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## **BELKAR™ - a new herbicide for the control of a wide range of broadleaf weeds in winter oilseed rape applied post-emergence in autumn**

*BELKAR™ - ein neues Herbizid zur Bekämpfung eines breiten Spektrums von dikotylen Unkräutern in Winterraps im Nachauflauf Herbst*

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### **Abstract**

Autumn-applied pre-emergence herbicides are currently the primary options for weed control used in winter oilseed rape. A characteristic of the new product BELKAR™ herbicide is that it will be applied post-emergence in autumn. BELKAR combines both active ingredients Arylex™ Active and Picloram and therefore contains two non-ALS mode of actions. While Picloram has been widely used in oilseed rape in recent years, Arylex is a new auxinic herbicide for the post-emergence weed control of important broad-leaved weeds. Arylex is the first member of the 'Arylpicolinate' structural class, a new class within the HRAC Group O. The ISO common name of Arylex is 'halauxifen-methyl' (DOW AGROSCIENCES, 2013). BELKAR is the first herbicide in Europe containing this active for the use in winter oilseed rape. With a maximum use rate of 0.5 L/ha, the product will deliver 4.8 g ae/ha of Arylex and 24 g ae/ha of Picloram. BELKAR can be applied as a sequential application from crop stage of BBCH 12-14 at rates of 0.25 L/ha or a single application with 0.5 L/ha from crop stage BBCH 16. BELKAR provides control of a wide range of key weeds, including most important ones such as *Capsella bursa-pastoris*, *Centaurea cyanus*, *Galium aparine*, *Papaver rhoeas*, *Geranium* spp., *Thlaspi arvense*, *Matricaria* spp. and *Descurainia sophia*. With BELKAR, a post-emergence herbicide application in autumn offers a viable option for effective weed control in oilseed rape. As a new concept, the tank mix combination BELKAR with the active ingredient Aminopyralid will even more expand the weed spectrum and will provide an alternative to pre-emergence herbicide applications in winter oilseed rape.

**Keywords:** Aminopyralid, Arylex, BELKAR, broadleaf weed control, picloram, winter oilseed rape

### **Zusammenfassung**

Die Anwendung von Voraufherbiziden im Herbst ist das vorrangige Mittel der Wahl bei der Unkrautbekämpfung im Winterraps. Der Ansatz für BELKAR™ ist die Verlagerung der Herbizidanwendung vom Vorauf in den Nachauflauf im Herbst. BELKAR kombiniert die beiden Wirkstoffe Arylex™ active und Picloram™ und enthält damit zwei nicht-ALS Wirkmechanismen. Picloram wird schon seit vielen Jahren erfolgreich im Winterraps eingesetzt, der Wirkstoff Arylex ist ein neuer Wirkstoff aus der Gruppe der Auxin-ähnlichen Herbizide für die Bekämpfung von wichtigen zweikeimblättrigen Unkräutern. Arylex ist der erste Vertreter der Wirkstoffgruppe der 'Arylpicolinate', einer neuen Gruppe innerhalb der HRAC-Gruppe O. Der wissenschaftliche Name von Arylex ist Halauxifen-methyl' (DOW AGROSCIENCES, 2013). BELKAR ist das erste Herbizid in Europa, welches den Wirkstoff Arylex zur Anwendung im Winterraps enthält.

Mit einer maximalen Aufwandmenge von 0.5 L/ha werden 4.8 g ae/ha Arylex und 24 g ae/ha Picloram ausgebracht. BELKAR kann sowohl im Rahmen einer Splitting-Anwendung mit 0.25 L/ha ab Kulturstadium BBCH 12-14 oder mit einer einmaligen Anwendung von 0.5 L/ha ab Kulturstadium BBCH 16 ausgebracht werden. BELKAR kontrolliert ein breites Spektrum an wichtigen Unkräutern im Winterraps, einschließlich *Capsella bursa-pastoris*, *Centaurea cyanus*, *Galium aparine*, *Papaver rhoeas*, *Geranium* spp., *Thlaspi arvense*, *Matricaria* spp. und *Descurainia sophia*. Mit BELKAR bietet sich dem Anwender in Zukunft ein neues Bekämpfungskonzept zur Unkrautbekämpfung im Nachauflauf im Winterraps. Durch die Tankmischung von BELKAR mit dem Wirkstoff Aminopyralid wird das Wirkungsspektrum auf dikotyle Unkräuter noch erweitert und somit eine wirksame Alternative zur Unkrautkontrolle im Vorauf geschaffen

