J. Agric. Sci. Mansoura Univ., 33(8): 5791 - 5808, 2008

UNCERTAINTY EVALUATION OF SEEDING RATE DURING LABORATORY TESTING OF SEED DRILL

Aboukarima, A. M. ; S. N. Abd El Halim and H. A. Morghany
Agric. Eng. Res. Inst., Agric. Res. Center, Ministry of Agric. and Land Reclamation

ABSTRACT

The government of Egypt encouraged the agricultural sector to enhance its strategic directions to achieve higher rate of agricultural output growth through different ways. One of these ways is enhancing possibilities of the testing laboratories overseen by Ministry of Agriculture and Land Reclamation by taking accredited steps acording to ISO 17025. However, ISO 17025 states testing laboratories shall have and shall apply procedures for estimating uncertainty of measurement. In order to improve the comparability of the testing results from different testing laboratories and give a reliable result on the basis of a specific standard, it is essential to evaluate and analyze the uncertainties related to measuring devices errors and test procedure.The testing laboratories of agricultural machines play important role to verify declarations/claims of the manufacturer/applicant for performance characteristics of machines that are in or ready for commercial production. The objectives of this study are to evaluate sources of uncertainty in measuring seed rate and to illustrate the effect of simulated forward speed and seeder opening on seeding rate. Simulated forward speed and seeder opening had significant effect on seeding rate. Increasing simulated forward speed resulted in increasing the seeding rate (g/s). The discussion and results presented focus on uncertainty related to seeding rate with unit of g/s and their estimation based on Type A and Type B methods. The Type A uncertainty was affected by treatments and had average value of 0.247 g/s. Meanwhile, the Type B uncertainty was affected by sensitivity coefficients and measuring instruments. The results are reported at k =2 for approximately 95% confidence level and the expanded uncertainty had average value of ± 0.633 g/s. The results showed that the measurement uncertainty in seeding rate was mainly caused by the adjustments of seed drill before test, and the instruments contributed a little to the measurement uncertainty of seeding rate. This finding implies that if uncertainty estimates are included with measured data sets and adequately communicated to researchers and decision makers, then optimal monitoring agricultural machine design will result.

INTRODUCTION

The government of Egypt encouraged the agricultural sector to enhance its strategic directions to achieve higher rate of agricultural output growth through different ways. One of these ways is enhancing possibilities of the testing laboratories overseen by Ministry of Agriculture and Land Reclamation. The testing wing of agricultural machines is belonged to Agricultural Engineering Research Institute (AEnRI). The tests are aimed to verify declarations/claims of the manufacturer/applicant for performance characteristics of machines that are in or ready for commercial production. AEnRI acts as an important link between manufacturers and users of agricultural machines as well as other agencies responsible for the introduction and popularization of farm equipments. Tests are carried out for providing confidential information on the performance of the machine, whether ready for commercial production or not or to provide any specific data that may be required by the manufacturer/applicant. The testing laboratories of AEnRI are equipped with specialized and scientific equipments/instruments for conducting various tests on a wide range of agriculture machines. To enhanch the posibilities of laboratories of the AEnRI, accredited steps acoording to ISO 17025 (2005) were taken. However, ISO 17025 states "testing laboratories shall have and shall apply procedures for estimating uncertainty of measurement". Also, ISO 17025 states "when estimating the uncertainty of measurement, all uncertainty components which are of importance in the given situation shall be taken into account using appropriate methods of analysis. In order to improve the comparability of the testing results from different testing laboratories and give a reliable result on the basis of a specific standard, it is essential to evaluate and analyze the uncertainties related to measuring devices errors and test procedure (Tang *et al.*, 2006).

Amount of seeds in rows is an important factor in crop production, which can affect growth and yield and this to a great extent depends on the performance of the metering mechanism of the seed drill/planter (Raheman and Singh, 2003). Therefore, testing of a seed drill/planter is an essential job to show the performance characteristics which affect seeding rate, seeding distribution…ect. For testing seed drill inside the laboratory, Bahnasy *et al.* (2007) developed simple unit for calibration and testing seed drills. The results showed that, the developed unit had ability to move the ground wheel with stable revaluations and the relative ease with which the unit is adjusted in the laboratory suits the technical know how of the factors affected on the imported or locally made seed drills could be studied. However, there are different factors like traveling speed, tire inflation, seeder drive wheel slippage; differences in the seeds affect the seeding rate (Hendawy, 1996). Also, testing of a seed drill in the field is costly and very difficult. Thus, a suitable laboratory setup is therefore needed to test a seeding drill to indicate its performance in easy way.

During testing the seed drill and to comply with ISO 17025 policies the laboratory must identify and estimate uncertainty for all quantitative measurements. Uncertainty is defined as the interval about the measurement or result that contains the true value for a given confidence interval Uncertainty arises as a result of random errors (Boriack *et al.*, 2004). The measurement uncertainty is defined as the parameter associated with the result of a measurement characterizing the dispersion of the value that could reasonably be attributed to the measurand. The object of a measurement is to determine the ‘‘true value’’ of a measurand. The true value is an ideal result that one could obtain only by means of a perfect measurement. A real measurement is affected by errors. Even if all the errors could be evaluated and corrected, there still remains an uncertainty about the result of the measurement that should be considered only as an estimation of the measurand (Tang *et al.*, 2006 and Husain and An-Nahdi, 2000).

