Comparing industrial grain and seed for sowing of the corn in condition of Uzbekistan

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Abstract. It is necessary to harvest the matured crop of the corn with low expenses and on time for producing qualitative seed. Therefore, the researches were performed that about determination maturing period of the corn in the period waxy matured of the corncob and physical-mechanical properties of the corn were studied too, for comparing industrial grain and corn for seeding. It was defined that during the experiment the corn may be harvested in its waxy matured period, namely 10-16 days earlier than maturing completely for producing industrial grain in condition of Uzbekistan. However, this harvesting method cannot be satisfied to produce corn for seeding. If the corn-crop is harvested earlier for producing industrial grain, there might be opportunity to do next agronomic and mechanized operations such as ploughing or providing the field with organic fertilizers before starting snowy days. But, for producing corn-seed, of course completely ripening period of the corn-grain should be waited. Studying physical-mechanical properties of the corn is important to determine parameters of the corn-harvester and thresher machines for harvesting seed-corn.

Key words: corn, pod-corn, corncob, seed, grain, ripening dynamics, corn mass.

1. Introdution

The corn is grown as one of the main plants in many countries at present time. Main reason is that, corn is an important forage plant for development a livestock and poultry-ranch [1-7]. Also, another reason is that, the productions are produced by the corn for using of food-stuffs industry, medicine and at technical aims, those productions are pop-corns, canned-foods, starch, crystallized sugar, alcohol and other production [8-10].

The motherland of corn is the country of North America. It is known that by the conclusive evidences archaeological and botanical scientists' observation, the corn was grown as a cultural plant in the southwestern part of the United States of America 3013 years ago. Wild corn was once thought to have existed in the "Tehuacбn" Valley of southern Mexico 7013 years ago and the corn growing was begun for cultural plant in this region 4613 year ago. Corn has been produced more than 500 million tons at the present day all over the world and the United States is the leader like corn-growing

country, with more than 40 percent of the world's production. Most of its crop is grown in the Midwestern region known as the Corn Belt, comprising Ohio, Indiana, Illinois, Iowa, Missouri, Kansas and Nebraska. The other leading corn-growing nations are China, Brazil, Mexico, Russia, Italy, India and other countries [11].

Corn is grown more 31000 hectares area in Uzbekistan with together on the top written countries too, this crop indicator is grown only on the main corn area but after harvesting wheat crops [12], again corn with other crops is seeded on the wheat field as a second crop in Uzbekistan [13,14] and after wheat harvesting only early-maturing and middle-maturing corn sorts are seeded, the early-maturing corn is ripened between 70-75 days and middle-maturing corn is ripened between 90-95 days in our Republic.

If we take it into a count that instead of wheat growing in empty area, this indicator will increase to 300000 hectares. One of the most task is to grow corn for seed. It is required to harvest the ripped crops without loss and qualitatively. Especially, if this work is performed by the help of mechanization method and technical instruments, we'll achieve to decreasing seriously labor and material expenses.

Nowadays, the complex of harvesting machines and earlier-harvesting technology are being produced for harvesting seed-corn in Uzbekistan. Researches are being performed for creating of the corn-harvester machine and corn-thresher machine. For determination the parameters and modes operation of the worker-elements the created machines, it is necessary to knew maturing period of crop and its physical-mechanical properties [15,16]. Therefore, we determined the maturing period of crop and its physical-mechanical properties of the corn for harvesting corn-seed.

2. Materials and methods

According to experience of the world researchers the harvesting methods which are as grain form or as pod-corn form are used to harvest the corn for industrial grain [17-27].

The corn stalks are reaped by the combine-harvesters for cropping the corn for grain, the corncobs are picked from their stalks and they are threshed by the combine-thresher, the grain is separated. This method is very thrifty, but for this method the corn has to be ripened completely, its moisture should be between 22-26 per cent [3].

In Uzbekistan this method is used in very few areas, because the stalk of the corn is used as coarse hay for cattle animals, also the vegetation period is long (120 days) and the corn that is seeded after wheat as repeatedly crop cannot catch to dry well. Furthermore, only the grain part of the corn is harvested by this method, and the stalk part of the corn is strewed on to surface of the field as humus (organic fertilizer). And this causes not to be harvested of the forage that is used as coarse hay for cattle animals.

Nowadays some new harvesting methods are being researched for settling these defects of the above-mentioned methods [3,18]. However, in Uzbekistan that harvesting methods cannot be used because of that expense of energy is high and the machines that are used for doing these operations are very expensive.

