

DLG Test Report 7444

Balkrishna Industries Ltd. (BKT TIRES)

Agricultural VF tires for tractors

BKT AGRIMAX V-FLECTO

Resources protection through soil preservation and fuel saving
User friendliness



BKT AGRIMAX V-FLECTO
VF540/65 R30 & VF650/65 R42

- Resources Protection
- ✓ Soil preservation
 - ✓ Fuel saving
 - ✓ User friendliness
 - ✓ Soil discharge and self-cleaning

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Overview

A test mark “DLG APPROVED for individual criteria” is awarded for agricultural products which have successfully fulfilled a scope-reduced usability testing conducted by DLG according to independent and recognized evaluation criteria. The test is intended to highlight particular innovations and key criteria of the test object. The test may contain criteria from the DLG test scope for overall tests, or focus on other value-determining characteristics and properties of the test object.



The minimum requirements, test conditions and procedures as well as the evaluation bases of the test results will be specified in consultation with an expert group of DLG. They correspond with the recognised rules of technology, as well as scientific and agricultural knowledge and requirements. The successful testing is concluded with the publication of a test report, as well as the awarding of the test mark, which is valid for five years from the date of awarding.

The present test was conducted with the BKT AGRIMAX V-FLECTO VF650/65 R42 and BKT AGRIMAX V-FLECTO VF540/65 R30 agricultural tires for tractors. The DLG test modules “Resources Protection” and “User friendliness” were tested.

Agricultural tires are an important component of agricultural machinery and vehicles. They have to cope with different surfaces and loads, withstand different speeds, and all that while maintaining consistent performance and a long service life. The requirements for agricultural tires are varied and demanding. There are many different types of agricultural tires suitable for different applications. The variety of application areas is large and ranges from soil cultivation to harvesting to transporting goods.

The DLG test module “Resources Protection” includes measurements on the effects of tires on the soil and on fuel consumption under practical conditions. For this purpose, the tractive force slip curve is determined at constant wheel loads for three different tire inflation pressures. The corresponding wheel contact areas (tire footprint area) are also measured. Ground pressures at 10 cm, 20 cm and 40 cm soil depth while passing and track depths after passing are measured with the low tire inflation pressure typical for the simulated field work. In addition, fuel consumption is determined during the field test runs and test runs are carried out on the DLG rolling testbed for simulation of transport tasks.

The DLG test module “User friendliness” examines soil discharge when driving out of the field and the self-cleaning behaviour of the tires.

Other criteria were not tested.

The product

Manufacturer

Balkrishna Industries Ltd. (BKT TIRES), Mumbai – 400013, India

Product:

BKT AGRIMAX V-FLECTO VF650/65 R42 and BKT AGRIMAX V-FLECTO VF540/65 R30

Description and technical data

- Tubeless radial tire
- Section width [mm]:
650/549
- Overall diameter [mm]:
1.913/1.464
- Recommended rim:
DW 23B/DW 20B



Figure 2:
BKT AGRIMAX V-FLECTO

Table 1:

Tyre pressure table BKT AGRIMAX V-FLECTO VF650/65 R42 / BKT AGRIMAX V-FLECTO VF540/65 R30

	Tyre pressure [bar]						
	0.6	0.8	1.0	1.2	1.4	1.6	2.0
Driving speed [km/hr]	Tyre load capacity [kg]						
10	3755/2380	4345/2755	4930/3125	5595/3550	6115/3875	6630/4205	7370/4675
25	3350/2250	4105/2605	4660/2955	5290/3355	5780/3665	6270/3975	6965/4420
30	3480/2205	4025/2555	4570/2900	5190/3290	5670/3595	6150/3900	6830/4335
40-65	3415/2165	3950/2505	4485/2845	5090/3230	5560/3525	6030/3825	6700/4250
70	3105/1970	3590/2275	4080/2585	4630/2935	5055/3205	5485/3480	6095/3865

Further technical data can be found on the manufacturer's homepage:
<https://www.bkt-tires.com/ww/us/agrimax-v-flecto>

Assessment in brief

The agricultural tractor tire combination BKT AGRIMAX V-FLECTO VF650/65 R42 and BKT AGRIMAX V-FLECTO VF540/65 R30 was able to convince in the DLG test with the specified test criteria. Based on the results achieved, the tire combination BKT AGRIMAX V-FLECTO VF650/65 R42 and BKT AGRIMAX V-FLECTO VF540/65 R30 is awarded the DLG-APPROVED quality mark for the test modules “Resources Protection” and “User friendliness”.

The tested BKT AGRIMAX V-FLECTO impressed in the field test. The traction and the tractive forces transmitted with it were better than the reference tires at 0.6 bar air pressure. The tire footprint area of the BKT AGRIMAX V-FLECTO measured at a wheel load of 2,345 kg was between 3,906 cm² and 5,040 cm². This results in a contact surface pressure of 0.47 kg/cm², which is 10 % better than the average of 0.52 kg/cm² of the reference tires. The tractive force slip curve shows that the BKT AGRIMAX V-FLECTO can transmit 67.5 kN at 37 % slip, with an internal tire pressure of 0.6 bar.

The ground pressures measured show a clear correlation between contact area and depth of penetration. The VF tires tested showed an average measured pressure of 0.63 bar, while the BKT AGRIMAX V-FLECTO measured 0.53 bar at a depth of 10 cm, that's 16 % less than the other tires.

