

FRUITS DIVERSITY OF *AVENA FATUA* L. WEED FROM WINTER WHEAT CROP

Nicolae Ionescu*, Sorin Gabriel Ionescu**, Mihaela Ioana Georgescu***,
Elena Săvulescu****, Aurelian Penescu*****

*Agricultural Research and Development Station Pitești, Pitești - Albota road km 5,
117030, Pitești, România, e-mail: nicolae_ionescu@yahoo.com

**University of Agronomic Sciences and Veterinary Medicine București,
blvd. Mărăști no. 59, 011464, București, România, e-mail: sorin_ionescu636@yahoo.com,

***University of Agronomic Sciences and Veterinary Medicine București,
blvd. Mărăști no. 59, 011464, București, România, e-mail: mihaelaigeorgescu@yahoo.com,

****University of Agronomic Sciences and Veterinary Medicine București,
blvd. Mărăști no. 59, 011464, București, România, e-mail: elena_savulescu@yahoo.com,

*****University of Agronomic Sciences and Veterinary Medicine București,
blvd. Mărăști no. 59, 011464, București, România, e-mail: a_penescu@yahoo.com

Abstract

Wild oat – *Avena fatua* L. has experienced widespread in Southern territory, Argeș County. Characters of panicles and kernels highlights how adaptation weed held in these conditions. The analyzes and measurements showed that the panicle has an average of 20 cm, formed 5 knots ramifications, with a total of 40 spikelets. The average length of the glume was 21 mm and of the kernels was 15 mm. Kernels formed in the panicle were 71, they weighted 1.5 g, and the thousand kernels of weight (TKW) was 21 g. The average length of the awns measured in the bottom portion was 11.8 mm, and 21.1 mm in the portion from the top. Correlations obtained between various characters were positive and significant. Thus, the length of panicle with total number of spikelets was the closest ($r = 0.829^{***}$). Length of glume with kernel length ($r = 0.366^{***}$), the length of kernel with awn length ($r = 0.375^{***}$) and kernel weight/panicle with TKW (thousand kernels weight) ($r = 0.334^{***}$), values were slightly lower. The present study demonstrated the wide possibilities of that weed, recently adapted into winter wheat crop.

Keywords: *Avena fatua*, diversity, panicles, kernels, winter wheat

1. INTRODUCTION

In the last decade, weed *Avena fatua* L. [pro syn. *Avena sativa* ssp. *fatua* (L.) Fiori, *A. nigra* Wallr, AVEFA code Bayer, common wild oat, spring wild oat, wild-oat], has spread greatly in the South region (Martin and Field, 1987; Beckie and Shirriff, 2012). Among cereals, weed adapted best in oat (Wildeman, 2004; Willenborg et al, 2005) and winter wheat (Carlson and Hill, 1985; Cudney et al., 1989a, 1989b, 1991; Bubar, 1992). From observations we found that weed in wheat may cause economic damage (Rola, 1984; Rooney, 1991). Its control with herbicides is still not enough (Holm et al., 2000). In promoting specific weed management (SWM) (Barton et al., 1992; Weaver et al., 1993; Polziehn, 2011) proved useful and some degree of morphological diversity (Sharma et Van den Born, 1978; Adamczewski and Korniak, 2003). The plant is annual, with erect stems, with size of 60-160 cm. The inflorescence is a panicle of 10-40 cm long and 20 cm wide. Panicle has several

nodes which spreads more branches. By branches formed pedicelled spikelets. Each has 2-3 flowers provided with scar at the base, which causes them to fall separately at maturity. Spikelets have 18-28 mm long, with 9-11 veins. Glumes close 2-3 flowers/fruit. Each of flowers/fruits has one joint under glume. Lemma and palea close kernels. Lemma is hairy, 18-28 mm long. Kernels are long of 6-8 mm and awns of 25-40 mm long (Adkins et al., 1986, 1987; Lalelo et al., 2008). The plant is hexaploid ($2n = 42$), with the genome AACCCD. Ecotypes with $2n = 21$ were found in India and South Africa. Hexaploides ($2n = 42$) were found also in Northern Europe and Japan (Wildeman, 2004). In the USA and China predominates hexaploid wild-oat ($2n = 6x = 42$). From a climate perspective, weeds easily adapts to new conditions. It prefers the clay-loam or clay soils with sufficient moisture (Akey and Morrison, 1984; Agenbag and deVilliers, 1989; Khan et al., 2008). Weed adaptability in southern territory could be found by conducting diversity studies. Research conducted to establish diversity included: i) the panicle characters by length, number of nodes with ramification, number of spikelets, length of glumes, and ii) kernels characters by length, total number of kernels/panicle, total weight of kernels/panicle, thousand kernels weight (TKW), awn length by two parts: upper and lower.