The corn is harvested as formed corncob by two forms, namely husks are peeled from their pod-corns or without peeling the husks. This method is performed by the help corn harvester machines or combines. At first the stalks of the corn are reaped, pod-corn is stripped and stalks are cut, silo is unloaded on to transport that is moving in the side of combine. And corn-cobs are peeled from their husks or they are unloaded without being peeled on to trailer that is joined to the transport. This method is much better than others in Uzbekistan because the grain of the corn and also its stalks are harvested and pod-corn might be harvested when its moisture is 35-40 per cent.

Therefore, the researches were performed on earlier harvesting the corn crop as pod-corn form. At first it was explored for studying about maturing period of the corn crop for producing industrial grain then results were analyzed to determine physical-mechanical properties of corn-cobs and stalks to compare corn grain for seeding. The researches were observed by sorts of the corn that are most being grown in Uzbekistan, namely Uzbekistan-100 and Qorasuv-350 ABM sorts.

3. Results and Discussions

The results showed that studying of maturing dynamics of grain of the sort Uzbekisatn-100 from 4 September to 1 October (figure 1), the moisture of the grain changed from 68.6 per cent to 17.0 per cent between that period, the milk period of the grain went on until 2 September, and it consisted of 12 days, the paste period, namely decreasing of the moisture from 56.2 per cent to 39.0 per cent continued from 10 September to 16 September, and it organized 7 days. The waxy ripening period of the grain, namely the decreasing of the moisture from 40 per cent started on 15 September, on 28 September it reached to 18.2 per cent and ripened completely. So, that time the waxy ripening period of the corn consisted of 14-16 days.

As if this situation, it was defined that with early maturing sort of the corn which is named Qorasuv-350 AMB too. However, the waxy ripening period of this sort, namely the decreasing interval of the moisture from 40 per cent to 20 per cent was observed from 11 September to 23 September and that period was organized 11-12 days. It is seen that by experiments the ripening period of the corn from waxy ripening until completely ripening is 14-16 days for late-ripening corn, 10-12 days for early-ripening corn.

During the experiments also the changing of the drying dynamics was defined of the pod-corns that were harvested in different periods and dried in shade place and in sun shine. The results of the experiment showed that (figure 2), moisture of the sort Uzbekistan-100 of corn was 40.8 per cent on 15 September, namely it was harvested in waxy ripening period, and dried from 15 September to 11 October, the mass of the corncob decreased from 316 grams until 187 grams. The mass of the drying corncobs decreased sharply from 316 grams to 207 grams from 15 September to 27 September, it decreased from 207 grams to 190 grams and fell down slightly from 27 September to 3 October. When it was observed from 3 October to 11 October, decreased to 187 grams, almost did not change.

As if this experiment another one was performed with sort of the corn which is named Qorasuv-350 AMB. So, the moisture of this sort was about 40 per cent on 11 September, this sort of the corn was harvested on 11 September because it had already ripened as waxy form and the changing of the mass was observed by 11 October.
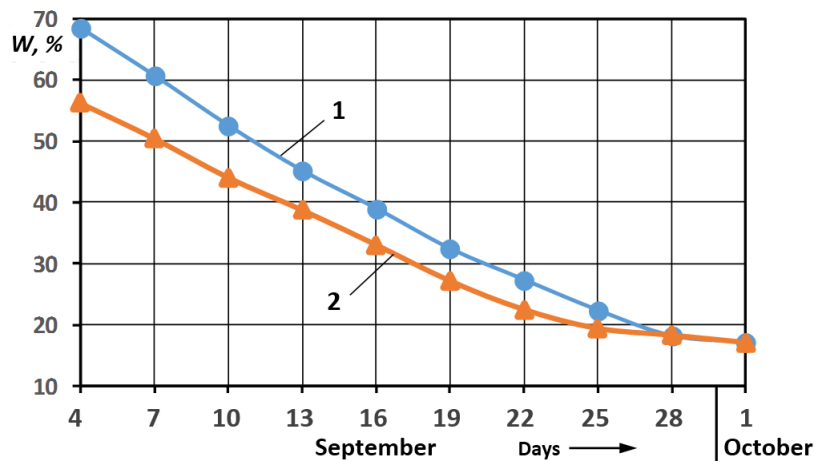

Figure 1. The ripening dynamics of the ear of corn. 1 - the sort of Uzbekistan-100; 2 - the sort of Qorasuv–350 AMB, W – Moisture of the grain.

