Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Judging on the Performances of Fertilizer Feeding Unit With Rolling System

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ABSTRACT

A simple rolling system was investigated and setting in the bottom of fertilizing unit to utilize the recommended amount of fertilizer adding to the seeds during/after planting. So that it can be used individually, to perform the fertilizing operation after planting, or combined with the drilling machine. The judging on the performances of fertilizer feeding unit with rolling system is identified under four different forward speeds (FS) of 2.5; 3.7; 5.0 and 8.5 km/h and different operating ratio between fertilizer unit landing wheel and rotating shaft of fertilizer rolling system (OR) under gate area (GA) of 15cm2. The granulated fertilizer (Potassium nitrate and Urea) were used in the experiment to assess the performance of the investigated rolling system on fertilizer application rate (kg/fedd.).The results of the study were compared statistically to obtain the most suitable treatments to the addition of activating doses of fertilizers during planting and growing crop service. The experimental results indicated thatthe recommended amount 12.0 kg/feddpotassium nitrate for the investigated rolling unit may be defined under forward speed of 5.0 k m/h and a Operating ratio of "1.0 to 2.0". On the other hand, at recommended amount 30.0 kg/fedd or 33.0 kg/fedd potassium nitrate for the investigated fertilizer system may be conformed under forward speed of 3.7 km/h and with a operating ratio of "1.0 to 4.1" or "1.0 to 4.8" respectively.

Keywords: forward speed –operating rate- fertilizer roller -drill - combined and planter.

INTRODUCTION

Agricultural tools, implements and equipment are one of the key inputs in crop production industry. They reduce also drudgery on the farm, increases production and productivity and make cumbersome works easier, timely and efficient.

Development strategies which look to the "seed-fertilizer revolution" as the primary source of technical change in agriculture include three key elements: Agricultural research leading to the development of high-yielding varieties which have the capacity to respond to high levels of soil fertility, Greatly increased application of chemical fertilizers; and activities which promote both the widespread use of the new varieties and the associated changes in farm practices which are needed if these varieties are to realize their high yield potential.

Nutrients are essential for crop production. All plants require nutrients to grow and a significant portion of these nutrients are removed and exported when a crop is harvested. Fertilizers are required for optimum crop growth providing crops the necessary nutrients.

While drilling chemical fertilizers in the soil there are problems we face such fertilizer distribution is irregular. (Thaper, 2014). Also, Ţenu et al., (2018) mentioned that fertilization with solid chemical fertilizers is an important part of the growing technology; the fertilizer spreaders must achieve distribution uniformity higher than 90%. Plants grown in protected spaces need higher amounts of mineral substances and, as a result, supplementary fertilizations are needed. On the other hand, Lucreţiaetal.,(2010)reported that, designing and implementing a technical equipment by high operating performance, able to spread minimum rates per unit surface, without fertilizer losses on overdoses has become a real necessity along with making this equipment available for agricultural manufactures and farmers.The result is concretized in obtaining high quality and profitable productions and especially in preserving the environment and limiting the ecological damages at national, regional and local level, on short or longer term.

Sanaeifar and Sheikhdavoodi (2012)mentioned that the uniformity and accuracy of chemical fertilizer and seed broadcasting on field surface are significant parameters of broadcaster performance. Improper and inaccurate broadcasting causes abnormal and nonhomogeneous soil fertility which is against to the purposes of sustainable agriculture. Broadcasters also are used for planting seeds like wheat, barley etc., so it's appropriate performance effect on crop production. The results of this study help us to analyze broadcaster performance parameters and choose suitable device for best fitting to our purposes. While, Paulson et al., (2018) said that the modern farming operations are continually looking for ways to reduce operational costs, and increase productivity. Naturally, equipment manufacturers are also looking to increase equipment throughput. This is particularly evident in seeding technology changes over the past several decades. However, factors such as the mechanical strength of the frame, public roadway size restrictions, field increases. Therefore, productivity gains from increased seeding speed are layout, and available tractor power present challenges to future width increasingly important.

