table 2. Analysis of Variance of six parameters of given Wheat Genotypes.

SOV	Degree of Freedom			Mean Sum of Square		
	TRT	VAR	TRT*VAR	TRT	VAR	TRT*VAR
Germination %	1	27	27	0.14286	2.58730	0.29101
Shoot Length	1	27	27	12.3690	21.8572	10.1180
Root Length	1	27	27	27.7506	14.4520	6.2721
Coleoptile Length	1	27	27	1.20765	0.89887	0.43202
SDW	1	27	27	0.00118	0.00005	0.00003
RDW	1	27	27	1.264E-04	8.247E-06	2.863E-06

Table 3. Correlation for all parameters.

	Coleoptile	Germination	RDW	Root	SDW
Control (T1); Germination 0.7986; P-VALUE 0.0000					
RDW	0.7461	0.7492			
	0.0000	0.0000			
Root	0.8109	0.7534	0.8057		
	0.0000	0.0000	0.0000		
SDW	0.7480	0.6789	0.8647	0.7391	
	0.0000	0.0000	0.0000	0.0000	
Shoot	0.9010	0.7558	0.8848	0.8852	0.8530
	0.0000	0.0000	0.0000	0.0000	0.0000
15 % - PEG (T2); Germination 0.8040; P-VALUE 0.0000					
RDW	0.8238	0.7657			
	0.0000	0.0000			
Root	0.8459	0.7419	0.8279		
	0.0000	0.0000	0.0000		
SDW	0.8547	0.7946	0.8908	0.8861	
	0.0000	0.0000	0.0000	0.0000	
Shoot	0.8924	0.8200	0.8515	0.9233	0.9441
	0.0000	0.0000	0.0000	0.0000	0.0000

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHORS CONTRIBUTIONS

All the authors contributed equally to this work.