BKT AGRIMAX V-FLECTO and one of the reference tires had the smallest track depth at 0.6 bar.

The track depth was 11.4 % lower compared to the average value across all tires tested.

The BKT AGRIMAX V-FLECTO and one reference tire also achieved the highest area performance of 2.66 ha/h. Both are 2.3 % better than the average and even 5.1 % better than the worst reference tire in the test. The fuel consumption in l/ha shows a similar picture. Tires with a higher area coverage are more efficient in relation to the area worked. A 3 m wide tillage implement was also assumed here. The average fuel consumption in the test is 18.1 l/ha, with 0.6 bar tire inflation pressure (IP) and a braking force of 40 kN. Here too, the BKT AGRIMAX V-FLECTO performs best in comparison and is 1.8 % better than the average.

In transport test at the DLG rolling testbed with the 40 km/hr variant, the BKT AGRIMAX V-FLECTO is in first place and is 0.7 % better than the average value of all tires tested in terms of specific fuel consumption. In the 50 km/hr variant, the BKT AGRIMAX V-FLECTO is also in first place with a specific fuel consumption that is 1.0 % lower than the average value of all tires tested. In terms of fuel consumption per ton and kilometre, the BKT AGRIMAX

V-FLECTO achieves a saving of 0.7 % in the 40 km/hr variant and 0.8 % less in the 50 km/hr variant than the average of all tires tested.

The self-cleaning measurements show that at the set IP of 0.6 bar, the amount of soil picked up by the tires varies depending on the tread and tire manufacturer. The BKT AGRIMAX V-FLECTO picked up the least amount of soil here, followed by the next competitor with an 8 % gap and the worst with 126 % more dirt on the road.

Table 1:
Overview of results

DLG QUALITY PROFILE	Evaluation*
Soil conservation	
Wheel contact area	■ ■ ■ ■ ■
Ground pressure	■ ■ ■ ■ ■
Track depth	■ ■ ■ ■ ■
Fuel saving	
Field work	■ ■ ■ ■ □
Transportation tasks	■ ■ ■ ■ □
User friendliness	
Soil discharge	■ ■ ■ ■ ■
Self-cleaning	■ ■ ■ ■ ■

* The DLG test framework provides the following options in its evaluation schemes:
 ■ ■ ■ or better = meets, exceeds or clearly exceeds the specified DLG standard,
 ■ □ = meets the legal requirements for marketability, ■ = failed

The method

Resources protection

The aim of testing agricultural tires for tractors in the DLG Testing Module “Resources Protection” is to examine the tires in terms of their effect on the soil during field use and fuel consumption during field use and during transport tasks. For this purpose, the tires are mounted on suitable tractors and driven in field tests under practical operating conditions and on the DLG rolling testbed.

Measurements for the tractive force slip curve and the tire footprint areas are carried out in the field test with three inflation pressure settings. The tire inflation pressure to be set are determined as a function of the wheel loads actually applied during the test via the manufacturer inflation pressure tables determined according to the following procedure:

- Maximum (nominal) permissible inflation pressure (IP_{MAX})
- Medium inflation pressure according to manufacturer’s specifications with determined load capacity for 50 km/hr
- Minimum inflation pressure according to manufacturer’s specifications with determined load capacity for 10 km/hr (IP_{MIN})

The measurements of ground pressures at 10 cm, 20 cm and 40 cm soil depth while passing and track depths after passing are measured with the low tire inflation pressure typical for the simulated field work.

The test runs are carried out on suitable agricultural land under suitable and comparable conditions. The test areas must be sufficiently large, homogeneous, even and suitably prepared for the work to be simulated. The test areas (soil type, texture, vegetation if applicable, impact history) and test conditions (weather, soil moisture and condition of the test area) are documented.

The following parameters are determined as essential parameters for the evaluation in the field test inside the DLG test module “Resources Protection”:

- Wheel loads
- Inflation pressures
- Actual driving speed
- Distance driven
- Fuel consumption in l/hr
- Tire footprint area
- Ground pressure during the pass at 10 cm, 20 cm and 40 cm ground depth (Bolling probes)
- Track depth after passing

For the simulation of transport tasks measurement runs carried out at the DLG rolling testbed. The test method is based on the ‘DLG Powermix’ test framework. The ‘DLG Powermix’ transport test simulates two different test courses:

- uphill course that requires high pulling power
- flat land course with a relatively low tractive power requirement

The elevation profiles of the real road courses had been entered to the test software which reproduced them on the rolling testbed. The measurements taken are:

- engine speed
- fuel consumption
- AdBlue consumption
- ground speed and time taken

The main technical parameters of the used vehicles that are relevant for the test are recorded and documented.

User friendliness

The soil discharge and self-cleaning are measured after driving over the field several times. For this purpose, a silage film is laid out after the crossings and driven over with the tractor. After a total of three rear wheel revolutions, the tractor is stopped and the remaining soil is removed from the tire treads and weighed.

To classify the measurement results, comparative tests are carried out in the test with reference tires available on the market.



Figure 3:
Tractor at the DLG rolling testbed

Detailed account of the test results

DLG Test module “Resources protection”

Test field

The first trials were conducted in September 2023 in the vicinity of Neumünster (SH) on a harvested wheat field. The area was cultivated with an intercrop (mustard). The soil type at the trial site is silty loam and the trial area is largely homogeneous and even. The soil moisture content measured at random during the trial was around 39 % over the trial period at a depth of 0 to 30 cm.

