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Investigation of Seed Rate Affecting Working on the Sloping Land With Sainfoin Seeds

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ABSTRACT

In this research, influences of slopes and straight position on seed norm were examined using HASSIA universal drill seeder manufacturing by TZDK. Degree of inclination was taken % 20 all slope directions (Slope directions were right, left forward and backward). Trials were conducted flat position in addition to all inclined positions of the drill seeder.
Sainfoin seeds were used in seed metering mechanism of the machine. Five different positions, two different travel speed, two different norm setting and three replications were taken account in the tests.
When the effects of slopes on seed norm are examined, following results can be obtained: seed norm increases in all slopes directions, especially backward positions in relation to flat position. This increase ranged from 5 % to 75 %. Furthermore, seed norm of 2 m/s travel speed was more than 1.5 m/s travel speed (appr. 5-8 %). Variation coefficient values, that mean homogeneity of rows, ranged from 12 % to 23 %.

Keywords: Seed norm, Sainfoin, Slope directions, Drill seeder,inclined positions

1. INTRODUCTION

There are various facilities in order to meet the needs of the growing population and better benefit from the narrow field of agriculture. One of them can be achieved by the examination of the planting mechanization, which is one of the agricultural mechanization levels and by enabling the available to be used more efficiently (Tingbo et al., 2004). Production per unit area (efficiency) will be further enhanced if the mechanization process that has indirect effects in agricultural production can be raised to the desired levels.

Thanks to emerging technologies in our country, combined seed drills that ideally provide the regularity between the fertilizer-seed and also sow both materials in different size into the soil simultaneously, are used in the cultivation of cereals. Those having these properties are called "*universal seed drills"*.

Due to the high feed value of forage legumes it has been a sainfoin attracted considerable attention. Many crops in the evaluation of catch up with the barren and dry land sainfoin is used as an important forage crop. Particularly in the improvement of pastures and forage grasses grow well in the mix. Erosion control can be utilized very effectively. Sainfoin is not abundant nectar is also a good bee pasture.

Universal planting equipment such as forage plants seeds of very small grains can sow the seeds in different sized adjustment possibilities until beans are available. In order to feed the rapidly growing population in our country with its own means of agricultural production should be increased. The uses of modern agricultural implements, among other factors play an important role in the production increase. Seeders in agricultural tools, seed depth and machines that are effective yield cultivation regularity .(Darmora, 1995).

Distribution of the seeds in the seed bed in horizontal and vertical planes and their variations, are important factors for the cultivation process is effective to directly yield (Karayel et al, 2006).

In sowing process, field tilt is one of the factors affecting the seed quality. The seed drills are desired to sow in a way that it won't be affected by the slope of the field. However, this feature is often not at the desired level. The main reason is due to the structural and functional properties of the seed drill.

In this study, sainfoin cultivation of universal seed drill with different operating positions (slopes) was investigated.

2. MATERIALS AND METHODS

In trials, Hassia D100 SD universal combined seed drill, which is manufactured by Turkish Agricultural Equipment Corporation (TZDK), is used. In seed drill machine, there is a fertilizer throwing system with fluted rollers having adjustable and fixed active areas. Some technical specifications of the machine and characteristics of planting and fertilizer throwing systems are given in Table 1 and Table 2, respectively. Also motion transmission scheme in the experimental setup of this machine is represented in Figure 1.

Table 1 Some technical specifications of the seed drill used in the experiments

Technical specifications	Value	Technical specifications	Value
Overall dimensions		Coulter disc types	Single disc
Width (mm)	2500	Coulter disc diameter (mm)	310
Height (mm)	1630	Number of coulters	19
Weight (kg)	680	Coulter arrangement	Double row
Transport width (mm)	2640	Lifting system	Mechanic
Seed hopper volume (dm^3)	250	Fertilizer shaft diameter (mm)	32
Fertilizer hopper volume (dm^3)	170	Seed shaft diameter (mm)	20
Seed and fertilizer pipe type	Bellows hose	Row spacing (mm)	132
Track width (m)	2.500	Wheel dimensions	6.00x16 AS