Jaiswal *et al.* (2004) reported that the uncertainty of measurement means doubt about the validity of the result of a measurement. The statement of the result is complete only if it contains both the value attributed to the measurand and the uncertainty of measurement associated with the value. It is understood that the result of the measurement is the best estimate of the value of measurand and that all components of uncertainty contribute to the dispersion. Bair and Rombouts (2006**)** reported that combined and expanded uncertainties of mass flow rate were 3.13 mg, 3.14 mg, 4.45 mg and 6.21 mg at of 0.2 mg/s, 10 mg/s, 100 mg/s and 200 mg/s flow rates, respectively**.**

Fig. (1) illustrates procedure for evaluating uncertainty of measurement according to International Standardization Organization (1995). Adams (2002) made summary of the calculation method of uncertainty as follows (1) Specify the measurand, (2) Derive the mathematical model, (3) Quantify the influence quantities, (4) Evaluate the standard uncertainty of each influence quantity, (5) Evaluate sensitivity coefficients and covariances, (6) Calculate the measurement result, (7) Determine the combined standard uncertainty, (8) Determine the expanded uncertainty, and (9) Reporting uncertainty**.**

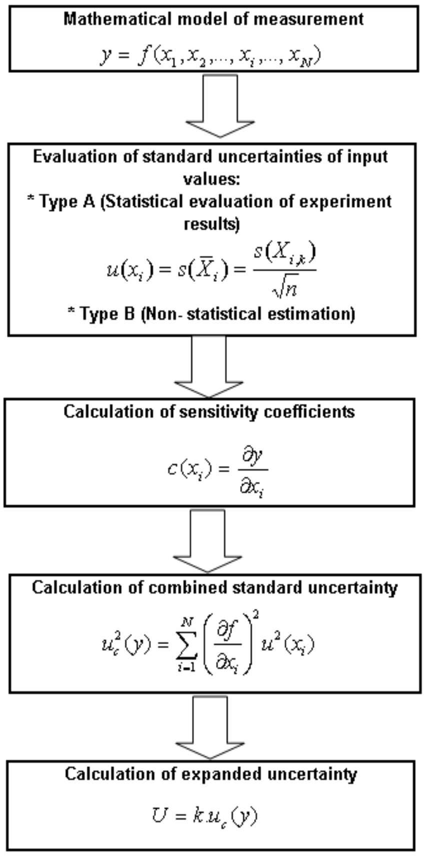

Fig. (1): Procedure for evaluating uncertainty of measurement according to International Standardization Organization (1995).

The objectives of this study are to evaluate sources of uncertainty in seeding rate during test a seeder and to illustrate the effect of forward speed and seeder opening (the opening distance on metering mechanism which the seeds were dropped in the seed drill tubes) on seeding rate. However, if uncertainty estimates are included with measured data sets and adequately communicated to scientists, public interests, and decision makers, then optimal monitoring machine design will result.

EQUIPMENT, PROCEDURES AND METHODS

Description of the seed drill under test:

Seed drill (Tye model No. 104-4220) was used during seeding rate test. Spacing between seeder units is 20.3 cm. The circumference of the ground drive wheel is 2.41 m. The seeder shaft is driven by different sprockets system through the ground wheel as shown in Fig. (2).The seeds get off from seed box by molded plastic seeder (metering mechanism) having different opening settings. The seeding rate was controlled by loosen the locknut on the end of the seeder shaft, and turn the wheel handle as shown in Fig. (2) to open or close the opening settings. In this study, three seeder opening (the opening distance on metering mechanism which the seeds were dropped in the seed drill tubes) were investigated namely, H1 = 10 mm, H2 = 14 mm and H3 = 21 mm. These openings were measured by calibrated Tye measure No. 501-098. Five tubes were selected to collect the seeds during test, so the working width of seed drill was (b = 101.5 cm).

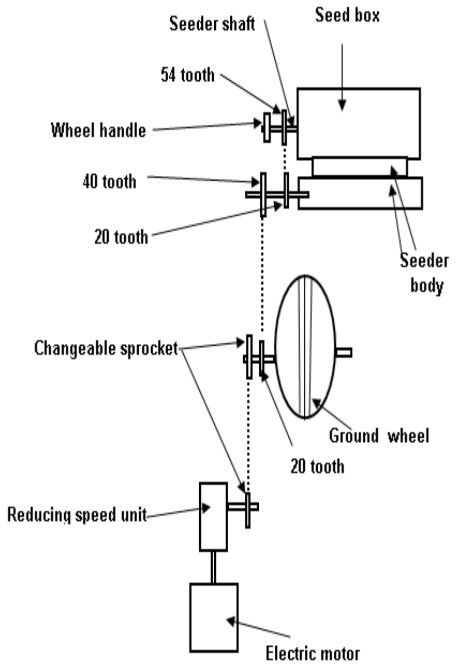

Fig. (2): The laboratory arrangements to drive seeder shaft.

Instrumentation:

Calibrated digital balance with maximum capacity of 3100 g was used to determine the mass of the seeds dropped from five tubes. Calibrated digital stopwatch was used to record test time. A calibrated cloth tape was used to measure the circumference of the ground wheel. Rotational speeds were recorded using speed meter. The grain moisture content was measured using calibrated device Wile35 model (Finland). The seed drill working width was measured by calibrated steel tape. Table (1) lists the specifications of the used instruments in this study during testing the seed drill.

Table (1): Specifications of the used devices during testing the seed drill.

Device	Model and made	Resolution	Uncertainty$	Calibration error
Digital balance*	PM 30 (Germany)	0.01 g	±0.006 g	-----
Digital stopwatch	Radioshack (China)	$\frac{1}{100}$ sec	$\pm 1\frac{1}{100}$ sec	-----
Cloth tape	Giahtdragon l (China)	1 cm	-----	+ 4 mm
Steel tape	VARIO5m (Germany)	1 mm	-----	+ 0.3 mm
Speed meter	Hasler Bern (Switzerland)	1 rpm	N.A.	N.A.
Grain moisture meter	Wile35 model (Finland)	1%	±1%	------

***The uncertainty of mass determination of the balance (mg) is = ± 0.006 g.**
N.A : not available.
$ Uncertainty according to calibration certificate.