The second set of field trials for self-cleaning test were conducted in November 2023 again in the vicinity of Neumünster (SH) on a harvested maize field.

Axle loads, rolling circumference, leads and inflation pressures

The wheels were mounted on a Fendt 724 Vario (Gen6) for the field test. The tractor was ballasted with a front weight of 1,200 kg. The wheel loads and axle loads were then determined. Table 3 shows the results. FENDT Vario 828 was used as the brake tractor.

The static weight distribution of 50 % on the front and rear axles of a pulling tractor changes dynamically as soon as the brakes are applied. The target weight distribution of 40 % on the front axle and 60 % on the rear axle is thus achieved.

Table 4 shows the initial date and the theoretical as well as the measured leads for the tested tires. The lead measured with an tire inflation pressure of 2 bar should be between 0.5 and 4.5 percent. All tires measured do this, three are less than 1 % and two are greater than 3 %.

The selected inflation pressures were based on the manufacturer specifications in the tire pressure tables for the determined tire load and speeds. The aim was to set the same tire inflation pressure for all tires. In the test carried out, the wheel loads allowed all selected inflation pressures without reaching their limits. The selected inflation pressures were as follows: $IP_{max} = 2.0$ bar; 50 km/hr = 1.3 bar; 10 km/hr = 0.6 bar.

Table 4:

Rolling circumferences and leads of tires

Rolling circumferences and leads						
	BKT AGRIMAX V-FLECTO	Reference tires A	Reference tires B	Reference tires C	Reference tires D	Reference tires E
Size front wheel	VF540/65 R30 158D	VF540/65 R30 161D	VF540/65 R30 158D	VF540/65 R30 158D	VF540/65 R30 158D	VF540/65 R30 158D
Rolling circumference [mm]	4,351	4,346	4,339	4,292	4,450	4,360
Size rear wheel	VF650/65 R42 174D	VF650/65 R42 174D	VF650/65 R42 174D	VF650/65 R42 174D	VF650/65 R42 174D	VF650/65 R42 174D
Rolling circumference [mm]	5,773	5,596	5,682	5,682	5,810	5,690
Theor. lead [%]	0.99	1.02	1.00	0.99	1.00	1.00
Measured lead at IP 2.0 bar [%]	0.80	0.99	4.33	3.85	1.075	0.76



Figure 4:

Test area after passing

Table 3:

Axle loads and wheel loads

Fendt 724 Vario (Gen6) front weight 1,200 kg			
	Axle load [kg]	Distribution [%]	Wheel load [kg]
Front	4,890	51	2,445
Rear	4,690	49	2,345
Total weight	9,580		

Tractive force slip curve

The tractive force/slip-behavior with inflation pressure of 0.6 bar shows that most of the tires tested can transmit tractive forces of approximately 68 kN. This means that a mass of 6.94 t is pulled by the tractor with a slip of 37 %. The BKT AGRIMAX V-FLECTO shows the best result here, closely followed by other reference tires, with the worst of the six tires tested managing to pull just 5.4 t.

Contact area – tire footprint area

The tire footprint of each tire type was visualized by dusting the right tires and afterwards measured. VF tire technology enables a bigger reduction in the tire’s inflation pressure. Increased tire footprint area reduces the pressure exerted on the ground. The results for the rear axle are shown in Table 5.

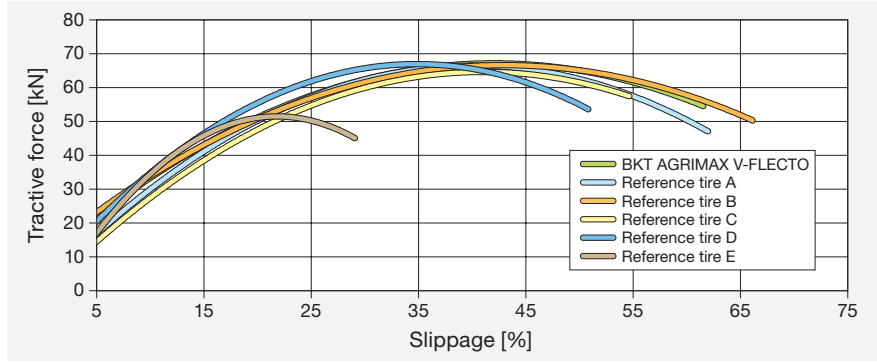


Figure 5: Traction/slip curve with 0.6 bar tire pressure



Figure 6: Dusted tire footprint area

As inspected, the tire footprint area increases as the inflation pressure decreases. Reducing the tire inflation pressure from 2.0 bar to 0.6 bar increases the tire footprint area of the tested tires by 5 % to 33 %. On average, an increase in tire footprint area of 21 % is achieved across all tires. Within the tested tires, the largest tire footprint area was measured for the BKT AGRIMAX V-FLECTO VF650/65 R42 at 0.6 bar inflation pressure.

At low inflation pressure (0.6 bar), the tire footprint areas of the BKT AGRIMAX V-FLECTO VF650/65 R42 were 4 % to 23 % larger compared to the other tires. It’s tire footprint area increases by 1,134 cm² when the tire’s inflation pressure is lowered by 1.4 bar.

The increase in tire footprint area at constant wheel load means a reduction in contact surface pressure per square centimetre of contact area. The average measured contact area pressure on the rear axle (in the test at 0.6 bar inflation pressure) is 0.52 kg/cm². Here, the BKT AGRIMAX V-FLECTO achieves the lowest contact surface pressure of 0.47 kg/cm² – i.e. 9.77 % lower than the average.