2. MATERIALS AND METHODS

Measurements were made in mid-June, the last 3 years, on the plant of *A. fatua*. They selected several areas under winter wheat in the Southern Highlands. They were chosen randomly among weed precincts, with 100 strains of *A. fatua*. Each of stems was cut panicle formed, after which they were brought to the laboratory. Measurements and determinations of panicles included: absolute length, number of nodes with branches, total spikelets number, glumes length, caryopsis length, total number of caryopsis/panicle, caryopsis weight/panicle, thousand kernels weight-TKW and awn length in two parts: upper and lower. Expression of character diversity analyzed on made by a suitable statistical frequency-specific polygon or histogram. Evolution ranges of values established both by class and by absolute values as such. The specifics of each character ecotype analyzed revealed the modal value (higher frequency) and variation limits concerned. Among the main characters were established some correlations. These became important by observing the trend in the newly studied ecotype. Charts were developed using Excel software. On the other hand, the measurements were processed statistically by means of analysis of variance on the ranks of variation. The indices were calculated: media ($\bar{a} = \frac{\sum x}{n}$), variance ($s^2 = \frac{1}{n-1} \left[\sum x^2 - \frac{(\sum x)^2}{n} \right]$), standard error ($s = \sqrt{s^2}$) and coefficient of variation ($s \% = \frac{s}{\bar{a}} \cdot 100$).

3. RESULTS AND DISCUSSIONS

The diversity of panicle and caryopsis characters. From what is known, the panicle of *A. fatua* have 10-40 cm lengths (Sharma et Van den Born, 1978). Measurements have shown that the new species ecotype was the length close to it, namely between 10 and 35 cm. The distribution frequency of these was different lengths and specific.

The highest frequency had a panicle 16-20 cm long (47%), followed by those with 21-25 cm (30%), while panicle of 31-35 cm have had a frequency of 4%. Shorter panicle (10-15 cm) accounted for 12%. The graph shows a high specific variability due to competition with winter wheat (Figure 1 and Figure 2). The number of branches of the panicle nodes was between 3 and 8. The highest frequency had a panicle with 6 knots (36%). Close to it was the panicle with 5 knots (33%). Panicles with 2 and 8 components were at a frequency of 2% (Figure 3). Number of spikelets from a panicle was between 10 and 115. Their frequency distribution was different (Figure 3). The panicles with the highest frequency of their spikelets were those 30-50 (38%). However, 89% of the

panicles were between 10 and 70 number of spikelets. Glumes length was variable (Morrison and Dushnicky, 1982; Maxwell et al., 2007). It were dominated those with 21-22 mm (55%). Panicle length limit was between 17 and 25 mm. Short glume of 17 mm and longer of 25 mm were 4% each (Figure 4). Compared with glumes the kernels (caryopsis) have shorter lengths (Figure 4). It dominated kernels with 14-16 mm long (57%). They followed the 17-19 mm with 22%. Smaller kernels of 7-8 mm were 1%, and those of 20 mm, 3%.