On 11 September the average mass of the corncob 247 grams, it decreased sharply till 154 grams by 1 October. Between 1-5 Octobers it decreased from 154 to 149 grams, from 5 October to 9 October it decreased insignificantly to 146 grams, then did not change, just remained constant.

The result of the experiment is showing that, the late-ripening corn that harvested in its waxy ripened period dries for 18-20 days, when early-ripening corn is dried in natural condition it is dried

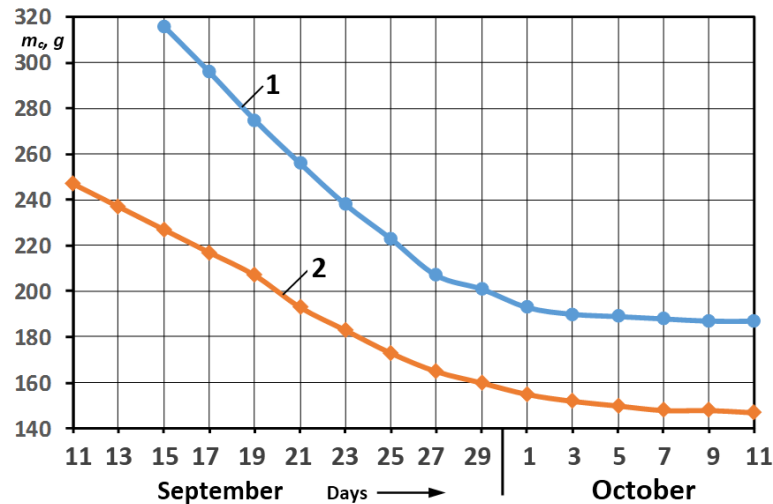for 14-15 days and moisture decreases from 18 percent, it can be ready for threshing and using industrial aim.

Figure 2. The line graph of changing of the corn mass that was harvested day by day, it was dried in shade place and the sun shine. 1 - the sort of Uzbekistan-100; 2 - the sort of Qorasuv–350 AMB.

This change is in good agreement with the results of K. Astanakulov's research on wheat [28].

After defining the maturing period of crop, we studied physical and mechanical properties of the corn. The experiments were tested by early-maturing sort "Qorasuv-350 AMB" and "Uzbekistan-100" late-maturing hybrid sort of the corn, these sorts are being grown mostly in our Republic. The size-mass indicators were determined of those sorts before harvesting crop. These indicators are shown (table 1 and table 2), they are average - $M_{ave.}$, average-square deviation - σ and coefficient variation - V. Results show in process of harvest the height of the corn stalk is average 192.7 – 257.0 cm, the diameter of stalk is 13.2 – 20.9 mm.

Table 1. Indicators of the early-maturing sort "Qorasuv-350 AMB"

Name of indicators	Amount of indicators		
	$M_{ave.}$	$\pm \sigma$	V, %
Common weight of the stalk, g	378.6	252.4	57.2
Weight of the corncob with husk, g	153.4	128.2	49.8
Height of the stalk, cm	192.7	37.3	19.3
Diameter of the stalk, mm	13.2	3.2	34.7
Distance from land till corncob, cm	80.3	18.0	22.4
Length of the pod-corn, cm	18.3	5.7	31.2
Diameter of the pod-corn, mm	38.9	6.0	15.4
Quantity of the leafs, piece	9.1	1.3	14.7

Position of the corncobs from land is at 80.3-123.6 cm height and this indicator is necessary for determine the height of the corncob picker-apparatus of the corn-harvester.

The pod-corns are harvested by the help corn-harvester machine and threshed, separated by the help corn-thresher machine, for substantiation the parameters of the corn-thresher machine the size-mass indicators were learned of the corncob and those indicators are shown (table 3).

Table 2. Indicators of the late-maturing sort "Uzbekistan-100"

Name of indicators	Amount of indicators		
	$M_{ave.}$	$\pm \sigma$	V, %
Common weight of the stalk, g	447.9	245.4	51.2
Weight of the pod-corn, g	197.5	130.2	65.9
Height of the stalk, cm	257.0	43.2	17.1
Diameter of the stalk, mm	20.9	4.2	20.2
Distance from land till corncob, cm	123.6	39.3	31.8
Length of the pod-corn cm	24.32	9.34	38.4
Diameter of the pod-corn, mm	39.81	12.46	31.3
Quantity of the leafs, piece	13.06	1.48	11.37

It was known that from learned results, every indicator of the corncob has self amount and self character, their also deviation differently from middle amount. Lengths of the corncobs with together husks are average 262.5 mm, average amount deviation 44.7 mm, their diameter from average amount 5.2 mm deviated and it organized 38.6 mm.

