Plant Archives Volume 20 No.2, 2020 pp. 6219-6227 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

THE EFFECT OF FORWARDING SPEED AND SOWING DEPTH ON THE STABILITY OF THE CHISEL FURROW OPENERS FOR THE MAIZE PLANTER (ÖZDUMAN) AND ITS EFFECT ON FIELD PERFORMANCE INDICATORS

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Abstract

The research was aimed to exam the effect of chisel furrow openers for the seed meter (ÖZDUMAN) on some field performance indicators. The field experiment was adopted to plant the Maize crop at the season 2019-2020 in fields of Nineveh Governorate, Al-Hamdania district, Al-Namrod district. The field soil is characterized as silty clay. The randomised complete block design (RCBD) was used to analyse the results under a split-split plots system. The experiment included studied factors for sowing depths (3 and 5) cm, three sowing forward speeds (2.5, 4.8, and 6) km/h and three spring tensile strength levels (242, 217, and 198) N, and their effect on some of the mechanised characteristics. These mechanised characteristics were the deviations between seeds (cm), seed depth deviations (cm), the efficacy of the chisel openers (%), uniformity of seed distribution (%), number of plants /5 m length and total seed yield (ton/ha). Finally, the triple interaction of depth (5) cm with forwarding speed (2.5) km/h and the spring tensile strength (217) N recorded the highest and best values in the number of plants, uniformity of seed distribution, and the total yield of seeds.

Key words : Maize planter, Seed forward speed, Sowing depth, Spring tensile strength, Furrow opener.

Introduction

Maize is one of the most important crops of food grains, as Maize is grown worldwide in about 70 countries, including 53 developing countries. Furthermore, China is one of the leaders in terms of planted area with corn, while the United States of America comes first in terms of corn export. The Arab world produces 8 million and 800 thousand tons of corn, with a large deficit of this main crop. Egypt is the first Arab country in corn production with 62% of Arab world production. As for Iraq, it comes second in terms of planted area and yield production (Al-Rifai and Nemer, 2017). The researcher Mohammed, (2017) pointed out in his research that the effect of forwarding speed on the indicator of plants number for the seeder (Gaspardo-SC-250), with the speed (4-5) km/h, has significant differences recorded for the number of plants (38.75) plant /5 m long, compared to the other two forward speeds (7-8 and 10-11) km/h, respectively. The reason for obtaining the largest plant numbers due to the type of sowing mechanism (the sowing unit), which is responsible for regulating the number of fallen seeds. Besides, the forward speed contributes to locating the increase or decrease in the required number of seeds. Sedeeq and Sheikh (2016), through a study, to evaluate the work performance of Nardi seeder, when modulating the sowing mechanism disks, showed the effect of the forward speed of the seeder (2.7, 3.7 and 5.1) km/h in the characteristics of the Maize corn seed