Treatments:

The treatments during testing the seed drill included seven different simulated forward speeds and three seeder openings. The simulated forward speeds were obtained by using developed setup using electric motor and reducing speed unit. The speed of the electric motor was 1500 rpm and the speed of the reducing speed unit shaft was 22 rpm. Different sprockets were selected on the reducing speed unit shaft and ground wheel shaft to get different rotational speeds as shown in Table (2).

Table (2): The simulated forward speeds during test.

No. of tooth of the sprocket on the reducing speed unit shaft	No. of tooth of the sprocket on the ground wheel shaft	No. of revolutions of the ground wheel shaft (N_1)	SFS	SFS symbol
(---)	(---)	(rpm)	(km/h)	(---)
20	54	8.15	1.18	V1
20	40	11.00	1.59	V2
40	54	16.30	2.36	V3
40	40	22.00	3.18	V4
54	40	29.70	4.29	V5
40	20	44.00	6.36	V6
54	20	59.40	8.59	V7

SFS: Simulated forward speed

Table (3) lists the symbol and name of each treatment under test. The simulated forward speed could be calculated as follows:

$$V = \frac{N_1 \times P \times 60}{1000} \quad (km/h) \qquad (1)$$

Where N_1 is number of revolutions of the ground drive wheel (rpm) and P is the circumference of the ground drive wheel (m).

Table (3): Symbols and name of combined treatments under test.

SFS	SP	Treatment symbol	SFS	SP	Treatment symbol	SFS	SP	Treatment symbol
V1	H1	T1	V1	H2	T8	V1	H3	T15
V2	H1	T2	V2	H2	T9	V2	H3	T16
V3	H1	T3	V3	H2	T10	V3	H3	T17
V4	H1	T4	V4	H2	T11	V4	H3	T18
V5	H1	T5	V5	H2	T12	V5	H3	T19
V6	H1	T6	V6	H2	T13	V6	H3	T20
V7	H1	T7	V7	H2	T14	V7	H3	T21

SP: Seeder opening.

Test procedure:

The laboratory experimental work and measurements were carried out in the Farm Tractors and Machinery Research & Test Station at Alexandria Governorate. The tests were conducted with the aid of the developed setup as shown in Fig. (3) as static test. The seed box above the five tubes was half filled with wheat seeds. The seed drill was held in the vice to free the drive wheel. Plastic box were placed on each of the discharge tubes to collect the deposited seeds. The seeding rate was adjusted using different combination treatments as shown in Table (3). Each test was completed in 30 sec and repeated five times. Commercial wheat seeds were brought from local market with average moisture content of 13.4% d.b to be used in the tests. The main physical properties of the used wheat seeds are presented in Table (4). The seeding rate (q, g/s) was calculated as follows:

$$q = \frac{W}{30} \quad (g/s) \qquad (2)$$

Where, W is the total mass of the deposited wheat seeds from 5 tubes of the seed drill (g). Meanwhile, the seeding rate (Q, kg/fed) was calculated as follows:

$$Q = \frac{W \times 4.2}{T \times V \times b} \quad (kg/fed) \qquad (3)$$

Where T is the test time (sec), b is the seed drill working width (m), V is forward speed (m/s) and 4.2 is conversion factor. Coefficient of variation (CV, %) was evaluated to reflect the sensitivity of the seed drill test. It was calculated as follows (ASAE Standards, 2004):

$$CV = \frac{s}{Q_{mean}} \times 100 \quad (\%) \qquad (4)$$

Where s is standard deviation of seeding rate (kg/fed) and Q_{mean} is the mean of seeding rate (kg/fed).The error in seeding rate was calculated according to ISO (1984) as follows:

$$E = \frac{Q_{max} - Q_{min}}{Q_{mean}} \times 100 \qquad (\%) \ldots\ldots\ldots\ldots\ldots\ldots \qquad (5)$$

In this study, the tolerance of the error during test is assumed to be less than or equal the coefficient of variation (CV).

Table (4): Main physical properties of the used wheat seeds.

Bulk density (kg/m^3)	Mass of 1000 seed (g)	Seed dimensions* (mm) Mean value ± s$		
742.98 ± 23.40	46.16 ± 0.93	Length	:	6.97 ± 0.36
		Width	:	3.73 ± 0.20
		Thickness	:	3.11 ± 0.15

*** Seed dimensions shown are the averages of 100 measurement trails.**
$ s is standard deviation.

Fig. (3): Developed setup using electric motor and reducing speed unit to drive the ground wheel shaft during laboratory test of seed drill.

Statistical analysis:

The data for seeding rate were statistically analyzed, using two-way analysis of variance (ANOVA) for the randomized complete design with five replicates. The used software was SAS (1986) using ANOVA procedure. Comparisons among treatment means, when significant, were conducted using least significant difference (LSD) at p = 0.05 level

Evaluation of uncertainties:

In general, the uncertainties can be classified into two types, namely, Type A and Type B uncertainties (Tang *et al.*, 2006). The former are the uncertainties determined by statistical means based on a number of repeated measurements under the same conditions, and the later derive from the calculation of uncertainties over the whole measurement by taking into account all available data, such as sensor uncertainty, data logger uncertainty and accuracy of instruments or sensors etc.

Type A evaluation of standard uncertainty:

The Type A evaluation of standard uncertainty is the method of evaluation by the statistical analysis of observations. The Type A standard uncertainty *u* (x_i) associated with the mean of *n* independent observations X_i is the estimated standard deviation of the mean given as follows:

$$u(x_i) = s(\overline{X}_i) = \frac{s(X_{i,k})}{\sqrt{n}} \qquad (6)$$

Where s is standard deviation and could be calculated as follows:

$$s = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \overline{X}_i)^2}{(n-1)}} \qquad (7)$$

By nature, Type A uncertainties depend on specific conditions of the test (Mathioulakis *et al.*, 1999).