Table 2 Some characteristics of seed and fertilizer throwing systems in combined seed drill machine

General Features	Seed	Fertilizer
Type	Fluted roller	Fluted roller
Material	Aluminum cast	Plastic
Roller diameter (mm)	52	82
Roller length (mm)	73	27
Number of flute (mm)	10	13
Flute depth (mm)	4	5
Flute width(mm)	38	25
Rotation	Opposite to feed direction	Opposite to feed direction
Cell material	Sheet	Sheet

Table 3 The specifications of the sainfoin used in experiment

Seed type	Weight of x1000 (gr)	Density (kg/dm^3)	Moisture content (%)
Sainfoin	22.83	0.422	9.32

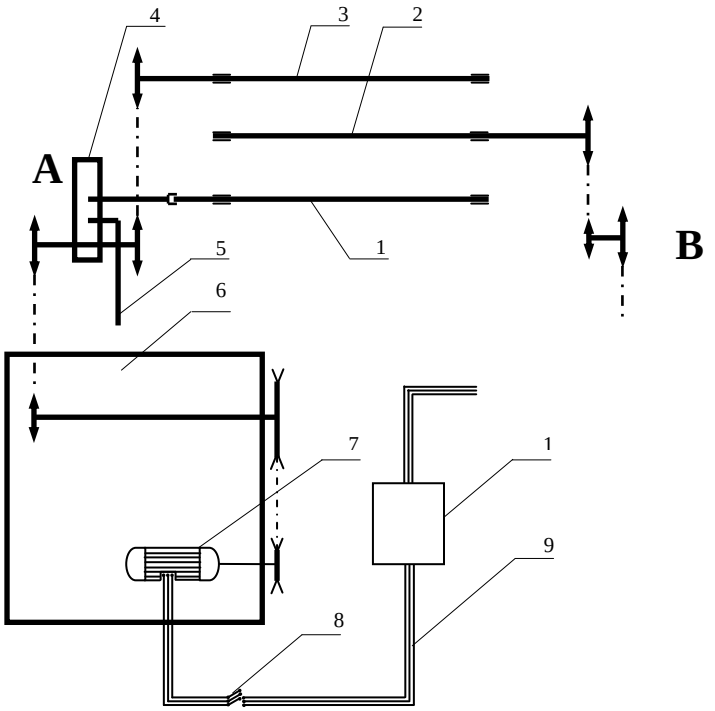
Sainfoin seed was used as seed. The trials were conducted in laboratory conditions. Seed rate can be adjusted by changing the seed drill spindle speed and active areas of fluted rollers.

Adjustable active area of the seed drill fluted roller can be seen in Figure 2. In the experiments, a precision scale with a precision of 0.01 and measurement range of 0-200 grams.

For the seed used in this study, 1000 grain weights, density and (%) moisture content were identified. Weighing with three repeat for each sample were performed and the average of three weighing was taken.

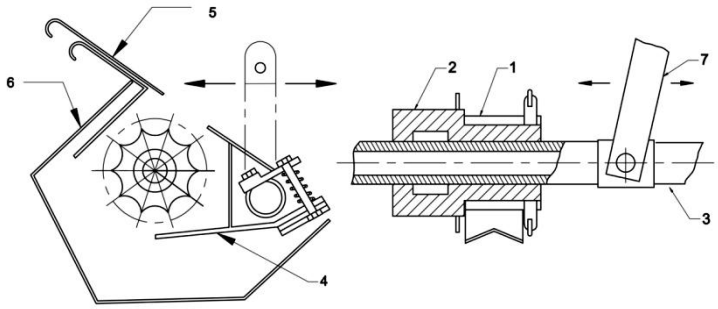
The experiments that were carried out with the seed drill system of the machine were performed in a total of 60 combinations including five different positions, two different seed norm and seed rate, and three repetitions.

Consequently, speeds were taken as V1=1.5 m/s and V2 = 2 m/s, outlet and feeding adjustments, in turn, were set to second position and fully open position, active area of the fluted rollers was set to second position and feed rate settings were taken as Q1=13 kg / ha, Q2=15 kg / ha, while the trials were performed with three repeats in five different locations. The operating positions of the machine are 5 different positions in total, including inclination of straight and 20% (11°, inclination directions are right, left, forward and backward).