Table 5: Rear axle tire footprint areas with selected IP

	Tire footprint area [cm ²]					
	BKT AGRIMAX V-FLECTO	Reference tires A	Reference tires B	Reference tires C	Reference tires D	Reference tires E
Size rear wheel	VF650/65 R42 174 D	VF650/65 R42 174 D	VF650/65 R42 174 D	VF650/65 R42 174 D	VF650/65 R42 174 D	VF650/65 R42 174 D
2.0 bar (IP max.)	3,906 (100 %)	3,782 (97 %)	3,540 (91 %)	4,020 (103 %)	3,828 (98 %)	3,712 (95 %)
1.3 bar	4,284 (100 %)	4,087 (95 %)	3,660 (85 %)	4,080 (95 %)	4,060 (95 %)	3,770 (88 %)
0.6 bar	5,040 (100 %)	4,836 (96 %)	4,720 (94 %)	4,680 (93 %)	4,350 (86 %)	3,886 (77 %)

Ground pressure

When driving over the ground pressure was measured in the test using Bolling tubes.

The ground pressure and its propagation are described in the literature as isobars. The decrease of ground pressure in depth is significantly influenced by the tire footprint area. The pressure under the track in the ground decreases with a higher depth, when driving over.

The BKT AGRIMAX V-FLECTO has the lowest ground pressure values measured on the Bolling tubes at an tire inflation pressure of 0.6 bar. Overall, there is a close correlation between the measured ground pressure values at a depth of 10 cm and the set tire inflation pressure. The ground pressure at a depth of 40 cm is mainly influenced by the size of the tire footprint area. The BKT AGRIMAX V-FLECTO in particular shows that the ground pressure is well below the limit of 0.2 bar described in the literature (-45 %).

Figure 8 shows the individual results.

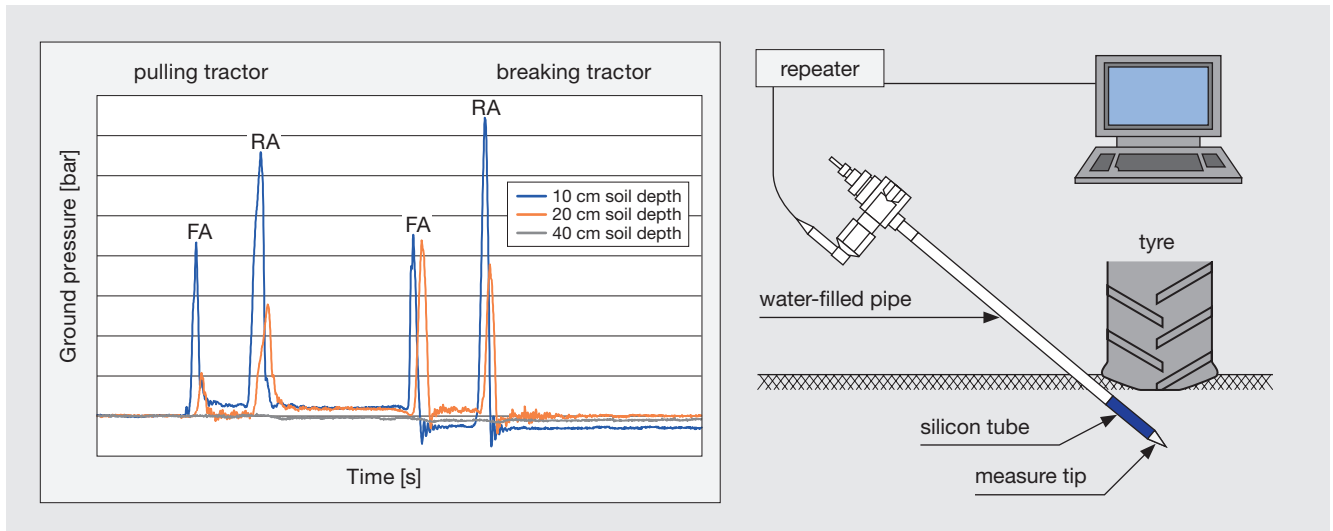


Figure 7:
Schematic representation of the ground pressure measurement by means of Bolling tubes