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DOI: 10.21608/jssae.2020.160912

Singh, and Nikhade (2014), reported that The main purpose of farmers in developing countries is to produce more agricultural products with the lowest possible energy input to meet the growing demand for food in the region. Many agricultural operations are performed with the help of draught animals on the small and marginal farms. Animal power contribution in the total power used in agriculture is about 33%.To maintain the natural resource base and at the same time increase food production with suitable sowing implement and minimum energy input requirement is necessary. Multipurpose Tool Seed cum Fertilizer Drill is one of the most suitable sowing implement for small farmers. It has main advantage that it consist a frame which can be change according to operation required.

Ramesh and Girishkumar (2014), studies that sowing operation is to put the seed and fertilizer in rows at desired depth and seed to seed spacing, cover the seeds with soil and provide proper compaction over the seed. The recommended row to row spacing, seed rate, seed to seed spacing and depth of seed placement vary from crop to crop and for different agro-climatic conditions to achieve optimum yields. Seed sowing devices plays a wide role in agriculture field. Also, Bulgakov*et a.l,* (2017) found that, when using the combined fertilizer-seeding unit, the uniformity of seed distribution along the length of the string will be substantially increased. At the same time, the field germination of seeds will increase, and the coefficient of variation in the depth of seed placement in the furrow will decrease. Based on the results of field experimental studies, an increase in the yield of spring wheat and barley was found in the application of a combined fertilizer-seed aggregate with the simultaneous introduction of a basic fertilizer-seeded fertilizer into the soil and sowing of cereals with the application of a starting dose of mineral fertilizer in comparison with the known schemes of such operations. The obtained results confirm the expediency of combining these technological operations with one pass of the combined machine-tractor unit (aggregate). Planted soybean crop to assess seed cum-fertilizer drill and simple seed drill were investigated by Dhakad*et al. (2017*). They investigated that seed-cum-fertilizer drill was found better in term of growth characters and yield of soybean in comparison with simple seed drill sowing machine. The net return is the best index of profitability of soybean crop and higher net return per ha. for soybean crop under seed cum fertilizer drill whereas lower net return per ha was recorded under normal seed drill sowing.

So, the experiments were conducted with the aim of judging of the tractor forward speed (FS) and operating ratio (OR) on the fertilizer application rates (FAR, kg per feddan). The results of the study were compared statistically to obtain the most suitable treatments to the addition of activating doses of fertilizers during planting and growing crop service.

MATERIALS AND METHODS

The present study and field measurements were carried out at Agricultural Engineering Station, Met Khalaf, Menoufia Governorate, Egypt and at Department of agricultural and Biosystem Engineering, Faculty of Agriculture, Menoufia University in November 2016.

The aim of the experiments were to studying and evaluating the performance of fertilizer drill unit.

The tractor was used as power source during conformed the experimental work (Naser 65Hp), Model 1975. Three forward speed with one back speed two transmission (slow and fast) are tractor specification.

Colorado seed drill was used in the experimental work, it made in Italy, model no 2500, 21 planting rows and Connecting with three point of tractor.

The fertilizer system consists of hoppers made from galvanized steel (3mm) thickness and dimensions of 210×50×60cm (length, width and depth respectively) with 21 fertilize tube.The distance between the tubes is 10 cm. The fertilizer drop height can be regulated in three levels form soil surface (5, 10 and 15cm) to change the spread of the fertilizer distribution.

The indoor experiments were conducted to determine the amount of fertilizer application rate under two open gate area (15, 22.5 cm^2)for rotation of land wheal that dun 2.5, 3.7, 5.0 and 8.5 km/h travel machine speads under and different operating ratio of fertilizer feeding shaft. as shown in tables (1,2,3 and 4)

Table 1. Fertilizer amount when using gear teeth 16 at different forward speeds and different operating rate at opening gate (15cm²).

O.R	Gat15Cm² at gear 16			
	2.5Km/h	3.7Km/h	5Km/h	8.5Km/h
1:2.4	14.40	14.16	14.28	13.92
1:2.7	16.92	16.80	16.92	16.32
1:3	19.20	19.08	18.96	19.32
1:3.3	21.96	21.36	21.60	21.36
1:3.6	24.12	24.00	23.88	24.00
1:3.9	26.28	26.40	26.16	26.28
1:4.2	28.80	28.56	28.68	28.56
1:4.5	30.96	30.84	31.20	31.80
1:4.8	33.60	33.36	33.60	33.12

Table 2. Fertilizer amount when using gear teeth 26 at forward speeds and different operating rate at opening gate (15cm²).

