Adaptation mechanic sowing apparatus for sowing soybean seeds with less damaging

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Abstract. Soybean is one of the most important crops. The density of the seedlings should be 200-300 thousand per hectare, 300-400 thousand seeds, and 400-500 thousand early varieties. In this article results of research in the field and laboratory are shown for sowing soybean seeds using SCHX-4 sowing machine and its mechanical sowing apparatus. In the experiments, the number of measurements at the sowing depth was 100 and the number of lines was 10. The sowing capacity was 35-40 kg, the sowing depth was 4 cm and the width of the line was 90 cm. During the experiment, the difference in sowing measure between real sowing and SCHX-4 which has a mechanical apparatus was 6.75% and the average sowing depth and its standard deviation were 3.8 and 0.31 cm respectively. The width between the main and side rows was 89.5 and 92.5 cm respectively, and the damage level of seed caused by seeder SCHX-4 was 5.2 %. This apparatus did not reach agrotechnical requirements. Thus a restrictor was installed was made from rubber and formed a semi molded formation on the hole where the seed enters the sowing apparatus which decreased the seed damage to 0.8 %.

1. Introduction
Soybean is one of the most important crops. Approximately 300 varieties of foodstuffs, raw materials, and valuable goods are produced from soybean crops and grains, as well as valuable poultry and fish forage. Soybean plants also absorb nitrogen from the atmosphere through symbiotic bacteria; the nitrogen is transformed into biological nitrogen and equates to the available nitrogen content of 80-100 kg/day in a hectare during the growing period.

This also helps to increase soil fertility and decreasing erosion soil [1,2,3,4,5]. Therefore soybean production is increasing every year and the current area is approximately 110 million hectares [6]. Currently, in Uzbekistan knowledge of soybean development is important. At the same time, research is underway to cultivate soybean as a rotation crop after whet. While efforts are being made to establish large scale soybean production in Uzbekistan, there are currently several difficulties in cultivating this crop.

The density of the seedlings should be 200-300 thousand per hectare, 300-400 thousand seeds, and 400-500 thousand early varieties. According to the sowing rate, the soil moisture content and the weight of 1000 grains should be 40-60 kg per hectare, and the depth should be 4-5 cm. Early observations have shown that not enough seedlings obtained from sowing in grain-free areas mainly because of damage caused by mechanical sowing machines.

Several studies have been conducted to sow soybean in different ways. L.Curto and others studied the slicing and injury caused by the sowing apparatus [7]. R.L.Parish, J.E.McCoy, and R.P.Braves studied the sowing apparatus for sowing soybean seeds and determined its performance [8]. D.E.Ess
and others examined a single with a spinning apparatus [9]. E.Boydak, M. Alpaslan, M. Hayta, S. Gercek, and M. Simsek investigated the effect of irrigation on soybean growth in the composition of soybeans in the Harran region of Turkey [10]. D. Karayel studied the planting of soybean and corn on a non-treated pneumatic slab [11]. J.D. Ray, L.G. Heatherly studied the effects of nitrogen applied in large quantities to irrigated and non-irrigated shrubs [12]. H.A. Bruns investigated soybean with a series of alternating ditches, row spacing, and planting times [13]. N. Ballaloui and others studied the effect of line spacing, width, sowing operation, soil type, and different management on soybean quality in the Mississippi delta of the United States [14]. M. Sgarbossava and others studied the effect of soybeans of different sizes and the effect of fertilizers on fertility [15].

H. Liu and others developed experimental platforms with vertical sowing discs used for sowing seeds and optimized their parameters [16]. He studied the effect of soybean and corn on the working order of the workflow [17]. H. L. Jia studied various sowing devices and developed a sowing apparatus for horizontally sowing into a sowing disc, allowing airflow with a pad drum directly on the machine without a ventilator, the device's diameter was 11 mm, and the quality of the work performed at high operating speed (12 km/h) exceeded that of the existing pneumatic planting device with a range of 24.4 mm and a slit number of 13 [18, 19, 20, 21].

S. M. Woo and others conducted research on the development of pneumatic mechanical syrup including corn and soybean seeds [22]. T. Atakulov studied the efficiency of direct sowing without shrubs in the southeastern Kazakhstan region [23]. In Uzbekistan the varieties of sowing schemes and parameters of sowing machines for sowing have been studied [24, 25, 26]. However, in the above studies, the authors did not investigate, evaluate, and improve the work of planting machines used for mechanical sowing. SCHX-4 is a mechanical type, it is one of the most widely used machines for seeding plants in Uzbekistan. That is why it is important to research and improve it in sowing the soybean.

### 2. Methods

The work-quality indexes of the sowing used in State Standards 31345-2007 and field testing and soil conditions were determined according to State Standards 20915-2011 [27, 28]. The experimental field consists of typically grey soil that was irrigated in the past, plowed in the fall, and flattened with a longitudinal stratum.

The GX-4 is equipped with a shell measuring bed, and spring water is supplied. Before planting, the field was treated with threaded teeth. Mechanical type SCHX-4 seeder was sealed for shrub planting.

Because it is the most commonly used in Uzbekistan. To prepare the serial GX-4, the soybean seeds were put into several bunkers, and in the case of the wheel, the rotors were put into operation. The number of soybeans per kilometer was calculated by calculating the path to the rotation of the cellar wheel.

Planting machines were set up from 35 to 40 seed shrubs per hectare. The depth was equal to 4 cm by lifting and lowering the support of the plowshare on the surface of the earth. The plowshare and soil-reel pulse pressure on the soil was 30-35 kilograms. In the experiments, the number of measurements at the sowing depth was 100 and the number of lines was 10. The sowing capacity was 35-40 kg, the sowing depth was 4 cm and the width of the line was 90 cm. Continuous fall and burial of the seed were monitored by the operator.