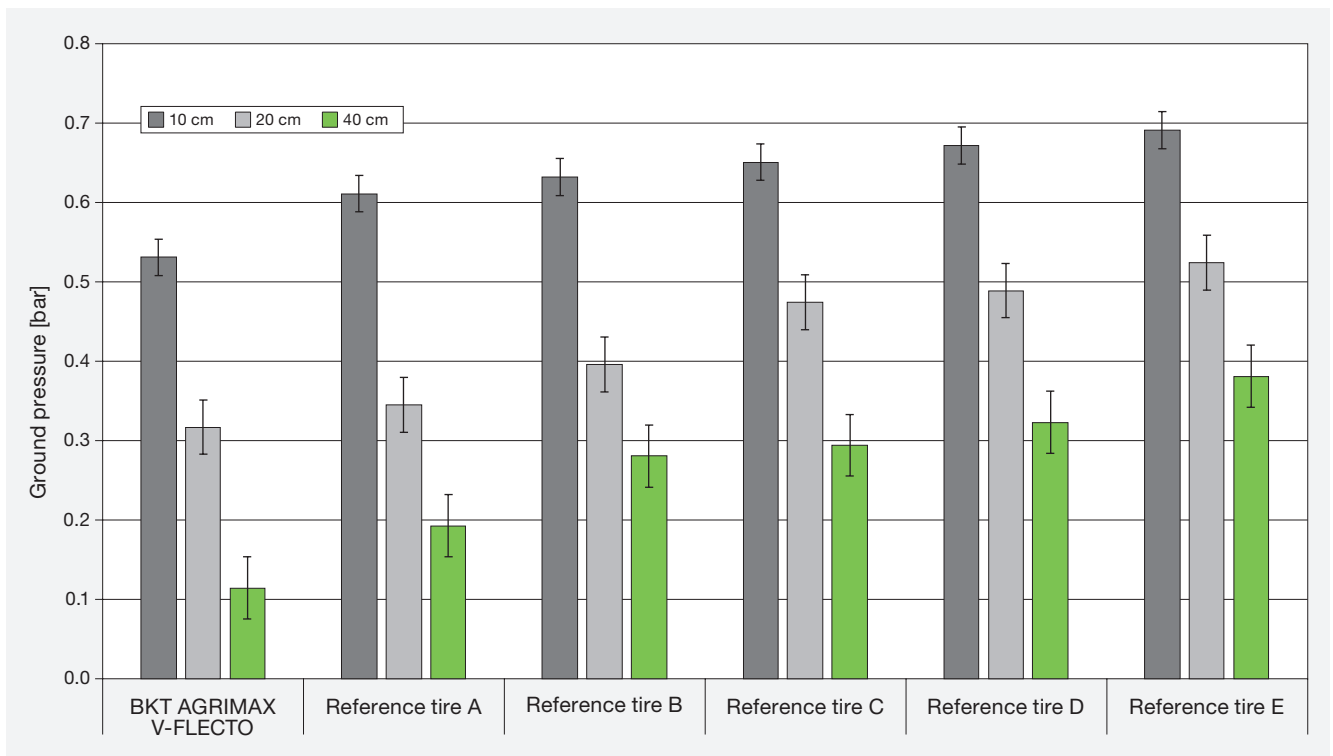


Figure 8:
Ground pressure at measurement depths of 10 cm, 20 cm and 40 cm

Track depth at IP 0.6 bar

The relationship between the tire footprint area, the contact area pressure and the resulting ground pressure can be seen in the track depth produced. As the track depth increases, so does the risk of compaction and the need for more intensive tillage to loosen and level the tracks. Figure 9 shows the track depths measured in the test under the experimental conditions.

The BKT AGRIMAX V-FLECTO and a second reference tire, had the smallest track depth at 0.6 bar.

The track depth was 11.4 % lower compared to the average value across all tires tested.

Tractive Power and area performance

The average transmittable tractive power (tractive force*speed) amounted to 100.37 kW in the field test. The BKT AGRIMAX V-FLECTO was able to transmit a 1.6 % higher tractive power and thus work efficiently with the energy used.

The area performance (based on a 3 m wide tillage implement) in ha/hr is on average 2.6 hectares per hour. Three of the tested tire sets are above and three below the average. The BKT AGRIMAX V-FLECTO and a second reference tire achieved the highest performance of 2.66 ha/hr here. Both were 2.3 % better than the average and even 5.1 % better than the worst reference tire in the test.