**Stichwörter:** Aminopyralid, Arylex, Bekämpfung dikotyle Unkräuter, BELKAR, Picloram, Winterraps

### **Introduction**

Dow AgroSciences has developed the new herbicide Arylex™ active, which targets important broadleaf weeds. Beside the currently ongoing development of the active in the cereal segment (DZIKOWSKI et al., 2016), two new products are developed for the use in winter oilseed rape based on this molecule. The combination of Arylex with the active picloram has the trade name BELKAR™

herbicide while Arylex in combination with the active clopyralid will have the trade name KORVETA™ herbicide. The product KORVETA will be available for the use as a spring application in winter oilseed rape.

### **Chemical properties of Arylex™ Active**

Common name	Halauxifen-methyl
Chemical family	Arylpicolinate
Empirical formula	C <sub>14</sub> H <sub>11</sub> Cl <sub>2</sub> FN <sub>2</sub> O <sub>3</sub>
Molecular weight	345.17 g/mol
Vapor pressure	5.9 x 10 <sup>-9</sup> Pa at 20°C
Solubility (water 20°C; in mg/L)	pH 5: 1,67; pH 7: 1,67; pH 9: 1,69
Octanol/Water Partition Co-Efficient ( <i>log P<sub>ow</sub></i> )	pH 7 = 3.76
Soil Adsorption Constant ( <i>K<sub>oc</sub></i> )	473 – 2659 mL/g (average = 1418 mL/g)

BELKAR is a selective herbicide for the control of dicotyledonous weeds in winter oilseed rape. The product contains 48 g ae/L picloram and 9.6 g ae/L halauxifen-methyl and is formulated as an emulsifiable concentrate (EC). With a maximum use rate of 0.5 L/ha, the product will deliver 4.8 g ae/ha of Arylex and 24 g ae/ha of Picloram.

The application timing of BELKAR is a post-emergence treatment. BELKAR can be applied as a sequential application from crop stage of BBCH 12 at rates of 0.25 L/ha followed by a second application from crop stage BBCH 16 with dose rates of 0.25 L/ha or a single application with 0.5 L/ha from crop stage BBCH 16. The actives Arylex and Picloram in the product BELKAR belong both to the HRAC-group O.

### **Characteristics of the formulated product BELKAR**

Active ingredients	Halauxyfen-methyl 9.6 g ae/L; picloram 48 g ae/L
Target crop	Winter oilseed rape
Formulation type	EC (Emulsifiable concentrate)
Mode of action	Synthetic auxins – both compounds; HRAC-group O
Application timing and recommended dose rate	Sequential application in autumn from crop stage BBCH 12-14: 0.25 L/ha from crop stage BBCH 16: 0.25 L/ha
	Single late application in autumn: from crop stage BBCH 16: 0.5 L/ha

### **Materials and Methods**

Development trials with BELKAR™ herbicide were conducted as a sequential application from targeted crop stage of BBCH 12-14 at a rate of 0.25 L/ha followed by a second application at targeted crop stage BBCH 16 or a single application with 0.5 L/ha from targeted crop stage BBCH 16.

Applications for targeted crop stage BBCH 12-14 were made when 90% of the crop had reached BBCH 12. Applications for targeted crop stage BBCH 16 were made when 90% of the crop had reached BBCH 16. At the sequential application, the application intervals between BBCH12-14 and BBCH 16 ranged from 14 to 28 days.