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yield. The results of the statistical analysis showed that the second forward speed (3.7) km/h, recorded higher significant value, for the largest seed yield amount (16.50) tons/ha. While, the third forward speed (5.1) km/h, recorded the minimum quantity of seed yield (7.08) tons/ha. Whereas, the reason was the size of the large seeds (12 mm) was inserted into the modified holes of the seed disks, which were diameter from (4.5 to 10) mm, were more compatible with the second forward speed. Thus, this means that the second forward speed is compatible with the speed of the sowing mechanism (modified sowing disks). As for the third forward speed, the opposite was for the incompatibility of the forward speed for the planter with the sowing mechanism and its speed in this variable. Al-Rajaboo *et al*., (2009) mentioned that the different seed depths significantly affected on the variable of plants numbers for 5 m in length, where the sowing depth (9-11) cm achieved significant difference with the largest number of plants at a length of 5 m, compared to the sowing depth (6-8) cm. The reason was assigned to the fact that the soil moisture stored in the large depths is ideal for seed growth better than the low depths. Thus the increase in plant density, which positively affected an increase in the total yield. Virk et al. (2019) in their research included the effect of down force (pressure forces) similar to the spring tensile strength (0, 0.45, 1.11, and 1.78) kN, and their effect on the depth deviation character of fields A and B. The results of the statistical analysis showed that there are no significant differences for both fields in this characteristic with the second, third and fourth levels of the pressure forces for both fields. Whereas, fields A and B were recorded at the first level of the spring tensile force significant difference to seed depth (3.3 and 3.7) cm, respectively. The reason for this is that the achieved seed depth increases with the changing conditions of the spring tensile level. Also, they indicated that the spring calibration achieved the best seed depth in the prevailing plantation conditions and type of soil. Francetto *et al.,* (2016) demonstrated in an experiment to evaluate the performance of two types of furrow openers (hoe and double-disc) and the effect of the shape and depth of the furrow (7-12) cm. The hoe opener achieves the best value, and record a maximum depth (11.39) cm. Meanwhile, a double-disc opener recorded the maximum depth (7.41) cm. Özmerzi *et al.,* (2002) performed a precision vacuum seeder use and examined the index of plant emergence rate and regularity of seed distribution at three seed depths (4, 6, 8) cm. The results showed that there was no significant difference for the distribution of seeds in different seed depths, but the highest rate of plant emergence was achieved in the depth of seed (4, 6) cm. They indicated that increasing the depth of sowing negatively affects the germination rate. Badua et al. (2018), in their study of the effect of forwarding speed (7.2, 9.7, 12.1, and 16.1) km/h, indicated on the deviation between the seeds in the line that there were no significant differences. However, the first speed achieved the lowest value compared to the rest of the speeds, which were (6.5, 6.9, 8.6, and 8.1) cm respectively. The reason for the difference in the values of the deviation in the seed distances due to the difference in the speed of the planter, which preserved the minimum vibrations of the seed units at low speeds. Thus, allowed the seeds to be dropped the seeds directly into the ditch that formed furrow openers. Hanna *et al.,* (2010) reported the effect of spring tensile strength affecting seed units and seed spacing distance, that no significant differences were seen when changing spring tensile strength levels. The researchers also indicated that the least effect (90%) was at the first level of the spring tensile strength. Also, they mention that increasing the loads due to the change in the spring tension level on the row-unit does not change the distance between the seeds, whether big or small. Also, they indicate that the recommended distance for maize crop seeding is (20) cm. Chen *et al.,* (2004) noted that traditional farmers developed pressure force on furrow openers by suspending springs and attaching them in an automatic parallel manner. Despite the use of some modern seed methods using hydraulic cylinders instead of mechanical springs. Chen *et al.,* (2004) mentioned that farmers used pressure on the sowing unit by a spring. The spring tension force level is manually adjusted to individual sowing units, using hydraulic cylinders and allowing load control to be made to multiple row units at one time. Garcia *et al.,* (2011) mentioned the corn planter, with an increased sowing speed (2.5 and 4.4) km/h, there was an increase in seeding depth, the peripheral speed of the sowing disc and the occurrence of double seeds, the decrease in seed distribution per meter. Virk *et al.,* (2020) indicate in a study of the performance for Maize corn planters at two types of fields (B and A), seed depths (2.5 and 5.1) cm, and four different pressure forces on the furrow openers for the depth measurement wheel affecting the seed unit and the extent of its effect on seed depth deviation. Where the results indicated an increase in deviations with the second depth (5.1) cm and a significant difference recorded in both plantations with a value of the deviation of depth (0.2) cm. While the first depth (2.5) cm recorded the little deviations for seed depth in both plantations. According to what was mentioned in previous researches and studies, the research aims to exam the effect of chisel furrow openers for the seed meter (ÖZDUMAN) on some field performance indicators. The factors adopted two sowings forward speed, two sowing depth, and three spring tensile strength.

Materials and Methods

This field experiment was implemented for the autumn season (2019 - 2020) in one of the farmer's plantations of in Al-Nimrud district in the Nineveh governorate. An Italian Maize seeds type (DRACAM) was used to plant the field. The area of the field used in the experiment was (4.235) m^2 with dimensions (77 x 55) meters. The field used for the experiment was cultivated with wheat crops in the previous season. The soil structure was silty clay. The cultivation was done with a three-disc disc plough at depth of (20-25) cm, and then the field was smoothed with a rotary plough. Then, the levelling process was carried out by the tablet equipment to obtain the best soil of equal appearance and to obtain the best flow for watering. The field was planted on 25-7-2019 using the Turkish maize planter (ÖZDUMAN), and it works with three furrow openers hoes. The distance between the furrow opener and the other was (70) cm, and the working width of the farmer (210) cm and the type of the feed mechanism. The sowing mechanism is operated by air deflating, that is, air suction, while the seed discs derive their movement from the ground wheels of the implant. Randomised complete block design RCBD system was used in the arrangement of split-split plots. Where the first factor took the main plots of seeding depths at levels (3 and 5) cm. While the second factor took the sub-plots for sowing speed at three levels (2.5, 4.8, and 6) km/h. The third factor took the sub-sub plots of the spring tensile strength at three levels (242, 217, and 198) N. The field was divided into experimental sectors and units, with three repetitions per treatment. The data were analysed using the computer according to the SAS program. The Dunkin Multi-Range Test was used to test the significance of the differences between the different mean averages under the 5% probability level (Dawod and Abdulyas, 1990). The following variables were studied:

1. Deviations between seeds in the line (cm)

The average seed distance was calculated after taking a set of readings, at three replications per line, for each experimental unit. Then to calculate the deviations for this variable was determined according to the equation of researchers (ALkhafaji and ALssabagh, 2011):

$$P = \frac{\sum(Pi)}{n} \quad \text{.... (1)}$$

P = average distance between seeds (cm), Pi = the distance from one seed to the next (cm), n = number of readings.

$$S.D\ d = \sqrt{\frac{\sum(Pi-P)^2}{n-1}} \quad \text{.... (2)}$$

S. D *d* = Standard deviation of the distance between seeds (cm).

2. Deviations for seed depths (cm)

The average seed depth was calculated after taking a set of readings, at three replications per line, for each experimental unit. Then to calculate the depth deviations of the seed using the following equations that were used by the researchers (ALkhafaji and ALssabagh, 2011):

$$D=\Sigma di/n \quad \text{.... (3)}$$

D = seed depth rate (cm), di = seed depth (cm), n = number of readings.

$$S.D\ s = \sqrt{\frac{\sum(di-D)^2}{n-1}} \quad \text{.... (4)}$$

S. D s = Standard deviation of seed depth (cm).

3. Efficiency work of furrow opener (%)

This variable was calculated by taking several random samples to verify the depth of the furrow opener, with three replications from each experimental unit. As for the method of calculating the efficiency of furrow opener, it was by the following law used by (Gbabo *et al.,* 2017):

$$Fo = \frac{Fad}{Fid} * 100 \quad \text{.... (5)}$$

Fo = Furrow opener working efficiency (%), Fad = actual furrow opener depth (cm), Fid = theoretical furrow opener depth (cm).

4. Number of plants for 5 m length

Through the use of the Al-Rajaboo *et al.,* (2009) method, a random (10) was chosen by using a random sampling box during the growth of plants in the second week of the onset of the corn crop emergence. This variable was calculated after taking several random samples with three replications from each experimental unit and finding the general mean for it.

5. Uniformity of seed distribution (%)

To calculate the uniformity of seed distribution in the field, several random samples were taken for the number of seeds actually planted for 5 m length. Then compare it to the number of seeds that the planter was calibrated with and at three replications from each experimental unit used (Sedeeq and Sheikh, 2016).

Uniformity of seed distribution = (the number of seeds actually planted / the number of seeds according to machine adjustment) * 100 .... (6)

6. Total yield of seeds (ton/ha)

When the leaves reached the point of dehydration and the stems were Corncob, the Maize was harvested by manual sickle and for three replications per treatment per experimental unit. Where (10) plants were randomly selected from the middle cultivation line and along the line and from different places. The reason because the midline is more competitive than the side-lines in food, light, and water. After that, the seeds from the sprouts were manually shredded and dried. In order not to lose the seeds, the moisture content of the seeds was calculated in the General Seed Company laboratories in Nineveh. After that, the seed moisture content was adjusted and delivered to the storage seed moisture content (15.5%) recommended by(Rajabo and Khalaf, 2006). After completion of the drying process and the delivery of the sample to the storage moisture, it was divided into 10 plants and then multiplied by the number of plants per hectare to calculate the total seed yield per ton/ha (AI-Obaidi, 2019).

Results and Discussion

The effect of the factors studied on the characteristic deviations between seeds in the line (cm)

