Indian J. Genet., 69(3): 243-246 (2009)

Short Communication

Inheritance of angled spikelet arrangement in *Triticum durum* Desf.

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(Received: May 2009; Revised: July 2009; Accepted: August 2009)

The genus *Triticum* includes diploid (2n=2x=14), tetraploid (2n=4x=28) and hexaploid (2n=6x=42) species. The phylogenetic relationships among different *Triticum* species has been largely clarified [1]. The spike or head size in wheat varies from 2-8 inches or more. The number of spikelets in each spike usually varies from 10-30 and are arranged at nodes on the rachis of spike. The shape of spike varies within as well as between the species. Normally, the shape of spike is tapering, parallel, clubbed or fusiform. The spikes of common wheat, *T. aestivum* are long, slender and somewhat flattened, whereas *T. durum* has somewhat shorter and flattened spikes. *T. aestivum* ssp. *compactum* possesses short spikes, about 2-3 inches in length, very compact and flattened. The density of spikelet also varies in different species as well as in the varieties of the same species, depending on the relative length of internode on the rachis. In dense spikes, the internode or the rachis segments are relatively short resulting in the dense arrangement of spikelets on the spike. In lax or very lax spikes, the internode length is more. Compact spike has not been reported in tetraploid wheat [2] and only compactoid spike is found. However, even the compactoid spikes of tetraploid wheat are not so dense. There are a few reports of dense spike in *Ae. squarrosa* (syn. *T. tauschii*) and *T. sinskajae* [3]. Besides the normal spikes, several other non-standard morphological forms of spikes are known [4]. In this paper, we report a nonstandard morphological form of spike in tetraploid wheat *Triticum durum* which to the best of the knowledge of authors has not been reported earlier. Normally arrangement of the spikelets on the spike is such that when seen from side, it appears smooth, may be parallel, tapering or fusiform. However, we came across two genotypes of *T. durum* where the arrangement of spikelets in the spike were irregular, as some spikelets tilted towards one side whereas others get angled in opposite direction. The present paper describes the inheritance of this peculiar morphology of spike.

Selection (Sel.) 1548 and Sel.1550

The material used in this study comprised two genotypes of *T. durum*, selection (Sel.) 1548 and Sel.1550, both having irregular arrangements of spikelets on the rachis (Fig. 1) and two genotypes, PDW 233 and PDW 291 with normal spikes. PDW 233 and PDW 291 were crossed with Sel.1548 and Sel.1550. The F_1 plants from these crosses were selfed to produce F_2 seeds. The F_1s, PDW233/Sel.1548 and PDW291/Sel.1548 were backcrossed with both the parents to generate two backcross generations. Reciprocal crosses were also made. However, only one backcross generation was produced from the reciprocal cross i.e. Sel.1548/PDW233//PDW233 (Table 1). Observations were recorded on spike shape at the time of maturity. The segregation pattern in each cross was analysed by the χ^2 test to determine goodness of fit of the observed values.

Spikelets in the normal spikes are attached to the rachis parallel to the axis of spike. However, in Sel.1548 and Sel.1550, the spikelets and the rachis do not form a horizontal line, but spikelets are attached in a slanting manner with the result that complete spikelet is angled away from the axis of rachis. The spikelet may be tilted (angled) on either side of the axis of rachis in a random fashion. However, not all the spikelets in a spike are

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angled. This arrangement of spikelets gives an irregular zig-zag shape to the spike (Figs. 1 and 2). In the parents, the spike shape was standard, whereas the F_1 plants derived from all the crosses produced irregular spike, although the intensity of the trait was less than the parent. The trait angled spikelet segregated into 3 angled spikelets: 1 normal spikelet arrangement (Table1). The degree of expression of the trait varied in different F_2 plants (Fig. 2). The results of F_2 populations were confirmed in backcross generations. When F_1 was backcrossed with PDW233 or PDW291, the backcrossed progenies segregated in expected ratio of 1 angled spikelet : 1 normal spikelet arrangement. The varying degree of expression of trait in F_2 as well as in B_1 generations indicated the influence of genetic background on the expression of the trait. Pooled analysis in F_2 and B_1 generations also showed the expected segregation of 3:1 and 1:1 with χ^2 values 0.136 and 1.924, respectively. The results of genetic analysis revealed that the trait angled spikelet is controlled by a single gene with incomplete dominance.