We analyzed the distribution area of the taken results and we determined their characterizations of the spread distance were smooth. We can see the non-smooth distribution of the amounts by weight corncob, its grain and of the piths. These indicators are average amounts 122.1 g, 99.3 g and 22.8 g, their variation surfaces are 42.1 % on corncobs and its pith, the grain weight is 44.7 %. The result showed that the deviation of the amount is seriously one from other.

Table 3. Size-mass indicators of the corncobs

Name of the indicators	Amount of the indicators		
	$M_{ave.}$	$\pm \sigma$	V, %
Length of the corncobs with together husks, mm.	262.5	44.7	17.0
Diameter of the corncobs with together husks, mm.	38.6	5.2	13.6
Weight of the corncobs with together husks, g	130.6	51.2	38.9
Quantity of the husks, pieces	6.2	1.9	30.7
Weight of the husks, g	8.5	3.3	38.9
Length of the husks, mm.	216.5	35.8	16.5
Weight of the corncob, g	122.1	51.4	42.1
Length of the corncob, mm.	208.7	42.7	20.5
Diameter of the corncob, mm.	37.6	4.5	12.1
Weight grain of the corncob, g	99.3	44.4	44.7
Weight of the pith, g	22.8	9.6	42.1
Diameter of the pith, g	24.2	3.1	13.0

There are husks of the corncobs average-amount 6.2 pieces and weight of the husks 8.5 g. Their deviation from average-amount is equal to amount of the husk 1.9 pieces and weight of the husks 3.3 g. Husks situated near 120° at around angle and those husks wrap 4-5 with compact thickness of the corncob.

After peeling husks of the corncobs their length is average 208.7 mm, diameter 37.6 mm and average-square deviation is equal to length 42.7 mm, at diameter 4.5 mm. and variation coefficients are equal to length 20.5 per cent, at diameter 12.1 per cent. The corncob with husk consists of husks 6.5-7.0 per cent, grains 76 per cent, piths 17 per cent.

Weight the grains of the corncobs 99.3 g, their deviation from average amount 44.4 g. One of the main indicators, they are weight and diameter of the pith. They are being shown (table 3), They equal

the diameter of the pith 24.2 mm, their weight 22.8 g and the deviation from average-amount of the indicators equal the diameter of the pith 3.1 mm, their weight 9.6 g.

They are being seen by the help definite results the main weight of the husk-corncobs they are grains 75.8 per cent, piths 17.7 percent, husks 6.5 per cent. The diameter of the pith is smaller 13.4 mm than peeled corncobs and corncobs with husk 14.4 mm. The main sizes of the grain are length, width and thickness, these indicators were learned by the help experiment.

It was known that by the experiment the main size of the grain is length and it changes from 8.4 mm till 10.5 mm, also more than 80 per cent grains are from 9 mm. till 10 mm. The middle length is 9.73 mm, their middle-square deviation 0.50 mm (table 4). The size of the width grain is near to its size length, it equal middle 8.34 mm, their middle-square deviation 0.67 mm, variation surface 8.05 percent.

The smaller size of the corn grains is its thickness, it is equal to average 5.16 mm, middle-square deviation 0.46 mm, variation coefficient 9.02 percent. It is seen from results, the grain length is more 1.39 mm than grain width, this difference is more 4.57 mm than grain thickness.

Table 4. Sizes of the corn grain

Sizes of the grain	$M_{ave.}$	$\pm \sigma$	V, %
Length, mm	9.73	0.50	5.14
Width, mm	8.34	0.67	8.05
Thickness, mm	5.16	0.46	9.02

The husk-corncobs are moved around worker-surface across and down of the corn-thresher machine, corncob is rubbed with worker-surfaces. Therefore, we must learn their friction coefficient. It was known that from experiment (table 5), there is difference between friction angle of the husk, pith and grain.