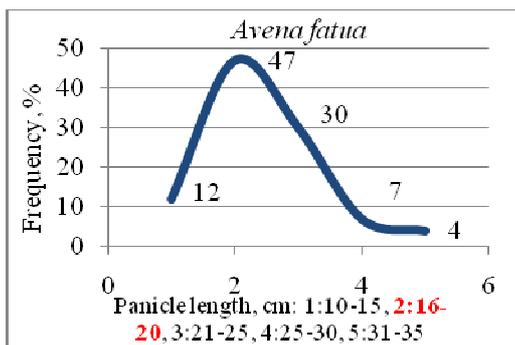


Figure 1. Evolution of wild oat panicle length

Figure 2. Panicle of *A. fatua*-left and *A. sativa*-right

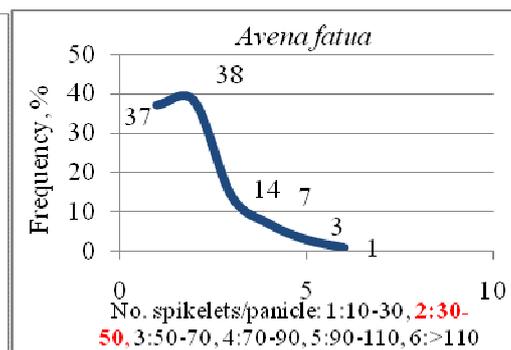
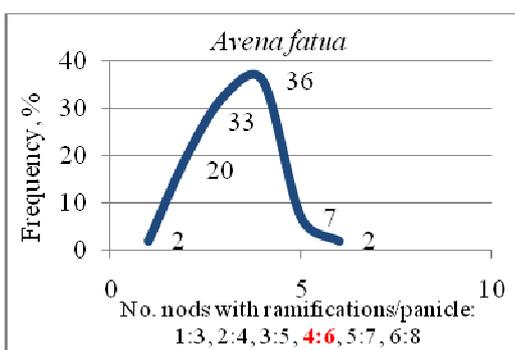


Figure 3. Evolution of the number of branches/ramifications (left) and number of spikelets/panicle (right)

As a number, panicle formed kernels between 10 and 203 (Figure 5). The higher frequency has a panicle with 40-70 kernels (41%). They were spaced between 10 and 40 kernels (20%), and those with 70 and over 100 kernels (19%). Panicles with more kernels, between 130 and 160 represented 5% of the total. Kernels panicle weight was between 0.20 and 5.34 g. The percentages biggest they had panicle with 0.20-1.00 g (35%) and 1.01-1.80 g (38%) (Figure 5). Panicles with heavier kernels (3.4-5.3 g) represented only 3% of the total.

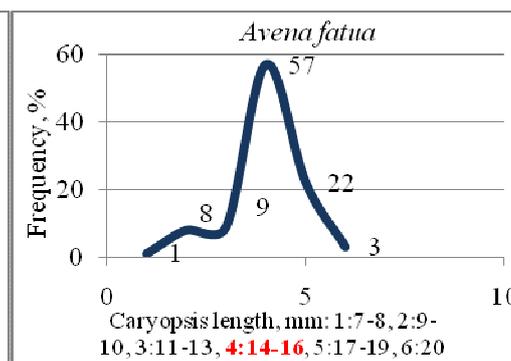
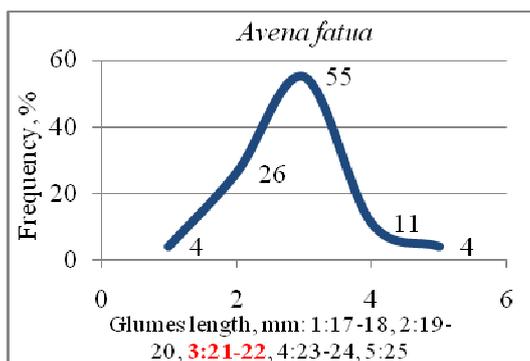


Figure 4. Evolution of glumes length (left) and caryopsis length of *A. fatua* weed (right)

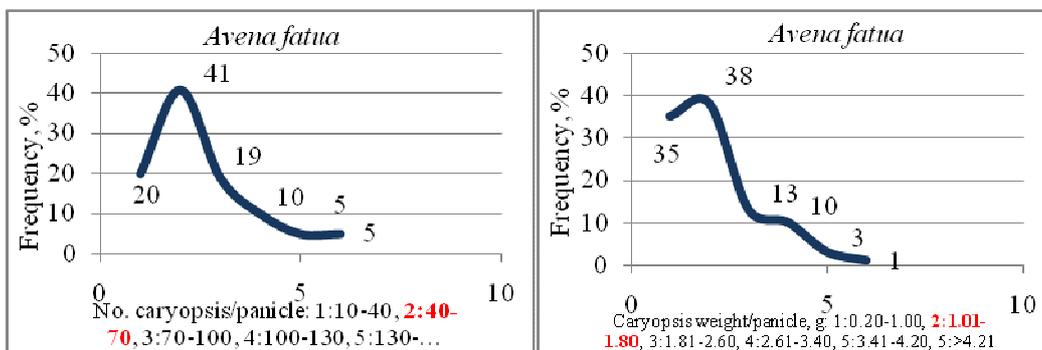


Figure 5. Evolution of caryopsis no. (left) and caryopsis weight from *A. fatua* panicle (right)