Table 1 shows that there were no significant differences in both depths (3-5) cm, as deviations between seeds in the line were recorded at a value of (4.60 and 4.74) cm, respectively. The reason may be that the difference in the two depths was close, which did not adversely affect this characteristic, as well as in the levels of spring tensile strength (242-217-198) N recorded deviations between the seeds in the line (4.58, 4.68 and 4.76) cm, respectively. In addition to that, the spring tensile strength has no function in the deviations between the seeds in the line as much as in the feeding disk where the side vibrations are responsible for the deviations in the seeds, and this is what came with the researcher (Hanna et al. 2010). While the third forward speed (6) km/h was significantly higher, recording the highest deviation between seeds, at a value of (6.76) cm. The reason is that there is greater stability for the planter and the tractor, and the furrow openers prevail at this speed for the resistances arising in the soil, and this is consistent with (Badua *et al.,* 2018). While the double interaction of depth and speed was recorded higher value at the third speed. Also in both the first and second depths, it recorded the highest deviations between seeds with a value of (6.66 and 6.86) cm, respectively. While it was found that the double interaction of depth with the spring pressure force level, no significant differences were observed. As for the dual interference of speed and the level of the spring tensile force, the third speed achieves high significant value for all levels of the spring tensile strength, recording deviations between seeds with values of (6.65, 6.72 and 6.90) cm. While the triple combination of depth, speed, and spring tensile force achieved at depth (5) cm with speed (6) km/h and spring tensile force level (198) N recorded the highest deviations with a value (6.96) cm. Moreover, the first depth (3) cm with the first speed (2.5) km/h and the first spring tensile strength level (242) N recorded the least deviations between the seeds with a value of (2.50) cm.

The effect of the studied factors on the characteristic deviations of seed depths (cm)

It is clear from table 2 that there were no significant differences in the two depths (3-5) cm, which recorded deviations of the sowing depths with a value of (0.28 - 0.39) cm, respectively. This is evidence that the furrow openers responsible for operating regularly. While the speed (6) km/h, achieve a significant difference and recorded the highest deviations for sowing depth of (0.61) cm. The reason is the occasional vibrations due to the inconsistency of the tractor speed with the power requirements of the furrow openers, or the occurrence of concussions with this speed. While the third level of the tensile strength of the spring (198) N scored the highest deviation of seed depth of (0.47) cm. This is because the greater the spring tensile strength, the greater the deviation of the depth due to the reactions resulting from the spring force to the presence of a horizontal and vertical force affecting the planter, and this is consistent with the researcher (Virk *et al.,* 2019). While the dual interaction of depth and forward speed was recorded in both depths (3 and 5) cm with speed (2.5) km/h, recording the lowest value for seed depth deviation (0.12-0.19) cm, respectively. Whereas, the dual interaction of depth (3) cm, and the spring tensile strength level (242) N achieved significant value, and recorded the lowest deviation of sowing depth of (0.10) cm. Moreover, the depth (5) cm at all spring tensile strength levels did not notice significant differences. As for the dual interaction of forwarding speed (6) km/h, and the spring tensile strength level (198) N, recording the highest deviation of sowing depth of (0.78) cm. As for the triple interaction of the depth (5) cm with the speed (6) km/h and the spring tensile strength level (198) N, it showed a significant difference in the deviation of seed depth (0.83) cm. While the depth (3) cm with the forward speed (2.5) km/h and the spring tensile strength (242) scored the best result with the least deviations of the seed depths with a value of (0.00) cm.

The effect of the factors studied on the work efficiency of the furrow openers (%)

It is noted from table 3 that there were no significant differences in both depths (3-5) cm in this variable, as efficiencies were recorded for the furrow openers (91 and 92%), respectively. While the two forward speeds (2.5 and 4.8) km/h, respectively, were registering higher significant value, of efficiency for furrow openers (96 and 94%), respectively. It is clear, that the efficiency of the furrow openers increases with the lower forward speed of the tractor and the planter together. This means that the forces affecting the furrow openers construct from the speed of the tractor and the planter was more stable at this speed. This is consistent with (Francetto *et al.,* 2016). While the spring tensile strength (242) N significantly outperformed the highest efficiency of the furrow opener (96%). The reason is assigned to the fact that the applied force of the furrow opener at the first level of spring tensile force gave a superior result. As a result of giving the spring an additional auxiliary force allowing penetration during the work of the furrow opener, which signifies a significant achievement for the two spring tensile forces (217-198) N. While the dual interaction was recorded in both the first and second depths with the first forward speed (2.5) km/h, the highest superior value for furrow opener efficiency was equal in the recorded values (0.96%), respectively. While the result of the dual interference of depth (3) cm with the first level of the spring tensile force (242) N signed significant value for the highest efficiency of the furrow opener with a value (97%). Whereas, the dual interaction of the two forward speeds (2.5 and 4.8) km/h with the spring tensile strength level (242) N recorded the highest and best values for the work efficiency of the furrow openers (99 and 98%), respectively. As for the triple combination, the first depth with the first forward speed and the first spring tensile strength, came out superior and registered the best ideal ratio for the furrow opener efficiency of (100%). Thus, this is evidence that the force gained from the action of the spring on the furrow opener made it more stable at slow speed and in the depth (3) cm, so it scored higher and better value for the work efficiency of furrow openers than the rest of treatments.