1. Seed shaft
2. Fertilizer shaft
3. Mixer shaft
4. Gear box
5. Norm adjustment lever
6. Wheel
7. Three-phase motor
8. On-off switch
9. Connection line
10. SIMOVERT P motion control device

Figure 1 The experimental setup of seed drill



1- Fluted roller
2- Pusher
3- Shaft
4- Outlet adjustment cap
5- Feeding adjustment cap
6- Casing
7- Active area adjustment lever

Figure 2 Fluted rollers with adjustable active area

Trials were conducted in the Laboratory of YüzüncüYıl University, Faculty of Agriculture, Agricultural Machinery Department. The analysis of variance (ANOVA) was applied to the values pertaining to the seed taken from trials which each outlet corrugated rollers seeds collected were applied to the value of sainfoin seed. It was determined whether the differences between the selected parameters are important or not.

Coefficients of variation (CV), average ($\bar{X}$) and standard deviation (S) were obtained in order to determine the effects of feed rate and operating position on seed norm values; variance analyses were made based on the data obtained from each coulter (Shargel et al , 2015).

In order to accurately assess the CV values, which is an expression of the distribution as a percentage of the average, the variation of the values of X determined in the measurement range must be taken into consideration (Carver et al, 2011).

$$CV = \sqrt{\frac{\sum\left(X_i - \bar{X}\right)^2}{(n-1)}} \cdot \frac{100}{\bar{X}}$$

here, CV is the coefficient of variation.

In situations where the variance analysis is of importance, it is possible to investigate which factors make the same effect and which different effect by means of Duncan test (Ranalli et al., 1997).

The values of factors that are significant according to the results of the analysis of variance were entered separately into the statistical program SPSS and were subjected to Duncan test (Lingzhi et al.,2014)

3. RESULTS AND DISCUSSION

The effects of operating positions and feed rate on sainfoin seed norms for 20 rotations of wheels of the seed drill are given in Figure 3.

As can be seen in Figure 3, when the seed drill works in combination of Q1V1, variation of norm in right, left, forward and backward mode of operation is observed as 12% decrease, 5% increase, 8% decrease, 18% decrease and 5% increase, respectively. When the seed drill works in combination of Q2V1, variation of norm in right, left, forward and backward mode of operation is also observed as 10% decrease, 13% increase, 8% decrease, 18% decrease and 17% increase, respectively. So it can be concluded that the combination of Q2V1 provides more increment between the operating positions compared to the Q1V1.

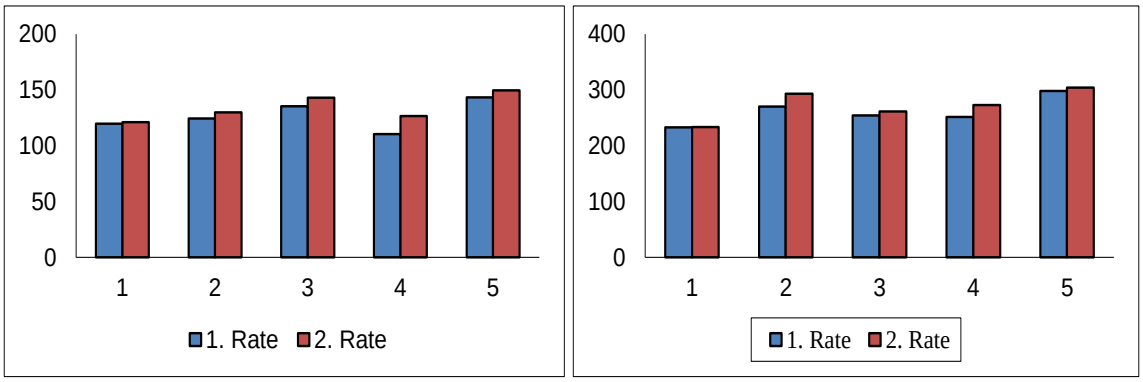


Figure 3 Total sainfoin amounts thrown away by rows for 20 rotations of wheel of seed drill based on operating positions and feed rates;
1: Right slope (11°), **2:** Left slope (11°), **3:** Straight, **4:** Forward slope (11°), **5:** Backward slope (11°)

The backward slope (5) causes to throw different amount of seeds for sainfoin. The small change is due to the scarcity of seed flow and lightness.