Trials were carried out in the maritime EPPO zone in the Czech Republic, Germany, United Kingdom, Denmark and Sweden. Trials were set up by the Dow AgroSciences internal field research and development department and by contract research organisations in accordance with GEP guidelines. Most of the trials followed a randomized complete block design with 4 replicates and plot sizes between 12 m<sup>2</sup> and 36 m<sup>2</sup>. The trials were carried out during the season 2013/2014 and 2014/2015.

Regular visual assessments of the herbicidal efficacy were made during autumn and spring after application. The weed control was rated visually as an overall score of the percentage control relative to the non-treated check.

In a further trial program initiated in autumn 2015 and continued in 2016 in Germany, the efficacy of BELKAR applied twice as a sequential application in combination with the active Aminopyralid was tested. At the first application (targeted crop stage BBCH 12-14), BELKAR was applied at a dose rate of 0.25 L/ha in tankmixture with Aminopyralid at a dose rate of 8 g ae/ha. At the second application (from targeted crop stage BBCH 16), BELKAR alone was applied at a dose rate of 0.25 L/ha. Application intervals between the two applications ranged from 14 to 28 days. Applications were carried out with spray volumes of 200 L/ha. For easier reading, this concept is hereinafter referred to as "BELKAR+Aminopyralid concept".

## Results

Efficacy spectrum of BELKAR™ herbicide when applied with sequential application at crop stage BBCH 12-14 and from crop stage BBCH 16

When applied as a sequential application, BELKAR provides a high level of control (93-99% efficacy) of a wide range of broadleaf weeds including key species such as *Capsella bursa-pastoris*, *Centaurea cyanus*, *Galium aparine*, *Lamium spp.*, *Fumaria officinalis*, *Papaver rhoeas*, *Geranium spp.*, *Thlaspi arvense* and *Descurainia sophia*. BELKAR applied as a sequential application provides 90% control of *Matricaria chamomilla*. *Stellaria media* is moderately susceptible but sufficiently controlled, while *Viola arvensis* is not sufficiently controlled.

**Tab. 1** Efficacy of BELKAR applied twice with 0.25 L/ha as a sequential application at crop stage BBCH 12-14 and from BBCH 16. Data from Germany, Czech Republic, United Kingdom, Denmark and Sweden are summarized.

**Tab. 1** Wirkung einer BELKAR-Splitting Anwendung in Raps zu BBCH Stadium 12-14 und BBCH 16 mit jeweils 0,25 l/ha. Datengrundlage sind Versuche aus Deutschland, Tschechien, Vereinigtes Königreich, Dänemark, Schweden.

Weed species	Weed code	Number of trials	Efficacy of BELKAR applied with a sequential application at crop stage BBCH 12-14 and from crop stage BBCH 16 [% control]
<i>Lamium spp.</i>	LAMSS	13	99.0
<i>Geranium pusillum</i>	GERPU	7	98.5
<i>Fumaria officinalis</i>	FUMOF	7	97.1
<i>Centaurea cyanus</i>	CENCY	5	96.5
<i>Thlaspi arvense</i>	THLAR	14	94.8
<i>Descurainia sophia</i>	DESSO	2	94.5
<i>Galium aparine</i>	GALAP	13	93.9
<i>Capsella bursa-pastoris</i>	CAPBP	19	93.9
<i>Papaver rhoeas</i>	PAPRH	12	93.5
<i>Matricaria chamomilla</i>	MATCH	4	90.1
<i>Stellaria media</i>	STEME	17	77.1
<i>Viola arvensis</i>	VIOAR	30	64.8

Efficacy spectrum BELKAR™ herbicide when applied as a single late application from crop stage BBCH 16

When applied as a single late application from crop stage BBCH 16, BELKAR provides very good control of key species such as *Centaurea cyanus*, *Galium aparine*, *Papaver rhoeas*, *Geranium spp.*, *Descurainia sophia* and *Lamium spp.* BELKAR showed good control of *Matricaria chamomilla* (>92% control).

*Thlaspi arvense*, a weed which becomes more difficult to control with increasing growth stages, showed moderate but still sufficient control at the late application timing of BELKAR. *Stellaria media* and *Viola arvensis* were not sufficiently controlled by a single late application.