The effect of the factors studied on the characteristic number of plants / 5m length

Table 4 indicates that there were no significant differences in both depths for the number of plants for 5 m in length, as the number of plants (22.93 and 23.56) was recorded. This is since plants took their sufficient moisture stock at both depths. In addition to the work efficiency of the furrow openers, which achieved the ideal depth, and this is consistent with the (Al-Rajaboo *et al.,* 2009). While it was noticed that the speed exceeded (2.5) km/h with the highest number of plants, recording (24.33) plants for 5 m length. The reason is that the first forward speed led to the regularity of the seed depth, which affected the plants obtaining sufficient moisture, then affected the number of growing plants. While the level (242) N of spring tensile strength recorded the highest number of plants (23.67) plants. The reason was assigned to the fact that the increased spring tensile strength reduced the soil resistance, which raised the efficiency of the furrow opener in the regularity of the depth of cultivation, which had a role in significant superiority, and this was what (Virk *et al.,* 2019) and (Hanna *et al.,* 2010) presented. While dual interaction in depth (5) cm with speed (2.5) km/h, recording the highest number of plants (24.56) plants. Whereas, the dual interaction scored at the depth (3) cm and the level (198) of the spring tensile strength the lowest number of plants, recording (22.44) plants. As for the dual interaction of the first forward speed with the first spring tensile strength level, it achieved the highest number of plants, recording (24.67) plants. As for the triple combination, depth (3), speed (6), and level (198) for the spring tensile strength, recorded the lowest number of plants (20.67) compared to the rest of the treatments. While the first depth with the first speed and the first level of the spring significant differences, recording the highest number of plants registered (24.67) for 5 m length compared to the rest of the treatments.

The effect of studied factors on the uniformity of seed distribution (%)

Table 5 clarify that there were no significant differences in both depths (3-5) cm, with proportions of uniformity of seed distribution (92 and 94%), respectively. The reason may be that the depths have no direct effect on this treatment, but the speed factor is the most important role in this treatment. While the speed (2.5) km/h, registering higher significant differences and recorded the highest percentage of uniformity of seed distribution (97%). The reason is that the stability of the planter was superior at this speed, which did not face reactions or resistance in the soil, and this is consistent with (Garcia *et al.,* 2011). While the first level of the spring tensile strength (242) N, significantly superior to record the highest uniformity of seeds (95%). The reason is that the increased tensile strength of the spring affected giving more stability to the work of the furrow opener, which recorded the highest uniformity of the seeds. On the other hand, other factors may affect this characteristic, such as the nature of the field, the type of soil, and the speed of sowing. As for dual interaction at the depth (3) cm with speed (6) km/h, the lowest percentage of uniformity of seed distribution was recorded (83%). As

Table 1: Effect of the studied factors on the characteristic deviations between seeds in the sowing line (cm).

Seed depth (cm)	Sowing forward speed (km/h)	Spring tensile strength (N)			Interaction depths with sowing forward speed	Seed depth (cm)
		242	217	198		
3	2.5	2.50 d	2.60 d	2.70 d	2.60 c	4.60 a
	4.8	4.57 c	4.57 c	4.53 c	4.56 b	
	6	6.57 b	6.57 b	6.83 ab	6.66 a	
5	2.5	2.73 d	2.77 d	2.80 d	2.77 c	4.74 a
	4.8	4.40 c	4.70 c	4.73 c	4.61 b	
	6	6.73 ab	6.87 ab	6.96 a	6.86 a	
Interaction of seed depths with the spring tensile strength	3	4.54 a	4.58 a	4.69 a	Sowing forward speed (km/h)	
	5	4.62 a	4.78 a	4.83 a		
Interaction of seeding forward speed with the spring tensile strength	2.5	2.62 c	2.68 c	2.75 c	2.68 c	
	4.8	4.48 b	4.63 b	4.63 b	4.58 b	
	6	6.65 a	6.72 a	6.90 a	6.76 a	
Spring tensile strength		4.58 a	4.68 a	4.76 a		

Similar letters indicate that there are no significant differences.
Lower values are the best.

Table 2: Shows the effect of the studied factors on the characteristics of deviations for seed depths (cm).