O.R	Gat15Cm² at gear 26			
	2.5Km/h	3.7Km/h	5Km/h	8.5Km/h
1:1.7	10.80	10.80	10.56	11.04
1:2	13.08	12.96	13.20	12.72
1:2.3	15.24	15.24	14.88	14.40
1:2.6	17.40	17.52	17.28	17.40
1:2.9	19.44	19.44	19.68	19.20
1:3.2	21.84	21.60	21.60	21.36
1:3.5	24.12	24.48	24.24	24.00
1:3.8	26.40	26.28	26.40	25.92
1:4.1	28.68	28.80	28.56	28.56

Table 3. Fertilizer amount when using gear teeth 16 at forward speeds and different operating rate at opening gate (22.5cm²).

O.R	Gat22.5Cm² at gear 16			
	2.5Km/h	3.7Km/h	5Km/h	8.5Km/h
1:2.4	60.00	58.80	57.12	57.60
1:2.7	63.24	62.88	62.40	62.40
1:3	66.96	67.08	66.96	66.72
1:3.3	70.68	70.68	70.56	70.68
1:3.6	73.80	73.44	73.80	73.44
1:3.9	77.52	77.40	76.72	76.80
1:4.2	80.88	81.00	80.64	79.68
1:4.5	84.24	84.00	83.76	84.48
1:4.8	87.00	86.88	86.52	86.40

Table 4. Fertilizer amount when using gear teeth 26 at different forward speeds and different operating rate at opening gate (22.5cm^2).

O.R	Gat22.5Cm^2 at gear 26			
	2.5Km/h	3.7Km/h	5Km/h	8.5Km/h
1:1.7	49.20	49.20	49.44	48.96
1:2	52.32	51.96	51.60	52.08
1:2.3	54.00	54.00	53.40	52.80
1:2.6	56.50	56.40	56.64	56.40
1:2.9	59.16	59.04	58.92	58.08
1:3.2	61.44	61.44	61.20	60.96
1:3.5	64.20	63.96	64.08	63.72
1:3.8	66.48	66.48	66.00	66.24
1:4.1	69.24	69.36	67.20	69.60

Dimensions of fertilizer unit gearbox were Width 30 cm, Height 20 cm, Depth 25 cm.

Fertilizer delivery system

Granular fertilizer shaft pulverizing the aggregate to facilitate its passage through the fertilizing tube, It made from iron shaft with diameter 2cm

The stirred shaft is supported on two chairs, and gets its motion from the ground wheel. It contains 21 groups of fingers, each group of four fingers supported in front of gates to break up the chemical fertilizer clumps as shown in Fig. (1)

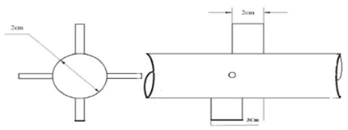

Fig. 1.fertilizer pulverizing shaft

The delivery spring with a length 110 cm and 4 cmdiameter made from spring steel to be easy clean after working day. Diameter of receive funnel was 8 cm. A lever is added under the fertilizer tubes to control the distance between the tubes according to the distance between the planting lines.

The fertilizer feeding rool is made from Teflon material to avoid . the inter act with chemical fertilizer . the main roll diameter are 6.0 cm and 3.0 cm wide It kay. Including 4 holes were distributing in equal distance. as shown in Fig. (٢)

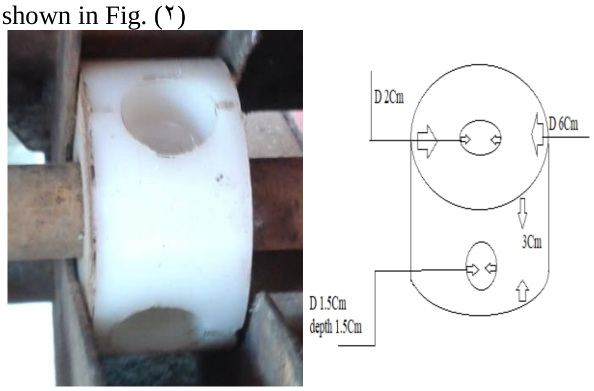

Fig. 2. Feeding roll

The fertilizer feeding gate

The fertilizer feeding gate was used by two dimensions 15 and 22.5cm^2.