### 3. Results and Discussion

The technical specification of the SCHX-4 seeder is shown in table 1.

| Indicators              | Indicator values |
|-------------------------|------------------|
| Width of coverage (m)   | 3.6              |
Distance between slots (cm) 7.5; 10; 15; 20; 30
The degree of slots when sowing in the prescribed amount (2. 3 or 4 seeds) (%) 65
Average seed number that seeded in a slot (piece) 5-6
Work velocity (km/h) up to 7
Work capacity (ha/h) up to 1.6
Overall dimensions (mm):
length 1500
width 3720
height 2050
Mass of seeding machine (kg) 500-550

Based on the established methods, experimental work on sowing seeds with the SChX-4 seeder with mechanical planting equipment was carried out (Fig. 1).

![Figure 1. Soybean sowing process with the SChX-4 seeder](image)

The seeder machine's width is 3.6m, which allows the seeds to be sown between 60, 70, and 90 cm. When sowing seeds, the distance between the nests is 7.5 cm, 10 cm, 15 cm, 20, and 30 cm, the nesting rate is 65%. For slot sockets, 45- and 12-gears are provided on the chain drive at 15 cm intervals, 45- and 16-gears at 20 cm intervals, 45- and 25-gears at 30 cm intervals, and 45- and 12-gears for row planting. The speed of the seeding machine is up to 7 km/h and its performance is 1.6 hectares (Table 1).

Based on the results of experiments, the sowing norms and depths of seeds for the SChX-4 ranged widely across of agrotechnical requirements (ATR) (Table 2).

| Table 2. Results of sowing seeds with the SChX-4 seeder |
|---------------------------------|-------------------------------|-----------------|----------------|
| Indicators                      | According to agrotechnical demand | Defined | Actual |
| Sowing measure (kg/ha)          | At least 10 %                  | 35-40   | 37.8   |
| Depth of sowing (cm):           |                               |         |       |
| Mean $M_{av}$                   | 3-6                           | 4       | 3.8    |
| Standard deviation $\sigma$     | 1                             | –       | 0.31   |
| Width between rows              |                               |         |       |
At the same time, the difference between the defined sowing norm and the actual sowing norm was 6.75 percent (10 percent maximum by ATP), mean sowing depth and its standard deviation were 3.8 cm and 0.31 cm (4.0 ± 1.0 in ATT) and the width of the adjacent line spacing was 89.5 cm and 92.5 cm respectively (90.0 ± 1.0 cm and 90.0 ± 5.0 cm respectively). However, the damage rate of seeds was 5.2%, which does not correspond with ATT. It was found that the seeding machine caused mechanical damage to the seeds between the sowing slurry and the sowing rod.

The SChX-4 seeder has been tested on a universal stand under laboratory conditions to eliminate the deficiencies identified as a result of a field-test investigation of mechanical sowing (Fig. 2). Seeds were damaged as a criterion for evaluation.

The SChX-4 seed sowing device has a semi molded cutter that ensures that the sowing unit is fitted to the shrub layer without damaging the shrub slices by the shingle rolling hole, which was prepared from the metal list, plastic, and rubber, was tested (Fig. 3 and Fig. 4).

| Actual side | 90±1 | 90 | 89.5 |
| Damage rate of seeds (%) | 1.0 | - | 5.2 |

**Figure 2.** Universal stand designed for testing machines for planting

**Figure 3.** View of the barrier that should be installed on the seed hole
Experiments consisted of the number of turns of the mechanical planting apparatus, i.e., 75, 100, 125, and 150 rpm/min. and 5 repeats. The number of cycles of the mechanical planting apparatus was 75 rpm/min. and 150 rpm/min, and the damage rate of the seeds was higher than that of a metal cutting machine from 2.5% to 5.4%, and from plastics, which restricted cultivation by 1.8% to 3.6% (Table 3).

![Image of barriers](image-url)

**Figure 4.** View of the barrier on the seed hole of the mechanic sowing apparatus

| Type of barrier installed on the mechanical sowing apparatus | Rotation number of the sowing apparatus (rpm) | Rate of damage seed (%) |
|---------------------------------------------------------------|-----------------------------------------------|-------------------------|
| Metal                                                         | 75                                           | 2.5                     |
|                                                               | 100                                          | 2.9                     |
|                                                               | 125                                          | 4.1                     |
|                                                               | 150                                          | 5.4                     |
| Plastic                                                       |                                              | 1.8                     |
|                                                               | 100                                          | 2.1                     |
|                                                               | 125                                          | 3.0                     |
|                                                               | 150                                          | 3.6                     |
| Rubber                                                        |                                              | 0.3                     |
|                                                               | 100                                          | 0.4                     |
|                                                               | 125                                          | 0.6                     |
|                                                               | 150                                          | 0.8                     |

Although the damage caused by the rubber increased by 0.3% to 0.8% but was less than that caused by the metal and plastic containment limitations, it was determined that the specified requirements did not exceed 1%. Based on this experiment, it is recommended that a rubber sack be placed at the bottom of the mechanical planting apparatus when sowing soybean.

### 4. Conclusions

Based on the results of the experiments, it is desirable to place a semi molded cut-out of rubber material into the sowing slots under the planting apparatus to reduce sowing damage when using mechanical planting devices.

Based on the results of the experiments, it is advisable to install a semi-crescendo scope of rubber material on the seeding holes at the bottom of the seeding machine to minimize the damage to the seeds when sowing with mechanical seeding machines. Seed damage in the seeding machine with a
rubber restraint was between 0.3 and 0.8 percent, which was 4-6 times less than metal and plastic barriers and did not exceed 1 percent.

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