Seed depth (cm)	Sowing forward speed (km/h)	Spring tensile strength (N)			Interaction depths with sowing forward speed	Seed depth (cm)
		242	217	198		
3	2.5	0.00 f	0.07 f	0.30b-f	0.12 c	0.28 a
	4.8	0.10 ef	0.23 c-f	0.33 b-f	0.22 c	
	6	0.20 f	0.57 a-e	0.73 ab	0.50 ab	
5	2.5	0.13 d-f	0.20 d-f	0.2 c-f	0.19 c	0.39 a
	4.8	0.13 d-f	0.23 c-f	0.40 a-f	0.26 ab	
	6	0.60 a-d	0.70a-c	0.83 a	0.71 a	
Interaction of seed depths with the spring tensile strength	3	0.10 b	0.29 ab	0.46 a	Sowing forward speed (km/h)	
	5	0.29 ab	0.38 a	0.49 a		
Interaction of seeding forward speed with the spring tensile strength	2.5	0.07 c	0.13 c	0.27 c	0.16 b	
	4.8	0.12 c	0.23 c	0.37 bc	0.24 b	
	6	0.40 bc	0.63 ab	0.78 a	0.61 a	
Spring tensile strength		0.19 c	0.33 b	0.47 a		

Similar letters indicate that there are no significant differences.
Lower values are the best.

for dual interaction, it was noted that the depth (5) cm was significantly higher with the first spring level, recording the highest uniformity of seed distribution (96%). Whereas, the dual interaction of the first forward speed with the first spring tensile strength level scored significantly for the highest uniformity of distribution (99%). As for the triple interference, the depth (3) cm with speed (2.5) km/h with a spring tension (242) N recorded the highest and best uniformity of the seeds (99%).

The effect of the studied factors on the characteristics of total seed yield (ton/ha)

Table 6 indicates the superiority of depth (5) cm, significantly, with the highest seed yield of (10.47) tons/ha. This is evidence that the depth (3) cm gave the root

Table 3: Shows the studied factors for the working efficiency of furrow openers (%).

Seed depth (cm)	Sowing forward speed (km/h)	Spring tensile strength (N)			Interaction depths with sowing forward speed	Seed depth (cm)
		242	217	198		
3	2.5	100 a	98 ab	90 a-d	96 a	91 a
	4.8	97 a-c	92 a-c	89a-d	93 ab	
	6	93 a-c	81 cd	75 d	83 c	
5	2.5	97 ab	96 a-c	95 a-c	96 a	92 a
	4.8	99 ab	95 a-c	92 a-c	95 a	
	6	88 a-d	86 a-d	83 b-d	86 bc	
Interaction of seed depths with the spring tensile strength	3	97 a	90 bc	85 c	Sowing forward speed (km/h)	
	5	95 ab	92 ab	90 bc		
Interaction of seeding forward speed with the spring tensile strength	2.5	99 a	97 a	93 ab	96 a	
	4.8	98 a	94 ab	90 ab	94 a	
	6	91 ab	84 bc	79 c	85 b	
Spring tensile strength		96 b	91 b	88 c		

Similar letters indicate that there are no significant differences.
A higher value is better in this variable.

Table 4: Shows the studied factors for the number of plants / 5 m in length.

Seed depth (cm)	Sowing forward speed (km/h)	Spring tensile strength (N)			Interaction depths with sowing forward speed	Seed depth (cm)
		242	217	198		
3	2.5	24.67 a	24.00 a-c	23.67 a-c	24.11 ab	22.93 a
	4.8	24.33 ab	23.67a-c	23.00 cd	23.67 b	
	6	21.00 e	21.33 e	20.67 e	21.00 d	
5	2.5	24.67 a	24.67 a	24.33 ab	24.56 a	23.56 a
	4.8	24.33 ab	24.00 a-c	23.33 bc	23.89 b	
	6	23.33bc	22.33 d	21.00 e	22.22 c	
Interaction of seed depths with the spring tensile strength	3	23.33 ab	23.00 ab	22.44 b	Sowing forward speed (km/h)	
	5	24.11 a	23.67 ab	22.89 ab		
Interaction of seeding forward speed with the spring tensile strength	2.5	24.67 a	24.33 ab	24.00 ab	24.33 a	
	4.8	24.33 ab	23.83 b	23.17 c	23.78 b	
	6	22.17 d	21.83 d	20.83 e	21.61 c	
Spring tensile strength		23.72 a	23.33 ab	22.67 b		

Similar letters indicate that there are no significant differences.
A higher value is better in this variable.