According to the results of the trials, percentage changes of the sainfoin norm were obtained based on the straight position (3) in order to identify the effect of the operating position and feed rate on seed norm (Figure 4).

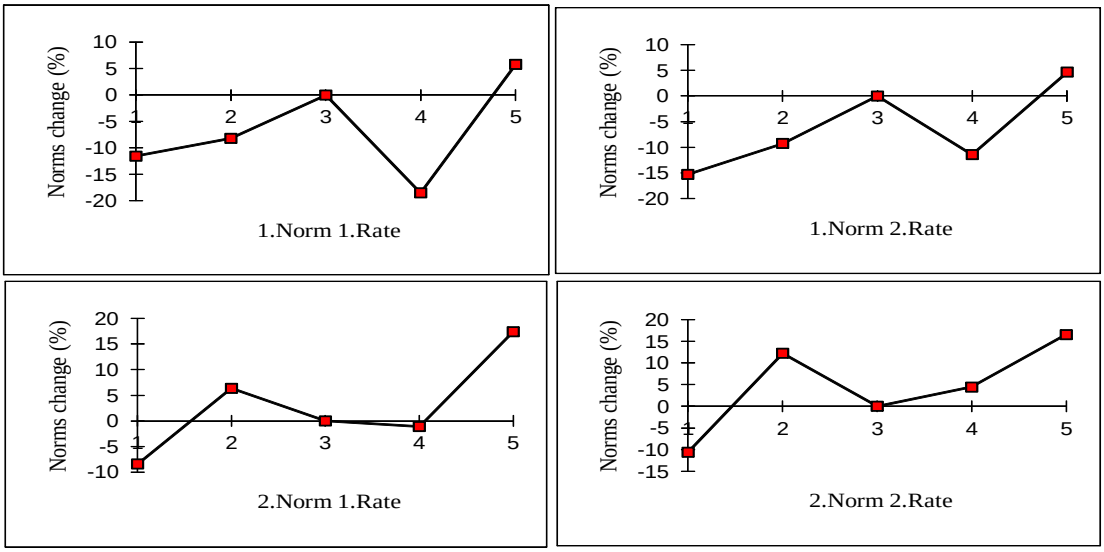


Figure 4 Proportional change in amount of the sainfoin thrown away in inclined positions based on the straight position (3);
1: Right slope (11°), **2:** Left slope (11°), **3:** Straight, **4:** Forward slope (11°), **5:** Backward slope (11°)

Distribution of the average value of three repeats performed for different amount of rows based on the operating position and feed rate is given in Figure 5.