One of the possible ways to increase the grain weight or grain number is to change the morphology of spike. Wide genetic variability on morphological structure of spike is available in wheat, which can be used for this purpose. While grain weight and grain number are of a multigenic character inheritance, however, the spike morphology is easily measured and at the same time controlled by less number of genes. Several non-standard morphological forms of spike have been reported, many of these have been derived from hybridization of *T. aestivum* with tetraploid species [4]. Branched spike in *T. turgidum* have been reported and transferred into hexaploid wheat *T. aestivum*. Branching in spike has been reported to be controlled by one or more recessive gene(s) depending upon the genotype used [5-8]. The gene(s) for branched spike have been located on chromosome 5A [9]. Tetraploid wheat *T. polonicum* possesses spikes with characteristically large glumes controlled by a single dominant gene P located on long arm of chromosome 7A. [10]. Another variation in spike characteristic “screwed spike” is controlled by a recessive gene, whereas “vertical sessile spikelets” where two to three spikelets grow vertically in a rachis node have been reported to be controlled by both dominant and recessive gene(s).”Tetrastichon spike”

Table 1. Segregation of the trait angled spikelet vs. normal spikelet arrangement in different segregating generations

Cross	Generation	No. of plants		Total	Expected ratio	χ^2	P value
		Irregular	Regular				
PDW233/Sel.1548	F_1	10	-	10	-	-	-
	F_2	123	43	166	3:1	0.072	0.80-0.70
PDW233/Sel.1548//PDW233	B_1	23	17	40	1:1	0.900	0.50-0.30
PDW233/Sel.1548//Sel.1548	B_2	77	-	77	-	-	-
Sel.1548/ PDW233	F_1	25	-	25	-	-	-
	F_2	140	47	187	3:1	0.002	0.98-0.95
Sel.1548/ PDW233//PDW233	B_1	32	25	57	1:1	0.860	0.50-0.30
PDW233/ Sel.1550	F_1	42	-	42		-	-
	F_2	168	53	221	3:1	0.122	0.80-0.70
Sel.1550/ PDW233	F_1	18	-	18	-	-	-
	F_2	185	58	243	3:1	0.166	0.70-0.50
PDW291/ Sel.1548	F_1	10	-	10	-	-	-
	F_2	42	16	58	3:1	0.207	0.70-0.50
PDW291/ Sel.1548//PDW291	B_1	11	9	20	1:1	0.200	0.70-0.50
PDW291/ Sel.1548// Sel.1548	B_1	10	-	10	-	-	-
PDW291/ Sel.1550	F_1	8	-			-	-
	F_2	161	49	210		0.311	0.70-0.50
Pooled	F_2	819	226	1085	3:1	0.136	0.80-0.70
	B_1	51	66	117	1:1	1.924	0.20-0.10

possesses two to three sessile spikelets close to each other in a horizontal position. Dencic [11] reported that the trait branched spike is controlled by two major genes, R and T acting in complementary manner in the absence of inhibitory gene N. Tetrastichon spike appears when one of the two major genes is dominant and recessive allele of inhibitor (nn) is present. Presence of dominant inhibitor allele (N) results in normal spike. Stability of branching spike character is also reported to be influenced by temperature and photoperiod conditions [5-6,12]. However, the investigated genetic material can be used in genetic and physiological studies. Since, the angled spikelets arrangement is controlled by single gene, it can serve as an important resource in breeding for enhancing high number of grains in wheat.

Fig. 1. Angled spikelet arrangement in Sel.1548 (left) and F_1 (middle) and normal spike in PDW233 (right)

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Fig. 2. Variation in expression of angled spikelet arrangement in parents (extreme left and right) and F_2

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