Table 5. Rubbing angle of the component corncobs

Sample	Movement way	Friction angle		
		M_{mid}	$\pm \sigma$	V, %
Husk	across	23.2	3.3	14.3
	down	22.7	4.2	18.6
Pith	across	13.2	4.0	30.5
	down	19.3	1.5	8.0
Grain	-	21.8	3.5	16.4

Across and down friction angle of the husk near one to other they equal 23.2^o and 22.7^o, also across and down friction angle of the pith organized 13.2^o and 19.3^o, it was determined that there is difference one from another 1.5 times. Friction angle of the grain was average 21.8^o, its middle-square deviation 3.5^o variation degree was 16.4 percent. The analyzing of taken results showed that, pith has leased to friction angle in the learned samples and it is between $13-19^o$, this indicator for husk is $22-23^o$ and for grain, it is $21-22^o$. We may say this, we'll pay attention to these results next for research works and we'll use from this information.

After observing experiments about determination ripening period and physical-mechanical properties of industrial grain of the corn, we decided to compare above mentioned experimental results with producing seed-corn. According to some agronomic researchers' observation, there is special determination method to harvest corn-crop for producing seed-corn figure 3, [25-27].
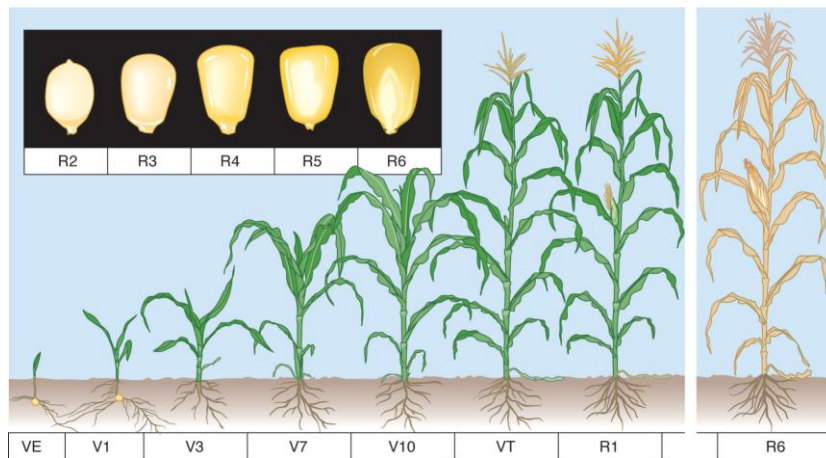
Figure 3. Corn-seed development.

During their research, they defined that matured corn-seed can be known by its color. When corn-seed matures, its color becomes dark-yellow and completely full as shown figure 3 R6 position. When we observed ripening period of the corn for producing industrial corn-grain, it was defined by comparison that most of the grain on ear becomes like R5 position of figure 3 while to be harvested. It means that, corn-grain which is harvested for industrial aim is not available for sowing as a seed.

Other researchers' team determined that, after harvesting pod-corn, corn-seeds should be further sorted in order to have a good quality. Some process should be followed to achieve it. First of all, select cobs of equal size with thick husks, then remove rotten cob and the cob which are not completely covered with husk, next step is to remove the cobs with too big and too small kernels (seeds). Remove the kernels from the top and bottom part of a cob for selecting uniform kernels as seed. Removed cobs or kernels (grain) should be used for food consumption, but not for seed figure 4, [26].

Figure 4. Selecting qualitative seed.

According to above mentioned observations, even full matured grains as shown R6 position of the fig. 2 cannot be sowed as the seed if they are located on the top and bottom part of the cob. So, many farmers in Uzbekistan and some foreign countries sow corn-seed formed R5 and R6 positions [18-23]. It influences to decrease the quality of seed and deterioration of the crop productivity. In addition, there is no any mechanized method and machines to harvest and select exactly middle part seeds of the cob. This situation demands to do new researches in condition of Uzbekistan.

4. Conclusion

According to observed researches, it was defined that the corn may be harvested in its waxy matured period, namely 10-16 days earlier than maturing completely for producing industrial grain in condition of Uzbekistan. The height of the corn stalk is average 192.7-257.0 cm, the diameter of stalk is 13.2-20.9 mm. Position of the corncobs from land is at 80.3-123.6 cm height and these indicators are very necessary for determine the height of the corncob picker-apparatus of the corn-harvester. The sizes of the corn cob are important to create mechanisms of corn-thresher machine. However, industrial grain that is matured as R5 or R6 cannot be available to sow. In addition, there is no any agricultural machine or equipment that can thresh and separate the grain from exactly middle part of the corn cob for sowing as seed. It means, additional researches should be performed about creating new type of corn thresher machine that can thresh and separate exactly part of the corn cob.

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