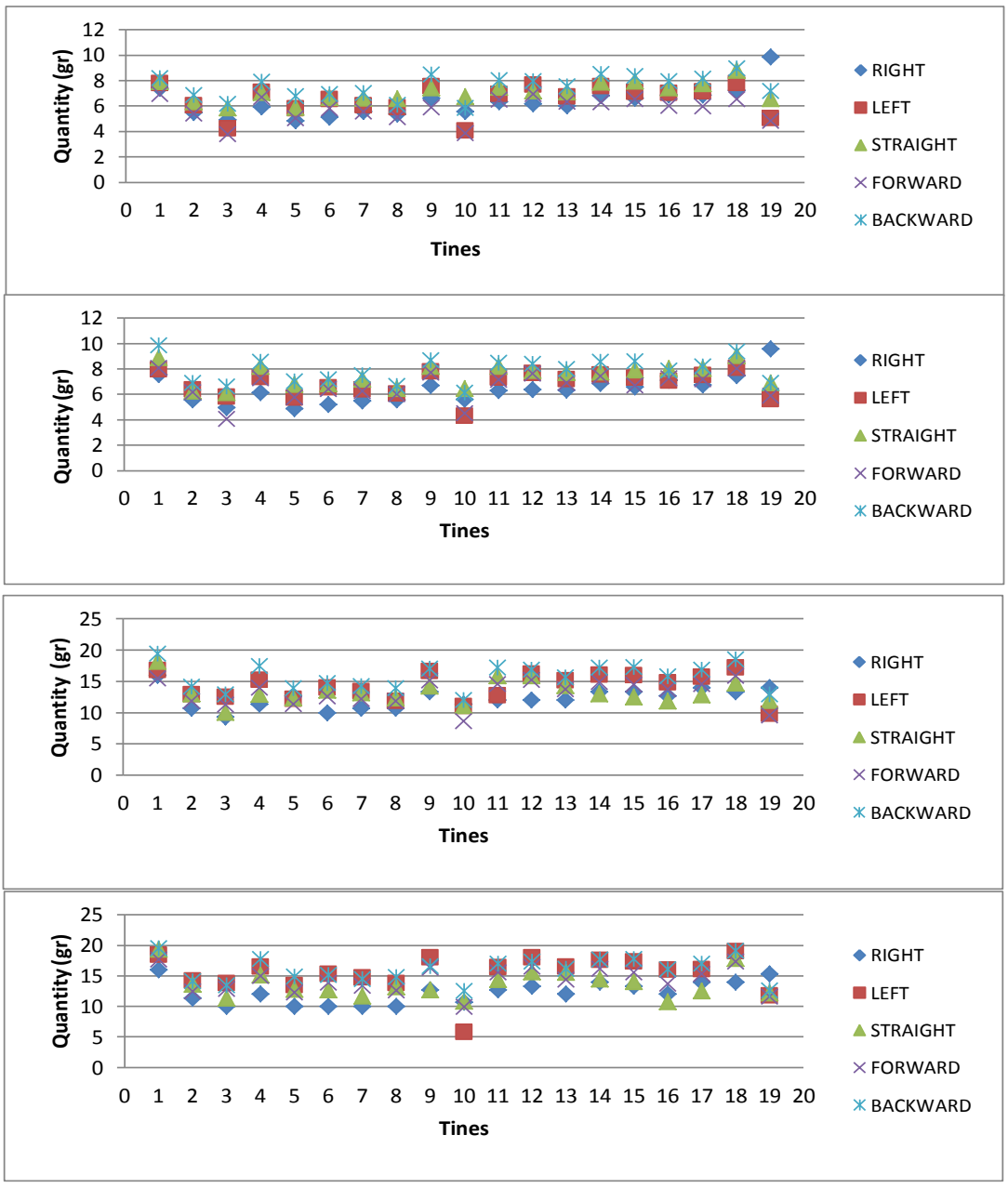


Figure 5 Distribution of the average value of three repeats performed for different amount of rows based on the operating position and feed rate

Figure 5 shows that backward slope position makes seed drill throw noticeably different amounts of seed compared to the other positions.

Coefficients of variation calculated for the positions can be seen in Table 4.

Table 4 The average of seed rates for different operating positions

POSITION	NORM 1				NORM 2				AVERAGE	
	RATE 1		RATE 2		RATE 1		RATE 2			
	$\bar{x}$	CV	$\bar{x}$	CV	$\bar{x}$	CV	$\bar{x}$	CV	$\bar{x}$	CV
RIGHT	6.30	0,19	6.37	0,17	12.25	0,17	12.28	0,16	9.30	0,36
LEFT	6.54	0,18	6.83	0,15	14.22	0,18	15.42	0,23	10.75	0,44
STRAIGHT	7.12	0,13	7.52	0,12	13.37	0,15	13.74	0,13	10.44	0,34
FORWARD	5.81	0,19	6.72	0,15	13.22	0,16	14.35	0,17	10.02	0,41
BACKWARD	7.59	0,13	7.88	0,13	15.69	0,14	16.01	0,15	11.79	0,37

In the study, coefficients of variation are found between 12% and 23% for sainfoin seeds.These limits are within the acceptable limits in the literature.

When the coefficients of variation are analyzed, it can be noticed that the lowest (CV) is provided by the straight position.