Type B evaluation of standard uncertainty:

Some uncertainty contributors cannot be evaluated statistically, or else a statistical evaluation would be impractical, or a statistical evaluation may simply be unnecessary. In these cases, the magnitude and associated uncertainty of an influence quantity has to be estimated based on past experience, taken from a handbook, extracted from a calibration report, etc. Estimates obtained in this way are called type B estimates. “Type B” does not refer to the nature of the uncertainty contributor itself; in particular, the reader should avoid the temptation to identify type B uncertainty estimates as “systematic” components of uncertainty.

The uncertainty due to the finite resolution (u_R)of digital indicating devices is a common uncertainty contributor. If the resolution of the device is *L* then we know that an indicated value *x* could lie anywhere between *x* ± 0.5*L*. Further, unless there’s some reason to believe otherwise, we can assume that the sensed value has an equal probability of lying anywhere within that interval. In this case the rectangular distribution is a good model for the uncertainty due to finite resolution and the standard uncertainty due to the finite resolution of the indicating device is as follows according to Adams (2002):

$$u_R = \frac{0.5 \times L}{\sqrt{3}} \qquad (8)$$

The rectangular distribution is frequently used in cases where the actual distribution is unknown. This is often the case in Type B uncertainty estimates where the value and associated uncertainty of an uncertainty contributor might be taken from a reference book (Adams, 2002). For containment limits ±*a*, the standard uncertainty estimates associated with the various probability distributions are as follows:

Rectangular $= \frac{a}{\sqrt{3}}$ ………………………………………………… (9)

Sensitivity coefficients:

Sensitivity coefficients are essentially conversion factors that allow one to convert the units of an input quantity into the units of the measurand. Sensitivity coefficients are also, and more importantly, measures of how much change is produced in the measurand by changes in an input quantity. Mathematically, sensitivity coefficients are obtained from partial derivatives of the model function *f* with respect to the input quantities. The model function for the seeding rate determination is as follows:

$$q = \frac{W}{T}$$

So, coefficients of sensitivity could be obtained as follows:

$$c_W = \frac{\partial q}{\partial W} = \frac{1}{T} = \frac{q}{W}$$

$$c_T = \frac{\partial q}{\partial T} = \frac{-W}{T^2} = \frac{-q}{T}.$$

The average seed mass (W) for each treatment is available form measurements, the test time (T) is 30 s and the average of seeding rate (q) for each treatment is available by calculation. With these values, the values of each of sensitivity coefficients could be determined. Table (5) shows the sensitivity coefficients for each treatment during seed drill test.

Combining the contributors:

I- Non-correlated input quantities:

Once all of the values of the uncertainty contributors u_i have been estimated and reduced to one standard deviation, and the sensitivity coefficients c_i have been determined, it is usually necessary only to “root-sum-square” their products, i.e., take the square root of the sum of the squares of the uncertainty estimates multiplied by the squares of their corresponding sensitivity coefficients, in order to determine the combined standard uncertainty u_c (Adams, 2002):

$u_c = \sqrt{\sum_i c_i^2 u_i^2}$ …………………………………………………… (10)

II- Correlated input quantities:

An important complication arises when input quantities are correlated. Correlation occurs when the values of input quantities are not independent. In this case, amongst the input quantities are the uncertainties of the various combinations of dead weights and these uncertainties are correlated- the errors from the calibration lab are passed on to the calibration uncertainty of each of the weights which in turn impact the uncertainty of the load cell calibration. Correlated input quantities are common in testing so, although the subject is complicated, we have no choice but to examine how to handle them **(Adams, 2002**). In the case of correlated input quantities, the combined variance is given as follows:

$$u_c = \sqrt{\sum_{i=1}^{n} c_i^2 u_i^2 + 2\sum_{i=1}^{n-1}\sum_{j=i+1}^{n} c_i c_j u_i u_j r(x_i, x_j)} \quad (11)$$

The correlation coefficient *r* (x_i, x_j) characterizes the degree of correlation between the input quantities x_i and x_j. For noncorrelated (independent) input quantities, *r* will be equal to zero. For perfectly correlated input quantities *r* will equal ±1. For varying degrees of correlation, *r* will vary between +1 and –1. In this study, the correlation was ignored (r =0), and then we obtain for the combined standard uncertainty as follows:

$$u_c = \sqrt{c_W^2 u_W^2 + c_T^2 u_T^2} \quad (12)$$

Table (5): Sensitivity coefficients for each treatment during seed drill test.

Treatment	Sensitivity coefficients		Treatment	Sensitivity coefficients	
	c_W	c_T		c_W	c_T
	(g/ s. g)*	**(g/ s. s)**		**(g/s .g)**	**(g/s.s)**
T1	0.033	-0.064	T12	0.033	-0.468
T2	0.033	-0.111	T13	0.033	-0.216
T3	0.033	-0.173	T14	0.033	-0.404
T4	0.033	-0.100	T15	0.033	-0.621
T5	0.033	-0.154	T16	0.033	-0.389
T6	0.033	-0.228	T17	0.033	-0.590
T7	0.033	-0.123	T18	0.033	-0.883
T8	0.033	-0.224	T19	0.033	-0.419
T9	0.033	-0.351	T20	0.033	-0.748
T10	0.033	-0.163	T21	0.033	-1.178
T11	0.033	-0.297			

*** c_W is constant because the test time was constant at 30 sec.**

Calculating the expanded uncertainty:

The additional measure of uncertainty that encompasses a large fraction of expected values of the measurand is called expanded uncertainty and is denoted by *U*. The expanded uncertainty *U* is obtained by multiplying the combined standard uncertainty by a coverage factor *k* (Adams, 2002):

$$U = k \times u_c(y) \quad (13)$$

In this study, coverage factor *k* assumed to be 2. This encompass approximately 95% of the possible values of the measurand (95% is just a conventional level of confidence), it is usually the case that the coverage factor *k* will be a number in the range of 2 to 3.