Digital balance

a digital balance was used in the present work todeter mine the weight of fertilizer amounts .
Country of manufacturing: Germany
Manufacturing Company: LoncherWaagen GMBH
Type: GP4102
Power source: Electricity
Maximum measurement, Kg: 5 kg
Accuracy, g.: 0.01 g

Fuel consumption calibration

When using the tractor, the fuel tank was completely filled, and after performing the required operation, a graduated tester was used to complete the filling of the entire fuel tank again, thus identifying the amount of fuel that was consumed.

Fertilizing material

Granulated fertilizer (Potassium nitrate and Urea) were used in the experiment to assess the performance of agriculture and fertilization.

physical and chemical properties of potassium nitrate: total nitrogen 13.7%, total potash oxide (k_2o)46.2% , impurities in water 0.01% , and shape : white crystalline powder

physical and chemical properties of urea: dissolves completely in water, contains 46% from nitrogen, easy to store, it has a natural ph and shape : white crystalline powder

statistical analysis

Data were analyzed according to the statistical model SPSS**.** significant differences among means were detected Also.

RESULTS AND DISCUSSION

Fertilizer applicate rate FAR,kg/fed

Mean squares, F values and probability for fertilizing rate (kg/feddan) for tractor forward speed (F.S.) and the machine Operating ration (O.R.) were presented in Table (٥) according to analysis of variance for (gate open 15 cm^2). The results of the studied analysis showed that, there were highly significant differences between tractor forward speed and Operating ratio at ($P \leq 0.05$).

Table 5. Variance analysis of fertilizing rate mean squares, F value and probability at gate (15 cm^2).

Source	Mean Square	F	Sig.
Forward Speed (F.S.)	0.46	99.69	**
Operating Ratio (O.R.)	514.51	112460.6	**
F.S.*O.R.	0.14	30.02	**
Error	0.01		

**** significant differences at P ≤ 0.05**

The mean values and standard error for fertilizing rate for different forward speeds 2.5, 3.7, 5.0, and 8.5km/h and different operating ratios.

The influences of forward speed on fertilizer rate were studied. The results showed that, the mean values for fertilizing rate for different forward speeds ranged from (21.62kg/Feddan) for 8.5 km/h at fast forward speed to (21.85kg/feddan) for 2.5 km/h forward speed.

The gear box teeth 16 and 26 give the largest number of combinations of final Operating ratios and wide range of the fertilizer amounts up to 18 operating ratios and fertilizer amounts, were ranged from (10.80kg/feddan) at Operating ratio 1:1.7 for teeth (26) to (33.42kg/feddan) at Operating ratio 1:4.8 for teeth (16).

Fig (3) showed that the fertilizing rate was 21.85 kg/feddan at forward speed of 2.5 km/h at forward speed and the fertilizing rate was reduced to 21.76 kg/feddan for both the forward speed of 3.7 km/h at forward speed and 5 km/h at transmission of tractor, respectively, and then reduced the fertilizing rate to 21.62 kg/feddan at the forward speed 8.5km/h at forward speed.

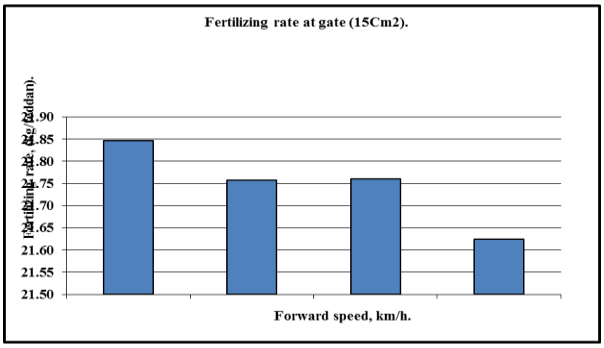

Figure 3. Fertilizing rate according to forward speed

It was observed also that there no effect for both the forward speed 3.7 at slow forward speed and 5 km/h at fast forward speed on the fertilizer amount, this means that a higher forward speed is better at saving work time per feddan, while it giving at same amount of FAR, where it the field performance rate of 1.94 feddan/h at forward speed 3.7 km/h and 2.63 feddan/h at forward speed 5 km/h with increasing about 36%. So that, speed was preferable to 5 km/h because it covered a larger area in less time. While, forward speed of 8.5 km/h was not recommended although it is fast and less in time.