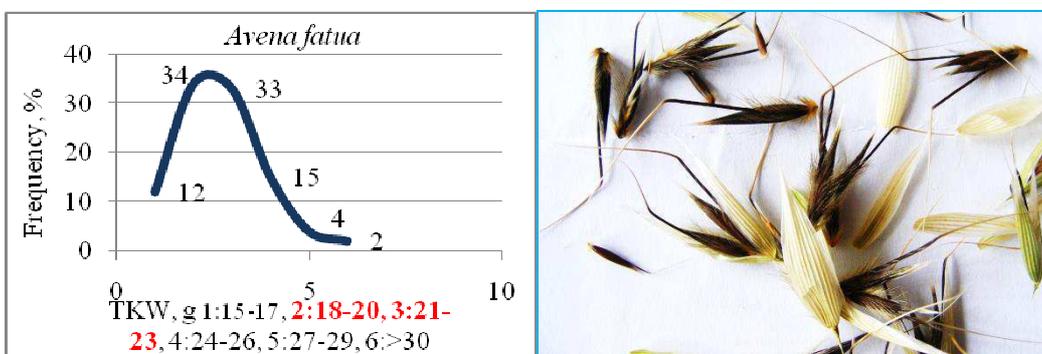


Figure 6. Evolution of thousand kernels/caryopsis weight (left); Glumes and caryopsis of *A. fatua* (right)

Thousand kernels weight (TKW) ranged between 15 and 33.8 g (Figure 6). The highest frequency was 18- 20 g (34%), followed by those of 21 to 23 g (33%). Kernels with the absolute weight of 30 g were only 2%.

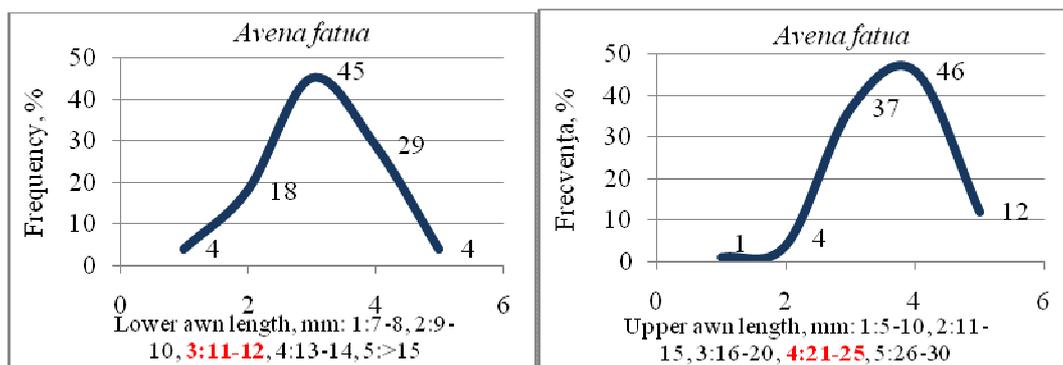


Figure 7. Evolution of *A. fatua* awns length, lower portion (left) and upper portion (right)

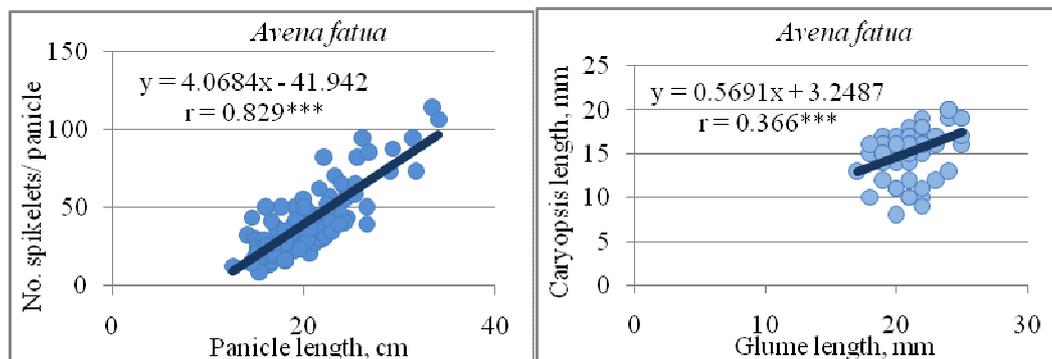


Figure 8. Correlations between panicle length with no. of spikelets/panicle (left) and glume length with caryopsis length of *A. fatua* weed (right)