Uncertainty budgets:

Every uncertainty analysis will include some assumptions and it is important that these assumptions be documented and justified. It is, unfortunately, common practice to regard uncertainty analysis as the pursuit of an "uncertainty budget".

RESULTS AND DISCUSSION

Seeding rate and flow evenness:

Seeding rate (g/s and kg/fed) and flow evenness (CV, %) were determined for each treatment. The analyses of variance for these values are presented in Table (6).

Table (6): Source of variation, degree of freedom (d.f) and probability (P-values) from ANOVA seeding rate.

Seeding rate (kg/fed)					
Source of variation	**d.f**	**Sum of Square**	**Mean Square**	**F Value**	**Pr > F**
Model	24	28385.35	1182.72	1684.73	0.0001
Error	80	56.16	0.70		
Corrected Total	104	28441.51			
Source of variation	**d.f**	**ANOVA SS**	**Mean Square**	**F Value**	**Pr > F**
Replications	4	1.75	0.44	0.62	0.6466
(V)	6	174.53	29.09	41.44	0.0001
(H)	2	28027.22	14013.61	19961.74	0.0001
$V \times H$	12	181.85	15.15	21.59	0.0001
Seeding rate (g/s)					
Source of variation	**d.f**	**Sum of Square**	**Mean Square**	**F Value**	**Pr > F**
Model	24	7544.14	314.34	11530.83	0.0001
Error	80	2.18	0.03		
Corrected Total	104	7546.32			
Source of variation	**d.f**	**ANOVA SS**	**Mean Square**	**F Value**	**Pr > F**
Replications	4	0.06	0.01	0.52	0.721
(V)	6	4925.66	820.94	30114.45	0.0001
(H)	2	1903.05	951.52	34904.51	0.0001
$V \times H$	12	715.38	59.62	2186.84	0.0001

V is simulated forward speed **H is seeder opening**

This table shows that, the simulated forward speed and seeder opening and the interactions had a significant effect ($P < 0.01$) on seeding rate. The performance curves obtained from these values are presented in Figs. (4 through 6). In general, the seeding rate (g/s) increased as the simulated forward speed and seeder opening increased. The seeding rate values were between 1.93 and 35.34 g/s (Fig. 4).

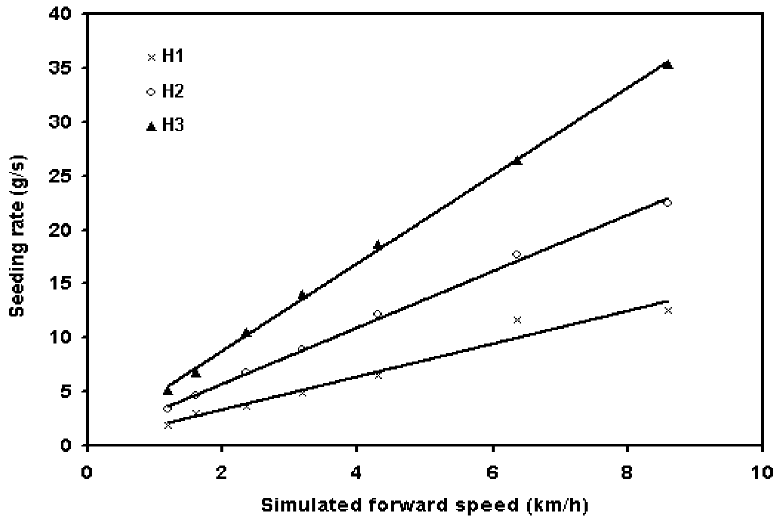

Fig. (4): Effect of simulated forward speed and seeder opening on average seeding rate (g/s).

In general, the seeding rate (kg/fed) decreased as the simulated forward speed increased and increased as seeder opening increased. The seeding rate values were between 21.81 and 65.58 kg/fed (Fig. 5). The values of CV varied from 2.57% to 10.53% as listed in Fig. (6). However, the values of CV between 10% and 20% were considered “acceptable,” the values between 5% and 10% “good,” and the values less than 5% “very good.” (Guler, 2005a, 2005b).

As seen Fig (6), the values of CV decreased with increases in the simulated forward speed and seeder opening. In general, the CV values obtained from the tests were within the acceptable limits for all treatments. Table (7) lists mean seeding rate as affected by simulated forward speed and seeder opening. It is obvious that, there is significant effect of simulated forward speed on seeding rate. However, the forward speed (V7) gave higher seeding rate in g/s and smaller seeding rate in kg/fed. Generally, seeder opening (H3) gave higher both seeding rate in different units.

Seeding rate error and tolerance percentage:

By using Eq. (5) for determining seeding rate errors and as shown in Fig. (7), there is no trend for seeding rate error. The error values were between 0.72 and 11.30 % as listed in Fig. (7). The error values obtained from the tests were within the tolerance limits for all treatments. But, only the values of seeding rate error obtained from T4, T7, T9 and T19 were above tolerance limits. However, T4 treatment is a combination of simulated forward speed of 3.18 km/h and 10 mm seeder opening, T7 treatment is a combination of simulated forward speed of 8.59 km/h and 10 mm seeder opening, T9 treatment is a combination of simulated forward speed of 1.59 km/h and 14 mm seeder opening and T19 treatment is a combination of simulated forward speed of 4.29 km/h and 21 mm seeder opening.