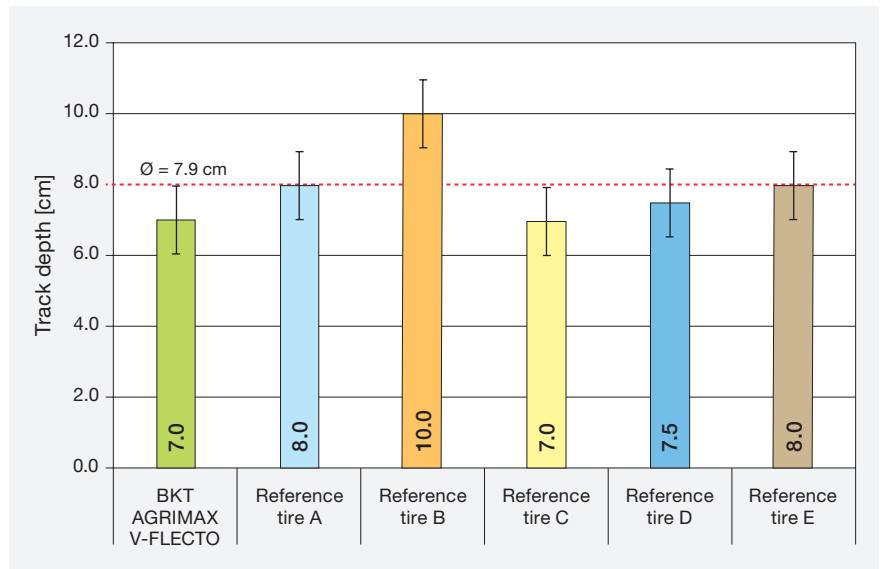


Figure 9:
Track depth

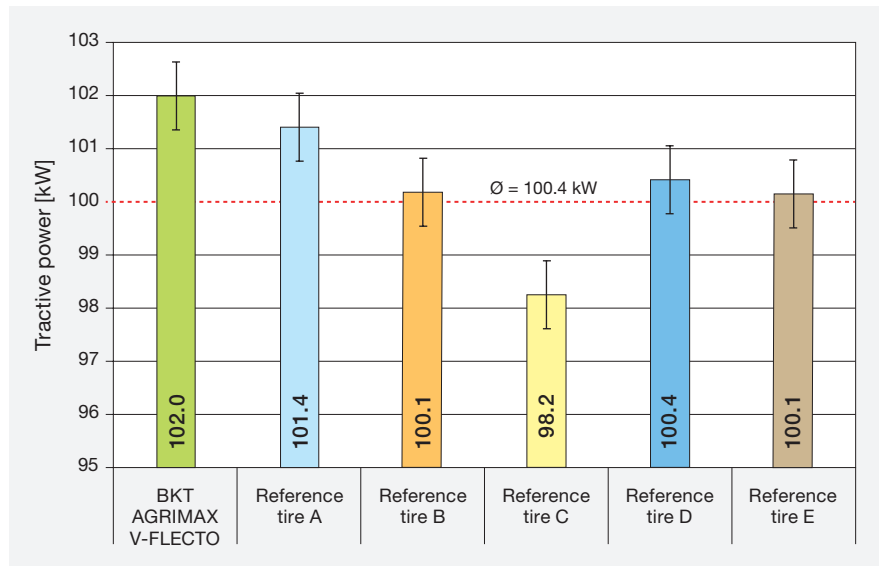


Figure 10:
Tractive Power [kW] with 0.6 bar IP and 40 kN braking force

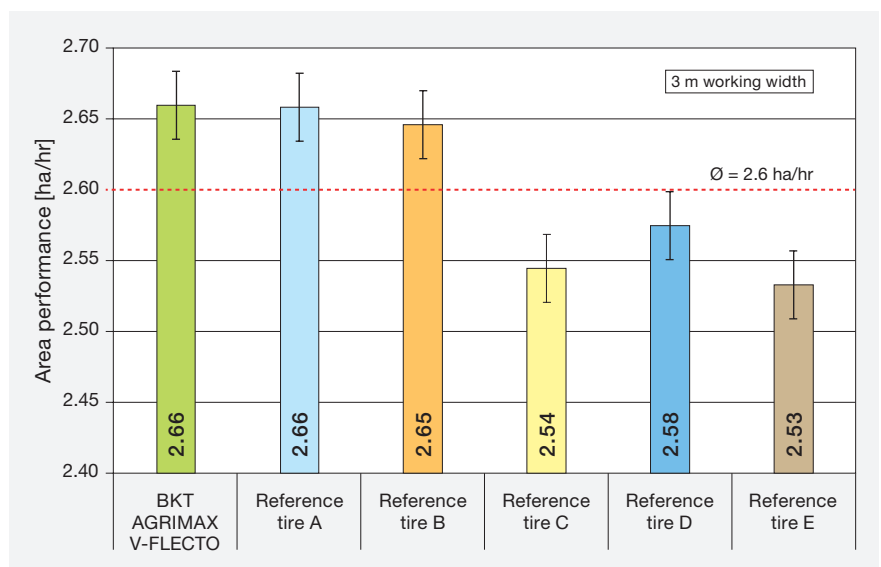


Figure 11:
Area Performance at 0.6 bar IP and 40 kN braking force

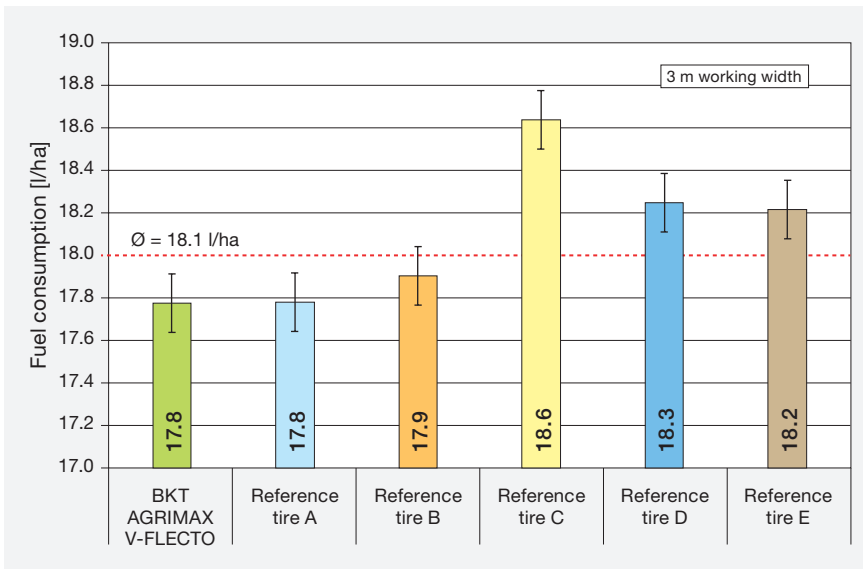


Figure 12:
Fuel consumption [l/ha] at 0.6 bar and 40 kN braking force

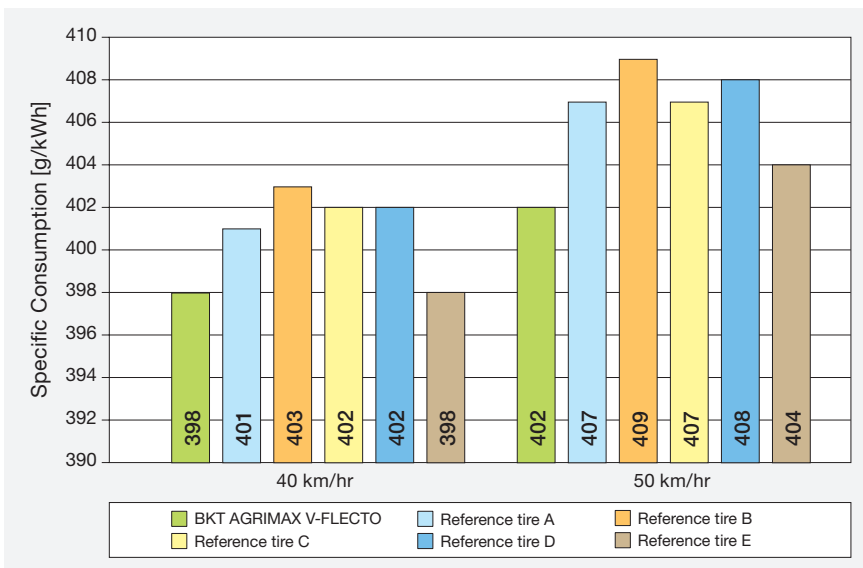


Figure 13:
Transport Test – Specific fuel consumption [g/kWh]

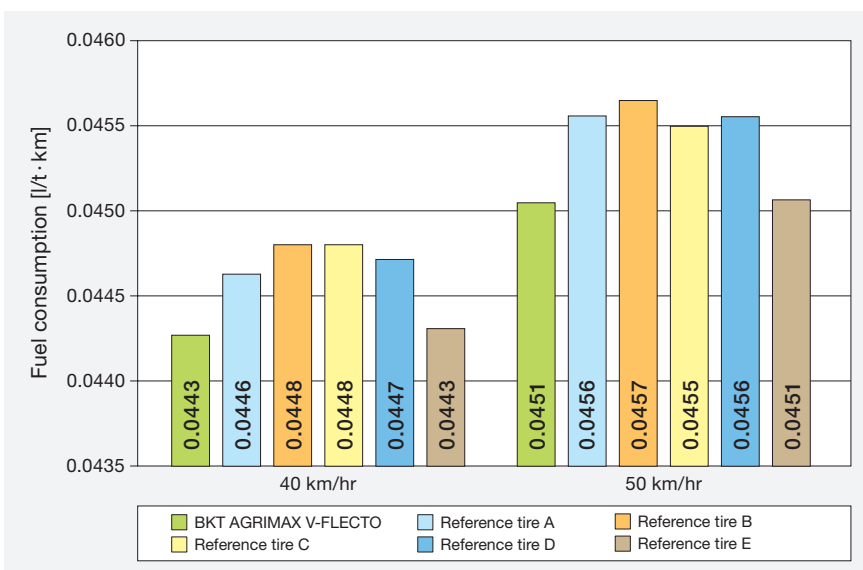


Figure 14:
Transport Test – Fuel consumption [l/t·km]

Fuel consumption in the field test

Fuel consumption in the field test was recorded by the CAN bus during each test run. The fuel consumption in l/ha shows a comparable result to the area performance. Tires with a higher area performance are more efficient in relation to the area worked. A 3 m wide tillage implement was also assumed here. The average consumption in the test is 18.1 l/ha, with 0.6 bar tire inflation pressure and a braking force of 40 kN. The BKT AGRIMAX V-FLECTO here also performs best in comparison and is 1.8 % better than the average.

Fuel consumption in transport tasks

The results of the transport test are given in specific fuel consumption [g/kWh] and fuel consumption in litre/ton and km [l/t·km]. This is available in the 40 km/hr and 50 km/hr variants on the flat track.