Awns length was examined for two portions: one at the base and another to the top. Awn from the base was between 7 and 16 mm. The highest frequency was 11-12 mm in length (45%). Awns with 7-8 mm length and 15 mm were only 4% each (Figure 7). Awn in top was between 5 and 30 mm length. Modal value was 21-25 mm (46%). Short awns in the top (5-10 mm) were 1%, and the longer awn (26-30 mm) was 12%.

Correlations between different morphological characters. From the study of the correlation between the length of panicle and number of spikelets/panicle resulted in a very favorable situation. The correlation coefficient, positive, had the $r = 0.829^{***}$. The relationship between glume length and caryopsis length was lower, $r = 0.366^{***}$ (Figure 8). Both correlations show that the weed was very good adaptability in the crop conditions analyzed.

Between kernel length and the length of awn obtained a positive correlation coefficient with a relatively low ($r = 0.375^{***}$). In another correlation between the weight of the kernels from panicle and TKW (thousand kernels weight) was obtained a positive correlation with good assurance, $r = 0.334^{***}$ (Figure 9). The explanation could be that the plant forms kernels of various lengths that relate dependent on the total length of awns.

Statistical indices of fruit *A. fatua* diversity. From the statistical estimation have emerged values that revealed the specifics of a new *A. fatua* ecotype that has spread to southern of territory (Table 1 and Table 2). Thus, the average length of panicle was 20.23 cm, they were formed 5.32 knots with branches, and 40.37 spikelets. The average length of the glume was 21.16 mm, and average length of the caryopsis was 15.29 mm. The average of the total number of kernels in a panicle was 71.4, for the total weight of the kernels in the panicle was 1.52 g and TKW 21.13 g. The average of the awn length measured 11.8 mm at the base and 21.2 mm at the top.

The variation coefficients were relatively small in awn length (both parts), kernel length and TKW. Middle variation was for nodes number and panicle length. Great variation was in number of spikelets/panicle, caryopsis number/panicle, and caryopsis weight/panicle.

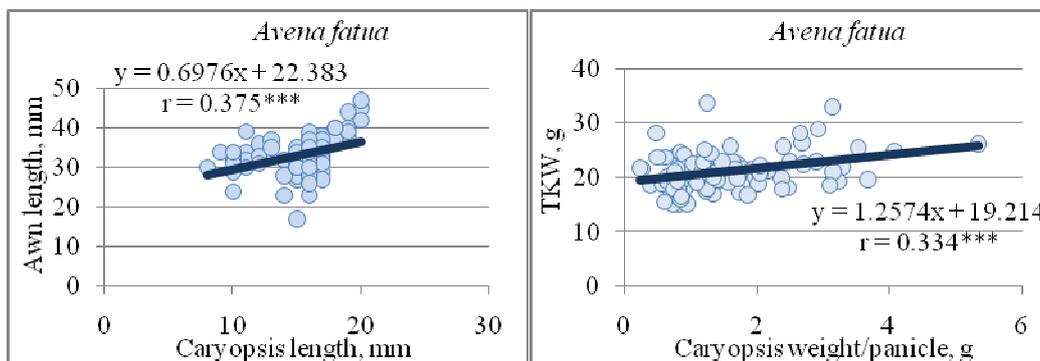


Figure 9. Correlations between caryopsis length with awn length (left) and caryopsis weight with TKW of *A. fatua* weed (right)

Table 1. Statistical indices of *A. fatua* panicles

Indices	Panicle length, cm	Number of nodes with ramifications	Number of spikelets	Glume length, mm
Average, \bar{a}	20.23	5.32	40.37	21.16
Variance, s^2	19.249	1.0077	463.9	0.193
Standard error, s	4.3874	1.0038	21.54	0.439
Coef. var, s%	21.69	18.87	53.36	20.76

Table 2. Statistical indices of *A. fatua* caryopsis

Indices	Caryopsis length, mm	Total number in panicle	Caryopsis weight, g	TKW, g	Awn length, mm	
					At basis	At the top
Average, \bar{a}	15.29	71.40	1.524	21.13	11.8	21.1
Variance, s^2	0.062	1522	0.808	11.89	0.034	0.129
Standard error, s	0.250	39.01	0.899	3.448	0.184	0.359
Coef. var, s%	16.35	54.64	58.97	16.32	15.61	17.00

4. CONCLUSIONS

Ecotype of *A. fatua* weed that was spread recently in the South, has shown good adaptability in winter wheat crop. This diversity is demonstrated broad array of analyzed characters (Table 3 and Table 4).