Table 5: The Analysis of Variance Results

Source	Type III Sum of Squares	df	Mean Square	F	P	
Corrected Model	15862,169[a]	19	834,851	251,045	,000	
Intercept	124763,117	1	124763,117	37517,011	,000	
rate	71,530	1	71,530	21,510	,000	**
norm	14721,743	1	14721,743	4426,916	,000	**
position	773,919	4	193,480	58,181	,000	**
Rate × norm	3,253	1	3,253	,978	,323	
rate × position	32,879	4	8,220	2,472	,043	*
norm × position	249,591	4	62,398	18,763	,000	**
rate × norm × position	9,252	4	2,313	,696	,595	
Error	3724,569	1120	3,326			
Total	144349,854	1140				
Corrected Total	19586,737	1139				

a. R Squared = ,810 (Adjusted R Squared = ,807)

(**) : $p < 0.01$, statistically very significant
(*) : $p < 0.05$, statistically significant

The effects of operating positions, feed rates and norm on the sainfoin seeds sowing were investigated by general linear model procedure and differences of averages in terms of positions are investigated by different post hoc tests.

Table 5 shows the analysis of variance applied to the data obtained from the studies performed with sainfoin seed.

According to the Table 5 it is found that rate, norm, position and norm × position × difference are have statistically very significant effect ($p < 0.01$) and rate × position has statistically significant effect ($p < 0.05$) on sainfoin seed averages. However, rate × norm and rate × norm × position interactions are found statistically insignificant ($p>0.05$).

According to analysis of variance results given by general linear model approach in Table 5, post hoc comparisons for positions are also given by Tukey HSD, Scheffe, LSD, Bonferroni and Sidak tests in Table 6. In Table 6 post hoc test results for position comparisons by all five different tests results showed that except for left-straight, straight-forward differences are found statistically significant ($p<0.01$).

Table 6: The Post Hoc Test Results For Positions

(I) Position	(J) Position	Mean Difference (I-J)	Tukey HSD	Scheffe	LSD	Bonferroni	Sidak
			P	P	P	P	P
Right	Left	-1.4550*	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	-1.1379*	**.000**	**.000**	**.000**	**.000**	**.000**
	Forward	-.7248*	**.000**	**0.001**	**.000**	**.000**	**.000**
	Backward	-2.4911*	**.000**	**.000**	**.000**	**.000**	**.000**
Left	Right	1.4550*	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	0.317	0.342	0.487	0.064	0.637	.482
	Forward	.7301*	**.000**	**0.001**	**.000**	**.000**	**.000**
	Backward	-1.0362*	**.000**	**.000**	**.000**	**.000**	**.000**
Straight	Right	1.1379*	**.000**	**.000**	**.000**	**.000**	**.000**
	Left	-0.317	0.342	0.487	0.064	0.637	.482
	Forward	0.4131	0.111	0.211	0.016	0.157	.147
	Backward	-1.3532*	**.000**	**.000**	**.000**	**.000**	**.000**
Forward	Right	.7248*	**.000**	**0.001**	**.000**	**.000**	**.000**
	Left	-.7301*	**.000**	**0.001**	**.000**	**.000**	**.000**
	Straight	-0.4131	0.111	0.211	0.016	0.157	.147
	Backward	-1.7663*	**.000**	**.000**	**.000**	**.000**	**.000**
Backward	Right	2.4911*	**.000**	**.000**	**.000**	**.000**	**.000**
	Left	1.0362*	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	1.3532*	**.000**	**.000**	**.000**	**.000**	**.000**
	Forward	1.7663*	**.000**	**.000**	**.000**	**.000**	**.000**