Figure (4) showed that the fertilizing rate increased by increasing the operating ratio for 1:2.4 to 1:4.8. The mean values for fertilizing rate for different operating ratios ranged from (14.19kg/feddan) for (1: 2.4) operating ratio to (33.42kg/feddan) for (1:4.8) operating ratio at the first gear teeth (16), where, the percentage of increase in the fertilizer amount was 57.5%.

On the other hand Figure (4) showed also that the fertilizing rate increased by increasing the operating ratio for 1:1.7 to 1:4.1. The mean values for fertilizing rate for different Operating ratios ranged from (10.80kg/feddan) for (1:1.7) Operating ratio to (28.64kg/feddan) for (1:4.1) Operating ratio at the second gear teeth (26), where, the percentage of increase in the fertilizer amount was 2.3 %.

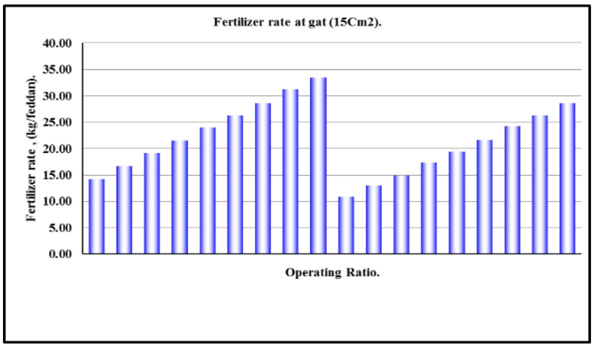

Figure 4. Fertilizing rate according to operating ratio at f.s 2.5Km/h.

Interaction effect of F.S and O.R on fertilizer rate for open gate ($15cm^2$)

The interaction effect between forward speed and gears Operating ratio on fertilizing rate was studied. It showed highly significant differences at ($P \leq 0.05$) as presented in Table (5).

That there is a slight change in fertilizer amount between forward speed 2.5and 3.7 km/h at slow forward speed , 5 and 8.5 km/hand at fast forward speed km/h into the same operating ratio.

The influence of forward speed on fertilizing rate was studied. Figure (5) showed that the fertilizing rate increased by increasing the Operating ratio for 1:2.4 to 1:4.8. The mean values for fertilizing rate for different Operating ratios increased from (14.40kg/feddan) for (1to 2.4) Operating ratio to (33.60kg/feddan) for (1 to 4.8) Operating ratio at the first gear teeth (16), where, the percentage of increase in the fertilizer amount was 57.14%, this percentage was approximately fixed at forward speeds 2.5, 3.7, 5 and 8.5 km/h.

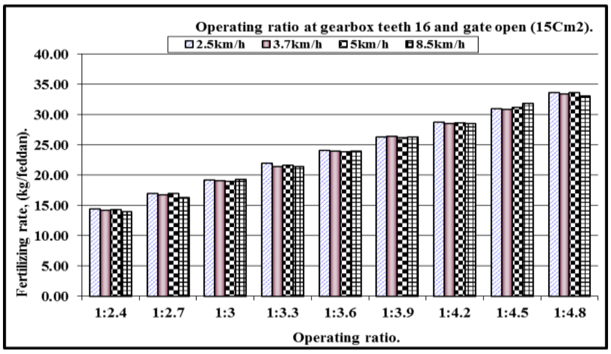

Figure 5. Fertilizing rate according to operating ratio and slow forward speed at gate open (15Cm2).

Figure (6) showed that the fertilizing rate increased by increasing the Operating ratio for 1:1.7 to 1:4.1. The mean values for fertilizing rate for different operating ratios increased from (10.80kg/feddan) to (28.68kg/feddan) at gear teeth (26), where, the percentage of the increase in the fertilizer amount was 62.34%, this percentage was approximately the same at forward speeds 2.5, 3.7, 5 and 8.5 km/h at the same Operating ratio.

The slightly differences in fertilizer amounts between four forward speeds for the same Operating ratio may be due to the field surface variation skileling fertilizer unit.