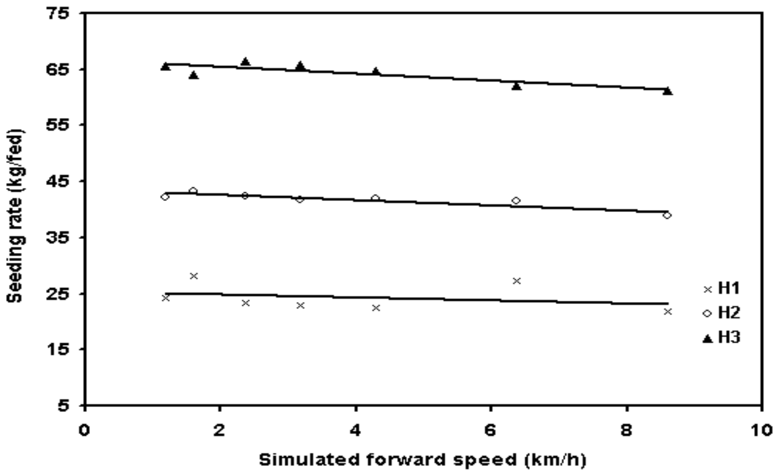

Fig. (5): Effect of simulated forward speed and seeder opening on average seeding rate (kg/fed).

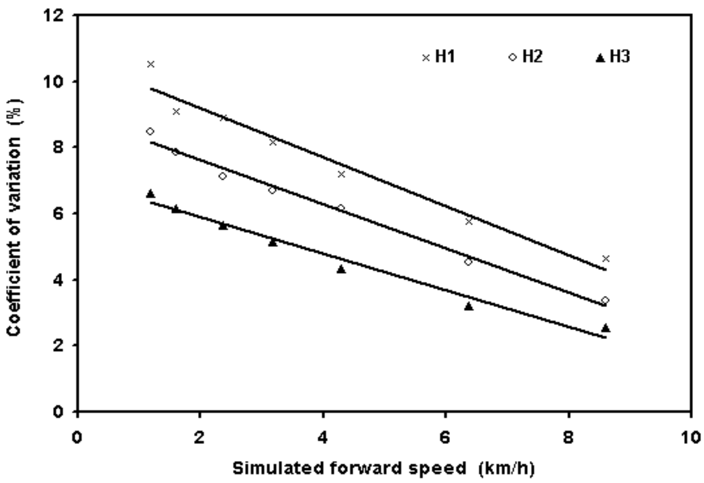

Fig. (6): Effect of simulated forward speed and seeder opening on coefficient of variation of seeding rate.

Table (7): Mean seeding rate as affected by simulated forward speed and seeder opening.

	Mean seeding rate+	
	(kg/fed)	**(g/s)**
V7	40.68e	23.48a
V6	43.59bcd	18.62b
V5	43.06d	12.41c
V4	43.44cd	9.28d
V3	44.14b	6.98e
V2	45.18a	4.82f
V1	44.03cb	3.48g
LSD (5%)	0.61	0.12
H3	64.25a	16.72a
H2	41.74b	10.84b
H1	24.34c	6.32c
LSD$ (5%)	0.39	0.08

+ Means followed by different letters in each column are significantly different at P = 0.05.
$ LSD = least significance difference.

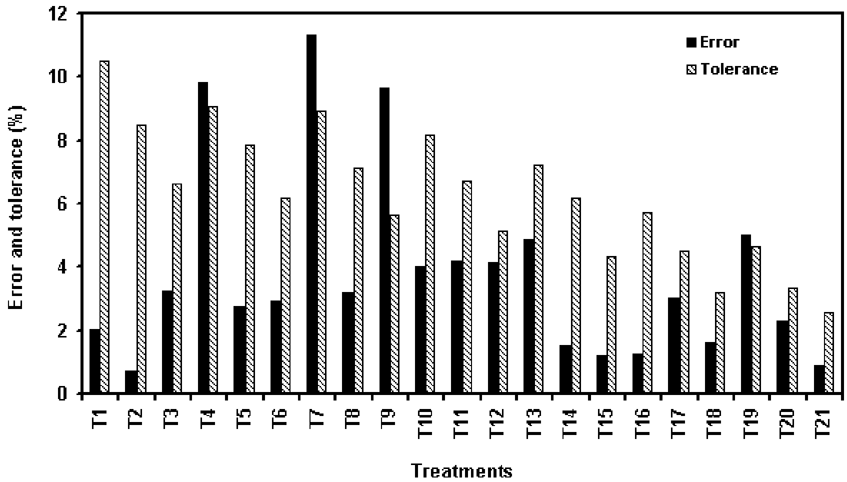

Fig. (7): Effect of treatments on error of obtained seeding rate (kg/fed).

Evaluation of uncertainty:

Type A evaluation of standard uncertainty:

Five readings were taken for seeding rate (q, g/s). For T1 treatment, the average of seeding rate was 1.93 g/s and the experimental standard deviation was 0.20 g/s. By applying Eq. (6), the Type A standard uncertainty of q (repeatability) is:

$$u_q = \frac{0.2}{\sqrt{5}} = 0.0907 \quad g/s$$

This procedure was undertaken for all treatments and Table (8) lists Type A uncertainty for all treatments during testing the seed drill. The Type A uncertainty values were between 0.09 and 0.41 g/s (Table 8) with overall average of 0.25 g/s.

Table (8): Type A uncertainty for different treatments during testing the seed drill.