The tested set of BKT AGRIMAX V-FLECTO tires mounted on a Fendt 720 Vario Gen6, achieved good results compared to the tested reference tires under the same conditions. In the overall assessment in the transport test with the 40 km/hr variant, the BKT AGRIMAX V-FLECTO and a second reference tire share first place here and are 0.7 % better in specific fuel consumption than the average value of all tires tested. In the 50 km/hr variant, the BKT AGRIMAX V-FLECTO is also in first place with a specific fuel consumption that is 1.0 % lower than the average value of all tires tested.

In terms of fuel consumption per ton·kilometre, the BKT AGRIMAX V-FLECTO achieves a saving of 0.7 % in the 40 km/hr variant and 0.8 % less in the 50 km/hr variant than the average of all tires tested.

DLG Test module “User friendliness”

The soil discharge and self-cleaning was measured after the maize harvest by using the tires on a harvested maize field and driving several lanes across the field. On average, the tire sets lost 12.6 kg of soil and were almost free of soil build-up after three wheel rotations.

BKT AGRIMAX V-FLECTO has the lowest values here, 46 % below the average, followed by the next reference tire with 8% more soil. The weakest reference tire in this category carried 80 % more soil and lost it on the road than the average, which is 126 % more than the BKT AGRIMAX V-FLECTO.