Table 7: The Post Hoc Test Results In Terms of Positions For Norm1

(I) Position	(J) Position	Mean Difference (I-J)	Tukey HSD	Scheffe	LSD	Bonferroni	Sidak
			P	P	P	P	P
Right	Left	9	.093	.184	**.013**	.129	.121
	Straight	.0723	.986	.992	.607	1.000	1.000
	Forward	-1.3949*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Backward	-.9851*	**.000**	**.000**	**.000**	**.000**	**.000**
Left	Right	.3508	.093	.184	**.013**	.129	.121
	Straight	.4231*	**.023**	.061	**.003**	**.027**	**.027**
	Forward	-1.0441*	**.000**	**.000**	**.000**	**.000**	**.000**
	Backward	-.6343*	**.000**	**.000**	**.000**	**.000**	**.000**
Straight	Right	-.0723	.986	.992	.607	1.000	1.000
	Left	-.4231*	**.023**	.061	**.003**	**.027**	**.027**
	Forward	-1.4672*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Backward	-1.0574*	**.000**	**.000**	**.000**	**.000**	**.000**
Forward	Right	1.3949*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Left	1.0441*	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	1.4672*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Backward	.4098*	**.030**	.076	**.004**	**.037**	**.036**
Backward	Right	.9851*	**.000**	**.000**	**.000**	**.000**	**.000**
	Left	.6343*	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	1.0574*	**.000**	**.000**	**.000**	**.000**	**.000**
	Forward	-.4098*	**.030**	.076	**.004**	**.037**	**.036**

According to analysis of variance results given by general linear model approach in Table 5, norm and norm × position interaction has statistically significant effect ($p < 0.05$) on sainfoin seed averages. For norm1, In Table 7 post hoc test results for position comparisons by all five different tests results generally showed that except for right-left and right-straight differences are found statistically significant ($p<0.05$).

Table 8: The Post Hoc Test Results In Terms of Positions For Norm 2

(I) Position	(J) Position	Mean Difference (I-J)	Tukey HSD	Scheffe	LSD	Bonferroni	Sidak
			P	P	P	P	P
Right	Left	t	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	-1.5219*	**.000**	**.000**	**.000**	**.000**	**.000**
	Forward	-3.5874*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Backward	-1.2908*	**.000**	**.002**	**.000**	**.000**	**.000**
Left	Right	2.5591*	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	1.0372*	**.008**	**.026**	**.001**	**.009**	**.009**
	Forward	-1.0282*	**.009**	**.029**	**.001**	**.010**	**.010**
	Backward	1.2683*	**.001**	**.003**	**.000**	**.001**	**.001**
Straight	Right	1.5219*	**.000**	**.000**	**.000**	**.000**	**.000**
	Left	-1.0372*	**.008**	**.026**	**.001**	**.009**	**.009**
	Forward	-2.0654*	**.000**	**.000**	**.000**	**.000**	**.000**
	Backward	.2311	.946	.968	.458	1.000	.998
Forward	Right	3.5874*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Left	1.0282*	**.009**	**.029**	**.001**	**.010**	**.010**
	Straight	2.0654*	**.000**	**.000**	**.000**	**.000**	**.000**
	Backward	2.2966*	**.000**	**.000**	**.000**	**.000**	**.000**
Backward	Right	1.2908*	**.000**	**.002**	**.000**	**.000**	**.000**
	Left	-1.2683*	**.001**	**.003**	**.000**	**.001**	**.001**
	Straight	-.2311	.946	.968	.458	1.000	.998
	Forward	-2.2966*	**.000**	**.000**	**.000**	**.000**	**.000**

According to analysis of variance results given by general linear model approach in Table 5, norm and norm ×position interaction has statistically significant effect ($p < 0.05$) on sainfoin seed averages. For norm2, In Table 8 post hoc test results for position comparisons by all five different tests results all showed that except for backward-straight differences are found statistically significant ($p<0.05$).

Table 9: The Post Hoc Test Results In Terms of Positions For Rate1

(I) Position	(J) Position	Mean Difference (I-J)	Tukey HSD	Scheffe	LSD	Bonferroni	Sidak
			P	P	P	P	P
Right	Left	9	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	-.2441	.825	.889	.287	1.000	.966
	Forward	-2.3680*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Backward	-.9719*	**.000**	**.001**	**.000**	**.000**	**.000**
Left	Right	1.1101*	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	.8660*	**.002**	**.007**	**.000**	**.002**	**.002**
	Forward	-1.2579*	**.000**	**.000**	**.000**	**.000**	**.000**
	Backward	.1382	.975	.985	.547	1.000	1.000
Straight	Right	.2441	.825	.889	.287	1.000	.966