Treatment	Type A (g/s)	Treatment	Type A (g/s)	Treatment	Type A (g/s)
T1	0.091	T8	0.214	T15	0.360
T2	0.126	T9	0.266	T16	0.300
T3	0.154	T10	0.179	T17	0.357
T4	0.122	T11	0.267	T18	0.379
T5	0.163	T12	0.323	T19	0.261
T6	0.188	T13	0.209	T20	0.337
T7	0.147	T14	0.334	T21	0.406
Average = 0.247 g/s					

Type B evaluation of standard uncertainty:

Two instruments were used in the test and each instrument has standard uncertainty from calibration certificate and has also resolution value. The standard uncertainty for these instruments at 95.45% confidence level and k = 2. The standard uncertainty for balance (u_w) is as follows:

$$u_w = \frac{0.006}{2} = 0.003 \quad g$$

Where 0.006 is uncertainty from calibration certificate for the balance and the divisor 2 is for normal distribution. The resolution of the digital balance is 0.01 g. taking the limits to be half of the resolution, therefore the limits of this uncertainty component is 0.005 g. Since upper and lower limit of this uncertainty component is given, therefore assuming rectangular distribution. For rectangular distribution, the standard uncertainty $u_R(W)$ due to resolution of device under calibration is:

$$u_R = \frac{0.005}{\sqrt{3}} = 0.002887 \quad g$$

Where 0.005 is uncertainty component due to resolution for the balance and the divisor $\sqrt{3}$ is for rectangular distribution. This procedure was undertaken for two instruments and Table (9) lists Type B uncertainty during testing the seed drill.

Table (9): Type B uncertainty for different instruments during testing the seed drill.

Source of uncertainty		Estimated value	Distribution	Divisor	Standard uncertainty
Balance u_w	Standard	±0.006 g	Normal	2	0.003 g
	Resolution	0.01 g	Rectangular	$\sqrt{3}$	0.002887 g
Stop watch u_T	Standard	±1.01 sec	Normal	2	0.505 sec
	Resolution	0.01 sec	Rectangular	$\sqrt{3}$	0.002887 sec

Combined standard uncertainty:

The combined standard uncertainty (u_c) is calculated as follows:

$$u_c = \sqrt{c_q^2 u_q^2 + \sum_{i=1}^{2} c_W^2 u_W^2 + \sum_{i=1}^{2} c_T^2 u_T^2}$$

Where c_q is sensitivity coefficient for standard uncertainty of repeatability (Type A) and equals 1. Meanwhile, c_W and c_T are sensitivity coefficients and are listed in Table (5) for each treatment during seed drill test.

Expanded uncertainty:

Expanded uncertainty (U) is given by $U = k \times u_c(y)$ where k is a coverage factor. From student's t-distribution, for 95.45% confidence level, the value of coverage factor k is 2. For treatment T1, $U = 2 \times 0.096 = 0.193 \quad g/s$.

Table (10) lists expanded uncertainty in determining seeding rate during seed drill test at different treatments (k =2).

Table (10): Expanded uncertainty in determining seeding rate during seed drill test at different treatments (k =2).

	Expanded uncertainty (U, g/s)		Expanded uncertainty (U, g/s)		Expanded uncertainty (U, g/s)
T1	±0.193	T8	±0.485	T15	±0.955
T2	±0.276	T9	±0.640	T16	±0.718
T3	±0.353	T10	±0.393	T17	±0.930
T4	±0.264	T11	±0.613	T18	±1.170
T5	±0.361	T12	±0.801	T19	±0.672
T6	±0.441	T13	±0.471	T20	±1.013
T7	±0.320	T14	±0.783	T21	±1.441
Average = ±0.633 g/s					

Table (11): Statement of the uncertainty budget in determining seeding rate during seed drill test at treatment (T1).

Uncertainty Source	Estimated value	Distribution	Divisor	Standard uncertainty	Sensitivity coefficient	Uncertainty contribution
Balance	±0.006 g	Normal	2	0.003 g	0.033g/s.g	0.000099 g/s
	0.01 g	Rectangular	$\sqrt{3}$	0.00288675	0.033g/s.g	0.0000953g/s
Stop watch	±1.01 sec	Normal	2	0.505 sec	0.064g/s.s	0.03232 g/s
	0.01 sec	Rectangular	$\sqrt{3}$	0.00288675	0.064g/s.s	0.000185 g/s
Type A	0.091g/s	Normal	1	0.091g/s	1	0.091 g/s
Combined standard uncertainty						0.097 g/s
Coverage factor (k)						2
Expanded uncertainty (U)						± 0.193 g/s

Also, Table (11) shows statement of the uncertainty budget in determining seeding rate during seed drill test at treatment (T1).
During testing seed drill and seeding rate at T1 is 1.93 g/s with expanded uncertainty of ± 0.193 g/s (i.e ± (0.193/1.93)*100 = ±10%) at k =2 and approximately 95% confidence level.

Conclusion

This study evaluated the sources of uncertainty for seeding rate during test of seed drill in the laboratory. These sources include values from calibration certificates, repeatability, and resolution source. The study also dealt with the effect of different seed drill settings on the uncertainty. These settings are different forward speeds and seeder openings. The uncertainty estimates are included with measured data sets and adequately communicated to researchers and decision makers, and then optimal monitoring machine design like seed drills will result. The Type A uncertainty was affected by seed drill settings and had average value of 0.247 g/s. The Type B uncertainty was affected by sensitivity coefficients and measuring instruments. A proper evaluation of uncertainty is good professional practice and can provide laboratories and customers with valuable information about the quality and reliability of the result.

REFERENCES

Adams, T. M. (2002). G104 - A2LA Guide for Estimation of Measurement Uncertainty In Testing: 42 p.

ASAE standards, 51st ed. S386.2 (2004). Calibration and distribution pattern testing of agricultural aerial application equipment. St. Joseph, Mich.: ASAE.

Bahnasy, A. F.; A. M. Aboukarima; M. E. Morsi and S. N. Abd El Halim (2007).Development a simple laboratory unit for calibration and testing seed drills. J. Agric. Sci. Mansoura Univ., 32(12):10109-10117.