group a greater opportunity to absorb nutrients and benefit from the soil by branching the roots with regular irrigation periods. While the speed came (2.5) km/h, registered the highest seed yield (10.76) tons/ha, and this agrees with (Sedeeq and Sheikh, 2016). While the forward speed (6) km/h, recorded fewer seeds yield (9.17) tons/ha. The reason for this decrease in the quantity of the product by increasing the speed is due to several factors, the most important of which is the efficiency of the furrow opener. As for the difference between the yield values at the difference in forwarding speed, it is due to the deviation of the seed depths resulting from the efficiency of the furrow opener, which enables the seeds to be delivered to the required depth, which is reflected in the total yield. While the first level of the spring tensile strength scored the highest yield. While the dual interaction in the second depth and the first forward speed recorded the highest value of the seed yield (11.09) tons/ha. While the dual interaction was recorded in the first depth and the third level for the spring tensile strength, the lowest quantity

Table 5: Shows the effect of the studied factors on the uniformity of seed distribution (%).

Seed depth (cm)	Sowing forward speed (km/h)	Spring tensile strength (N)			Interaction depths with sowing forward speed	Seed depth (cm)
		242	217	198		
3	2.5	99 a	96 a-c	95 a-c	96 ab	92 a
	4.8	97 ab	95 a-c	92 cd	95 b	
	6	84 e	85 e	83 e	83 d	
5	2.5	99 a	99 a	97 ab	98 a	94 a
	4.8	97 ab	96 a-c	93 bc	96 b	
	6	93 bc	89 d	84 e	89 c	
Interaction of seed depths with the spring tensile strength	3	93 ab	92 ab	92 b	Sowing forward speed (km/h)	
	5	96 a	95 ab	92 ab		
Interaction of seeding forward speed with the spring tensile strength	2.5	99 a	97 ab	96 ab	97 a	
	4.8	97 ab	95 b	93 c	95 b	
	6	89 d	87 d	83 e	86 c	
Spring tensile strength		95 a	93 ab	91 b		

Similar letters indicate that there are no significant differences.

A higher value is better in this variable.

Table 6: Shows the effect of the studied factors on the total seeds yield (ton/ha).

Seed depth (cm)	Sowing forward speed (km/h)	Spring tensile strength (N)			Interaction depths with sowing forward speed	Seed depth (cm)
		242	217	198		
3	2.5	10.83a-c	10.40cd	10.03 de	10.42 b	9.56 b
	4.8	10.10de	9.73 e	9.00 f	9.61 c	
	6	9.07 f	8.80 f	8.10 g	8.66 d	
5	2.5	10.83 a-c	11.40 a	11.03 ab	11.09 a	10.47a
	4.8	11.10 ab	10.73 bc	10.03 de	10.62 b	
	6	10.10 de	9.83 de	9.13 f	9.69 c	
Interaction of seed depths with the spring tensile strength	3	10.00 b	9.94 c	9.04 d	Sowing forward speed (km/h)	
	5	10.68 a	10.66 a	10.07 b		
Interaction of seeding forward speed with the spring tensile strength	2.5	10.83 a	10.90 a	10.53 ab	10.76 a	
	4.8	10.60 ab	10.23 b	9.52 c	10.12 b	
	6	9.58 c	9.32 c	8.62 d	9.17 c	
Spring tensile strength		10.34 a	10.15 b	9.56 c		

Similar letters indicate that there are no significant differences.

A higher value is better in this variable.

yield (9.04) tons/ha. While the dual interaction in the first forward speed and the first and second levels of the spring tension recorded the highest yield amount (10.83 and 10.90) ton/ha, respectively. As for the triple combination, the depth achieved (5) cm with forwarding speed (2.5) km/h with the second level of the spring tensile strength (242) N, the best, and highest values for the grain yield (11.40) tons/ha. Also, it is the best value in all treatments. While the triple combination recorded in-depth (3) cm, speed (6) km/h, and the third level of spring tensile strength, the lowest quantity of yield (8.10) tons/ha compared to the rest of the treatments.

Conclusions

1. The second seed depth (5) cm recorded a significant difference in achieving the best values for all characteristics.
2. The first forward speed (2.5) km/h achieved the best significant results in all studied treatments except for two characteristics of deviations

between seeds and deviations for the depths of sowing.

3. The spring tensile strength (242 N) scored significant differences in all variables, except for the characteristic deviations of the depths of the seeds.
4. The triple combination recorded the best significant results in depth (5) cm with forwarding speed (2.5) km/h at a spring tensile strength (217 N) in the character of each number of plants for 5 m length, uniformity of seed distribution and total seed yield over other characteristics.