	Left	-.8660*	**.002**	**.007**	**.000**	**.002**	**.002**
	Forward	-2.1239*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Backward	-.7278*	**.014**	**.040**	**.002**	**.016**	**.016**
Forward	Right	2.3680*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Left	1.2579*	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	2.1239*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Backward	1.3961*	**.000**	**.000**	**.000**	**.000**	**.000**
Backward	Right	.9719*	**.000**	**.001**	**.000**	**.000**	**.000**
	Left	-.1382	.975	.985	.547	1.000	1.000
	Straight	.7278*	**.014**	**.040**	**.002**	**.016**	**.016**
	Forward	-1.3961*	**.000**	**.000**	**.000**	**.000**	**.000**

According to analysis of variance results given by general linear model approach in Table 5, rate and rate ×position interaction has statistically significant effect ($p < 0.05$) on sainfoin seed averages. For rate1, In Table 9 post hoc test results for position comparisons by all five different tests results all showed that except for right-straight and left-backward differences are found statistically significant ($p<0.05$).

Table 10: The Post Hoc Test Results In Terms of Positions For Rate2

(I) Position	(J) Position	Mean Difference (I-J)	Tukey HSD	Scheffe	LSD	Bonferroni	Sidak
			P	P	P	P	P
Right	Left	9	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	-1.2055*	**.000**	**.000**	**.000**	**.000**	**.000**
	Forward	-2.6143*	**.000**	**.000**	**.000**	**.000**	**.000**
	Backward	-1.3039*	**.000**	**.000**	**.000**	**.000**	**.000**
Left	Right	1.7998*	**.000**	**.000**	**.000**	**.000**	**.000**
	Straight	.5943	.132	.240	.019	.193	.177
	Forward	-.8145*	**.012**	**.036**	**.001**	**.014**	**.014**
	Backward	.4959	.288	.430	.051	.507	.406
Straight	Right	1.2055*	**.000**	**.000**	**.000**	**.000**	**.000**
	Left	-.5943	.132	.240	.019	.193	.177
	Forward	-1.4088*	**.000**	**.000**	**.000**	**.000**	**.000**
	Backward	-.0984	.995	.997	.698	1.000	1.000
Forward	Right	2.6143*	**.000**	**.000**	**.000**	**.000**	**0.000**
	Left	.8145*	**.012**	**.036**	**.001**	**.014**	**.014**
	Straight	1.4088*	**.000**	**.000**	**.000**	**.000**	**.000**
	Backward	1.3104*	**.000**	**.000**	**.000**	**.000**	**.000**
Backward	Right	1.3039*	**.000**	**.000**	**.000**	**.000**	**.000**
	Left	-.4959	.288	.430	.051	.507	.406
	Straight	.0984	.995	.997	.698	1.000	1.000
	Forward	-1.3104*	**.000**	**.000**	**.000**	**.000**	**.000**

According to analysis of variance results given by general linear model approach in Table 5, rate and rate × position interaction has statistically significant effect ($p < 0.05$) on sainfoin seed averages. For rate1, In Table 10 post hoc test results for position comparisons by all five different tests results all showed that except for left-straight, left-backward and backward-straight differences are found statistically significant ($p<0.05$).

When the *position x norm* interaction in the norm 1 in Table 7is viewed, it can be said that there are no differences statistically among seed norm changes between for right and left and right and straight slope positions. In the Norm 2 in Table 8 also no statistical difference is observed between the backward and straight positions.

When *position x rate* interaction is viewed in Table 9 and Table 10, it can be said that there is no seed norm changes between the feed rates in straight and right, and left and backward slope positions at rate 1, but seed norm changes for the feed rates in the backward and left, straight and left and straight slope position is of importance At rate 2.

CONCLUSIONS

These studies indicate that operating position, feed rate and norm are the effective factors on sainfoin seed norm and also as can be seen in Figure 3 and 4, the backward slope position is affected by yielding the most dissimilar norm change. In the case of backward inclined conditions, the outlet mouth adjustment cover (part 4 in **Figure 2**) must be replaced with a new adjustment lid design which will be convex or reveal in order to affect the seed planter more.

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