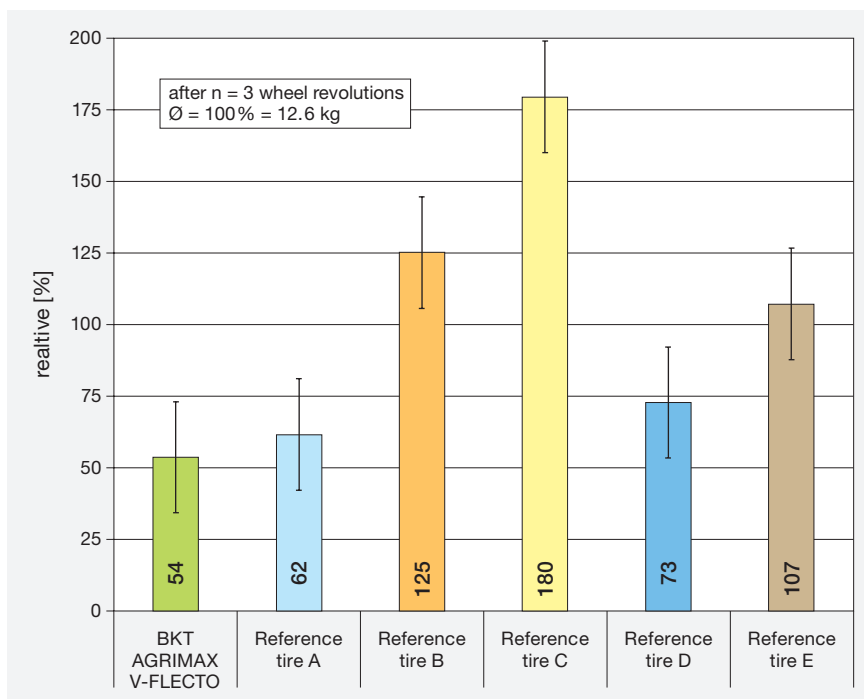


Figure 15:
Soil discharge and self-cleaning

Conclusion

VF technology represents a significant improvement in the tractor tire segment. According to the authors, factors such as soil preservation (track depth and ground pressure) are to be weighted higher than fuel consumption for the farmer and society.

The tested BKT AGRIMAX V-FLECTO impressed in the field test. The traction and the tractive forces transmitted with it were better than the reference tires at 0.6 bar inflation pressure. The tractive force slip curve shows that the BKT AGRIMAX V-FLECTO can transmit 67.5 kN at 37 % slip, with an inflation pressure of 0.6 bar.

Within the tested tires, the largest tire footprint area was measured for the BKT AGRIMAX V-FLECTO at 0.6 bar inflation pressure. The increased tire footprint area at constant wheel load leads to a comparatively low contact surface pressure per square centimetre of contact area. The ground pressures measured show a clear correlation between contact area and depth of penetration. The BKT AGRIMAX V-FLECTO showed at a depth of 10 cm a ground pressure 16 % less than the other tires and has the smallest track depth at 0.6 bar.

The BKT AGRIMAX V-FLECTO achieved the highest area performance and a low fuel consumption in l/ha.

In transport test at the DLG rolling testbed, the BKT AGRIMAX V-FLECTO share first place with a second reference tire for the 40 km/hr variant. In the 50 km/hr variant, the BKT AGRIMAX V-FLECTO is also in first place with a specific fuel consumption that is 1.0 % lower than the average value of all tires tested. In terms of fuel consumption per ton and km, the BKT AGRIMAX V-FLECTO achieves a saving of 0.7 % in the 40 km/hr variant and 0.8 % less in the 50 km/hr variant than the average of all tires tested.

The soil discharge and self-cleaning measurements show that at tire inflation pressure of 0.6 bar the BKT AGRIMAX V-FLECTO picked up the least amount of soil here, followed by the next reference tire with an 8 % gap and the worst with 126 % more dirt on the road.

The agricultural tractor tire combination BKT AGRIMAX V-FLECTO VF650/65 R42 and BKT AGRIMAX V-FLECTO VF540/65 R30 was able to convince in the DLG test with the specified test criteria. Based on the results achieved, the tire combination BKT AGRIMAX V-FLECTO VF650/65 R42 and BKT AGRIMAX V-FLECTO VF540/65 R30 is awarded the DLG-APPROVED quality mark for the test modules “Resources Protection” and “User friendliness”.

Further information

Testing agency

DLG TestService GmbH, Gross-Umstadt location, Germany, in cooperation with the Kiel University of Applied Sciences, Faculty of Agriculture, Dept. Agricultural Engineering

The tests are conducted on behalf of DLG e.V.

DLG test framework

DLG Test Framework for Agricultural Tyres (current as 07/2023)

Department

Vehicle technology

Examiner

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Photos and graphics

DLG, Kiel University of Applied Sciences, Department of Agriculture, Dept. Agricultural Engineering and BKT Europe Srl

* Author

DLG – the open network and professional voice

Founded in 1885 by the German engineer Max Eyth, DLG (Deutsche Landwirtschafts-Gesellschaft – German Agricultural Society) is an expert organisation in the fields of agriculture, agribusiness and the food sector. Its mission is to promote progress through the transfer of knowledge, quality standards and technology. As such, DLG is an open network and acts as the professional voice of the agricultural, agribusiness and food sectors.

As one of the leading organisations in the agricultural and food market, DLG organises international trade fairs and events in the specialist areas of crop production, animal husbandry, machinery and equipment for farming and forestry work as well as energy supply and food technology. DLG's quality tests for food, agricultural equipment and farm inputs are highly acclaimed around the world.

For more than 130 years, our mission has also been to promote dialogue between academia, farmers and

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Leaders in the testing of agricultural equipment and input products

The DLG Test Center Technology and Farm Inputs and its test methods, test profiles and quality seals hold a leading position in testing and certifying equipment and inputs for the agricultural industry. Our test methods and test profiles are developed by an independent and impartial commission to simulate in-field applications of the products. All tests are carried out using state-of-the-art measuring and test methods applying also international standards.

Internal test code DLG: 2308-0022

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