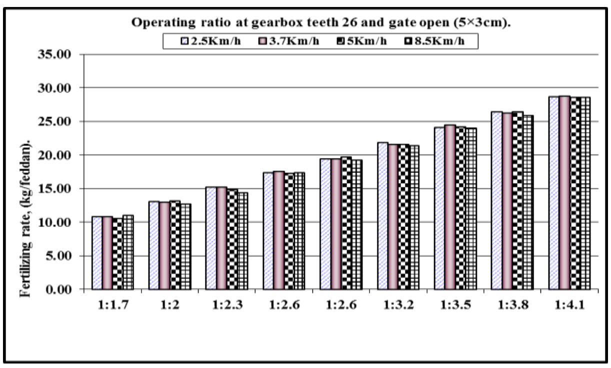

Figure 6. Fertilizing rate according to operating ratio and fast forward speed at gate open (15cm2).

From the obtained results, when planting wheat, the machine can be used at a forward speed (3.7km/h) and operating ratio (1:4.8) to give the recommended amount of fertilizer to the wheat crop, which is 33kg/feddan (Super phosphate in granules slope) at gat dimensions (15cm2), when planting alfalfa, the machine can be used at a forward speed (5km/h) and a Operating ratio (1:2) to give the recommended amount of fertilizer to the alfalfa crop, which is 12kg/feddan (Ammonium nitrate) at gat dimensions (15cm2). However, after planting alfalfa, the machine can be used at a forward speed (3.7km/h) and a Operating ratio (1:4.8) to give the recommended amount of fertilizer to the alfalfa crop, which is 30kg/feddan (potassium nitrate) at gat dimensions (15cm2).

CONCLUSION

- The recommended amount 12.0 kg/fedd potassium nitrate for the investigated rolling unit may be defined under forward speed of 5.0 km/h and a Operating ratio of "1.0 to 2.0".
- On the other hand, at recommended amount 30.0 kg/fedd or 33.0 kg/fedd potassium nitrate for the investigated fertilizer system may be conformed under forward speed of 3.7 km/h and with a operating ratio of "1.0 to 4.1" or "1.0 to 4.8" respectively.

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الحكم على أداء وحدة تغذية الأسمدة بالنظام الدوار

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تم فحص النظام الدوار البسيط ووضعه في أسفل وحدة التسميد للاستفادة من الكمية الموصى بها من السماد المضاف إلى البذور أثناء وبعد عملية الزراعة . بحيث يمكن استخدامها بشكل فردي لأداء عملية التسميد بعد الزراعة ، أو دمجها مع آلة الزراعة. ويمكن الحكم على آداء وحدة تغذية السماد مع النظام الدوار الذي تم تحديده تحت أربع سرعات أمامية مختلفة (٢,٥و ٣,٧ و ٥,٠و ٨,٥كم / س) ونسبة تشغيل مختلفة بين عجلة الأرض وعمود التغذية الدوار وذلك عند فتحة بوابة ١٥سم^{٢} . تم استخدام السماد الحبيبي (نترات البوتاسيوم واليوريا) في التجربة لتقييم أداء نظام التغذية الدوار المدروس على معدل إضافة السماد (كجم / فدان) ، وتمت مقارنة نتائج الدراسة إحصائياً للحصول على أنسب المعاملات مع إضافة جرعات تنشيطية من الأسمدة أثناء زراعة المحاصيل وخدمتها . أشارت النتائج التجريبية إلى أن الكمية الموصى بها ١٢,٠ كجم / فدان نترات البوتاسيوم لوحدة التسميد بالنظام الدوار التي تم فحصها يمكن تحديدها تحت سرعة أمامية تبلغ ٥,٠ كيلو متر / ساعة ونسبة تشغيل "١,٠ إلى ٢,٠". من ناحية أخرى ، عند المقدار الموصى به ٣٠,٠ كجم / فدان أو ٣٣,٠ كجم / فدان من نترات البوتاسيوم لنظام التسميد الذي تم تحديده يمكن أن تتوافق مع سرعة أمامية تبلغ ٣,٧ كم / ساعة وبنسبة تشغيل "١,٠ إلى ٤,١" أو "١,٠ إلى" ٤,٨ "على التوالي .