Thus, morphological characters were analyzed on the fruits by panicle length, number of nodes/panicle, number of spikelets/panicle, glume length. On the caryopsis were made the variation of length, total number/panicle, total caryopsis weight/panicle, thousand kernels weight (TKW) and awn length for the two portions (down and upper). Data of variability revealed that the most frequency (%) had an panicle with 16-20 cm length, 6 nodes/panicle, 30- 50 spikelets/panicle and 21-22 mm glume length (Table 3). For the caryopsis modal values were 14-16 mm for length, 40-70 number/panicle with 1.01-1.80 g weight, TKW was between 18 and 23 g and awn dimensions 11-12 mm for down portion and 21-25 mm for upper portion (Table 4).

Table 3. Structure and repartition of analysis values of *A.fatua* panicles

Panicle length cm, %		Number of nodes nr. %		Number of of spikelets nr. %		Glume length, mm, %	
10 – 15	12%	3	2%	10 – 30	37 %	17 – 18	4%
16 – 20	47%	4	20%	30 – 50	38%	19 – 20	26%
21 – 25	30%	5	33%	50 – 70	14%	21 – 22	55%
26 – 30	7%	6	36%	70 – 90	7%	23 – 24	11%
31 – 35	4%	7	7%	90 – 110	3%	25	4%
		8	2%	>110	1%		

Table 4. Structure and repartition of analysis values of *A. fatua* caryopsis

Caryopsis length mm, %	Total number/panicle nr. %		Caryopsis weight g, %		TKW g. %		Awn length			
	down mm	up mm, %	down mm	up mm, %	down mm	up mm, %	down mm	up mm, %	down mm	up mm, %
7 – 8 1%	10 – 40 20%		0.20-1.00 35%		15-17 12%		7-8 4%		5-0 1%	
9 – 10 8%	40 – 70 41%		1.01-1.80 38%		18-20 34%		9-10 18%		10-15 4%	
11 – 13 9%	70 – 100 19%		1.81-2.60 13%		21-23 33%		11-12 45%		16-20 37%	
14 – 16 57%	100 – 130 10%		2.61-3.40 10%		24-26 15%		13-14 29%		21-25 46%	
17 – 19 22%	130 – 160 5%		3.41-4.20 3%		27-29 4%		>15 4%		26-30 12%	
20 3%	>160 5%		>4.21 1%		>30 2%					

In order to control through proper management is good to know as many characters. It was found that a species expressing widest variability may find it easier means of control and stop eventually. Morphological variability, especially reproductive, being less known, could express eco-existing type here - Table 5.

Table 5. Mean values of the *Avena fatua* L. fruits variability

Nr.	Fruits characters	Literature	Research
1.	Panicle length, cm	10 - 40	12.6-34.1
2.	Panicle width, cm	20	-
3.	Number nods with ramifications/panicle	-	3 - 8
4.	Number spikelets/panicle	-	13 - 115
5.	Glume length, mm	-	17 – 25
6.	Lemma length, mm	18 - 28	-
7.	Caryopsis length, mm	6 - 8	8 – 20
8.	Number of caryopsis/panicle	-	11 - 203
9.	Caryopsis weight/ panicle, g	-	0.24 - 5.34
10.	TKW- thousand kernels weight, g	-	15.2 - 33.8
11.	Awn length at the bottom, mm	25 -40(total length of awn)	7 – 16
12.	Awn length at the top, mm	-	8 – 27

We have had panicle little shorter with 3-8 number of nods/panicle. Number of spikelets was between 13 and 115 with 17-25 mm length of glumes. Number of caryopsis/panicle was 11-203 with 8-20 mm length and 0.24-5.34 g total weight. Thousand kernels weight-TKW was 15.2- 33.8 g and awn dimensions 7-16 mm at the bottom portion and 8-27 mm at the top. Total awn length was 15-43 mm, larger than the data of literature.

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