Acknowledgment

The authors would like to acknowledge the University of Mosul for their support to complete this research.

References

AI-Obaidi, M.A.A. (2019). Evaluation of the effectiveness of some herbicides in the growth and yield of maize (*Zea mays* L.) and associated weeds. University of Mosul.

Al-Rajaboo, S.A.J.M.A.A.M.M.H.A.B. (2009). Effect of Row Space and Sowing Depth Using Seed Drill (GASPARDO SC-250) in Chickpeas (Cicer Arietinum L.) Crop Production. *Mesopotamia J. of Agric.*, **37(1):** 195–200. https://doi.org/DOI: 10.33899/magrj.2009.27388

Al-Rifai, E.Y.N. (2017). The Effect of Plant Density in The Productivity of Some Genotypes of Maize (*Zea mays* L.). *Al-Baath University Journal*, **39(8):** 111–133.

ALkhafaji, A.J.J.A.A.Al. (2011). Effect Of Seeding Speed And The Compression Force Of Loading Spring On Disc drill Performance. *Kufa Journal of Agricultural Sciences*, **3(1):** 140–148.

Badua, S.A., A. Sharda, R. Strasser, I. Ciampitti and T.W. Griffin (2018). Influence of Planter Downforce Setting and Ground Speed on Seeding Depth and Plant Spacing Uniformity of Corn. In *14th International Conference on Precision Agriculture*, 1–13.

Chen, Y.S.T.B.I. (2004). Drill and crop performances as affected by different drill configurations for no-till seeding. *Soil and Tillage Research*, **77(2):** 147–155. https://doi.org/10.1016/j.still.2003.12.001

Dawod, K.M.Z.A. (1990). *Statistical Procedures for Agricultural Researchs*. (K. M./ ; Z. A. Dawod, Ed.) (First). Mosul 41002: Higher Education Press.

Francetto, T.R. A. dos S.A.C.B.O.D. d.C.M.A.A.V. and D.P.C. (2016). Disturbance of Ultisol soil based on interactions between furrow openers and coulters for the no-tillage system. *Spanish Journal of Agricultural Research*, **14(3):** 1–10. https://doi.org/10.5424/sjar/2016143-9148

Garcia, R.F., W.G. do Vale, M.T.R. de Oliveira, E.M. Pereira, R.T. Amim and T.C. Braga (2011). Influência da velocidade de deslocamento no desempenho de uma semeadora-adubadora de precisão no Norte Fluminense. *Acta Scientiarum - Agronomy*, **33(3):** 417–422. https://doi.org/10.4025/actasciagron.v33i3.6085

Gbabo, A.A.N.E. and G.I.M. (2017). Development and Testing of a Tractor Drawn Five Row Furrow Opening Device. *Fuw trends in science & technology journal*, **2(1B):** 450–455. https://doi.org/10.13140/RG.2.2.32370.81606

Hanna, H.M.B.L.S.L.A. (2010). Soil loading effects of planter depth-gauge wheels on early corn growth. *Applied Engineering in Agriculture*, **26(4):** 551–556.

Mohammed, M.A.A. (2017). Studying The Possibility of Utilizing Grain Drill (Gaspardo Sc-250) in Planting Two Types of Different Crops. *Tikrit Journal of Agricultural Sciences*, **17(1):** 50–64.

Özmerzi, A.D.K.M.T. (2002). Effect of sowing depth on precision seeder uniformity. *Biosystems Engineering*, **82(2):** 227–230. https://doi.org/10.1006/bioe.2002.0057

Rajabo, A.A.A.S.K. (2006). *Seed Processing*. (First, Ed.), *seed Processing* (Rajabo, Ab). Mosul 41002: Ibn Al-Atheer House for Printing and Publishing, Mosul University.

Sedeeq, A.M.A.W.A.H.S. (2016). Modification Feeding Discs In Seed Direl Implement Type Nardi Working By Vacuum To Be Useful For Seeding Corn Seed In Deferent Sizes. *Journal Of Kirkuk University For Agricultural Sciences*, **7(3):** 76–86.

Virk, S.S.. J.P.F.W.M.P.G.L.P. (2020). Row-crop planter performance to support variable-rate seeding of maize. *Precision Agriculture*, **21(3):** 603–619. https://doi.org/10.1007/s11119-019-09685-3

Virk, S.S.. W.M.P.J.P.F.G.L.P. (2019). Field Validation of Seed Meter Performance at Varying Seeding Rates and Ground Speeds. *Applied Engineering in Agriculture*, **35(6):** 937–948.