Bair, M. and C. Rombouts (2006). Typical measurement uncertainty in gas flow measured by GFS 2102 gravimetric flow standard. DH Instruments, Inc. Technical note 6050TN09:10p.

Boriack, C. N.; S. C. Capareda; R. E. Lacey; A. Mutlu; S. Mukhtar; B. W. Shaw and C. B. Parnell, Jr. (2004). Uncertainty in ammonia flux measurement systems. An ASAE/CSAE Meeting Presentation Paper No. 04-4111.

Guler, I. E. (2005a). Effects of flute diameter, fluted roll length, and speed on alfalfa seed flow. Applied Engineering in Agriculture, 21(1): 5-7.

Guler,I. E. (2005b).Analysis of the effects of flute diameter, fluted roll Length and speed on sesame seed flow using Minitab. Journal of Applied Sciences, 5 (3): 488-491.

Hendawy, N.A. (1996). Factors affecting seed drilling rate. Misr J. Ag. Eng., 13 (1):202-210.

Husain, R. and K. A. An-Nahdi (2000). Uncertainty calculations in a measurement standards laboratory. Proc. Natl. Sci. Counc. ROC (A), Vol. 24, No. 3:210-215.

International Standardization Organization (1995): ISO Guide to the expression of uncertainty in measurement.
ISO (1984): ISO 7256-2:1984 Sowing equipment -- Test methods -- Part 2: Seed drills for sowing in lines.
ISO/IEC (2005): ISO 17025.General requirements for the competence of testing and calibration laboratories.
Jaiswa, S. K.; S.R. Gupta and L. Sridhar (2004). Evaluation of uncertainty of measurement in calibration of electrostatic voltmeter-a case study. J. Instrum. Soc. India, 34 (4): 284-291.
Mathioulakis, E.; K. Voropoulos and V. Belessiotis (1999). Assessment of uncertainty in solar collector modeling and testing. Solar Energy, 66 (5):337–347.
Raheman, H. and U. Singh (2003). A sensor for seed slow from seed metering mechanisms. IE (I) Journal AG, Vol. 84:6-8.
SAS (1986). User's Guide, Statistical Analysis System. SAS Ins., Inc., SAS Circle, P. O. Box 8000, Cary, N. C.
Tang, R.; Z. Lil; H. Zhong and Q. Lan (2006). Assessment of uncertainty in mean heat loss coefficient of all glass evacuated solar collector tube testing. Energy Conversion and Management, 47:60–67.

تقييم اللايقين لمعدل البذر أثناء الأختبار المعملي لآلة تسطير الحبوب

عبد الواحد محمد أبوكريمة، شكري نصر عبد الحليم وحمزة عبد العزيز مرغني
معهد بحوث الهندسة الزراعية، مركز البحوث الزراعية، وزارة الزراعة واستصلاح الأراضي

تشجع الحكومة المصرية القطاع الزراعي لتعزيز التوجهات الاستراتيجيه لتحقيق أعلى معدل نمو الناتج الزراعي من خلال طرق مختلفة. وأحد هذه الطرق هو تعزيز قدرات معامل الاختبارات التي تشرف عليها وزارة الزراعة واستصلاح الاراضي من خلال إتخاذ خطوات لإعتماد تلك المعامل طبقا للمواصفة آيزو 17025. ومن ناحية أخرى تلعب معامل اختبار المعدات الزراعية دورًا هامًا لاستكمال تلك التوجهات من خلال التحقق من خصائص وأداء المعدات الزراعية سواء للأفراد أو المنتجين للإنتاج التجاري وتمدنا هذه المعامل بمعلومات عن أداء المعدات الزراعية، سواء للانتاج التجاري أم لا أو تقديم أي بيانات محددة قد تكون لازمة وفقا لتعليمات المصنع / العميل. واعتماد المعامل طبقا للمواصفة آيزو 17025 يتطلب تقييم مصادر اللايقين أثناء الاختبارات. وأهداف الدراسه هي تقييم مصادر اللايقين لمعدل بذر البذور وتوضيح تأثير السرعة الأمامية ومقدار فتحة تلقيم البذور والتفاعل بينهما على معدل بذر البذور اثناء اختبار سطارة الحبوب. ويساعد تقدير اللايقين الباحثين وصانعي القرار عند تصميم المعدات الزراعية. وتركزت المناقشة على النتائج المتحصل عليها لتقييم اللايقين ذات الصلة بمعدل البذر بوحدات جم/ ثانية ، وكيفية القياس والتحليل المعملي لإجراءات قياس معدل البذر لسطارة الحبوب. وأوضحت النتائج أن السرعة الأمامية ومقدار فتحة التلقيم والتفاعل فيما بينها لهم تأثير معنوي على معدل البذر بوحدات (جم/ ثانية) و (كجم/فدان). وتلاحظ عند زيادة السرعة يزيد معدل البذر بوحدات (جم/ثانية) عند أي مقدار لفتحة تلقيم البذور. بينما ينخفض معدل البذر بوحدات (كجم / فدان) عند زيادة السرعة عند أي مقدار لفتحة تلقيم البذور. وتلاحظ من النتائج أن النوع (A) من حسابات اللايقين يتأثر بالمعاملات المستخدمة أثناء الاختبار وليس له إتجاه محدد، وتراوح المتوسط العام له 0.247 جم/ثانية أما النوع (B) من حسابات اللايقين تأثر بأجهزة القياس المستخدمة ومعدلات البذر المستخدمة من خلال عوامل الحساسية المؤثرة في هذا النوع. وإن تقييم اللايقين لا بد منه وهو جزء من أي قياس، وإجرائه بمعامل اختبار المعدات الزراعية يمكن أن يوفر معلومات جيدة للعملاء والمنتجين عن نوعية وموثوقيه نتائج الاختبارات.