**Tab. 2** Efficacy of BELKAR applied once with a dose rate of 0.5 L/ha at winter oilseed rape crop stage BBCH 16. Data from Germany, Czech Republic, United Kingdom, Denmark and Sweden are summarized.

**Tab. 2** Wirkung von BELKAR bei einmaliger Anwendung mit 0,5 l/ha zu Raps BBCH Stadium 16. Datengrundlage sind Versuche aus Deutschland, Tschechien, Vereinigtes Königreich, Dänemark, Schweden.

Weed species	Weed code	Number of trials	Efficacy of BELKAR applied as a single application from crop stage BBCH 16 [% control]
<i>Lamium spp.</i>	LAMSS	12	98.7
<i>Geranium pusillum</i>	GERPU	7	91.5
<i>Fumaria officinalis</i>	FUMOF	7	98.5
<i>Centaurea cyanus</i>	CENCY	5	98.2
<i>Thlaspi arvense</i>	THLAR	14	85.1
<i>Descurainia sophia</i>	DESSO	2	96.0
<i>Galium aparine</i>	GALAP	13	91.1
<i>Capsella bursa-pastoris</i>	CAPBP	19	91.3
<i>Papaver rhoeas</i>	PAPRH	11	93.6
<i>Matricaria chamomilla</i>	MATCH	3	92.0
<i>Stellaria media</i>	STEME	17	75.0
<i>Viola arvensis</i>	VIOAR	28	56.1

Field performance of the tankmix combination BELKAR™ herbicide with the active Aminopyralid ("BELKAR+Aminopyralid concept")

In a 2 year trial program, the efficacy of BELKAR applied twice as a sequential application in combination with Aminopyralid was tested. At the first application (targeted crop stage BBCH 12-14), BELKAR was applied at a dose rate of 0.25 L/ha in tankmixture with the active Aminopyralid at a dose rate of 8 g ae/ha. At the second application timing (from crop stage BBCH 16), BELKAR was applied at a dose rate of 0.25 L/ha. No Aminopyralid was added to BELKAR at the second application timing.

The addition of Aminopyralid to BELKAR expands the spectrum of activity against dicotyledonous weeds and provides more robust control against some weeds. Key species, such as *Capsella bursa-pastoris*, *Galium aparine*, *Geranium spp.*, *Thlaspi arvense*, *Fumaria officinalis* and *Descurainia sophia* are still controlled at a very high level. Furthermore, the efficacy against specific weeds, such as *Matricaria spp.*, *Papaver rhoeas* and *Centaurea cyanus* increases by trend (> 98% control). *Viola arvensis* proved more susceptible with >75% control.

**Tab. 3** Efficacy of BELKAR in tankmixture combination with aminopyralid. 2-year trial data from Germany are summarized.

**Tab. 3** Wirkung von BELKAR in Tankmischung mit Aminopyralid – Datengrundlage sind 2 jährige Versuchsergebnisse aus Deutschland.

Weed species	Weed code	Number of trials	Efficacy of BELKAR in combination with Aminopyralid* [% control]
<i>Lamium</i> spp.	LAMSS	2	98.5
<i>Geranium</i> spp.	GERSS	3	99.1
<i>Fumaria officinalis</i>	FUMOF	2	98.9
<i>Centaurea cyanus</i>	CENCY	3	99.1
<i>Thlaspi arvense</i>	THLAR	1	95.0
<i>Descurainia sophia</i>	DESSO	1	98.0
<i>Galium aparine</i>	GALAP	1	95.3
<i>Capsella bursa-pastoris</i>	CAPBP	3	96.1
<i>Papaver rhoeas</i>	PAPRH	3	98.0
<i>Matricaria</i> spp.	MATSS	3	98.0
<i>Stellaria media</i>	STEME	2	72.5
<i>Viola arvensis</i>	VIOAR	2	75.2

\*BELKAR 0.25 L/ha + Aminopyralid 8 g ae/ha at targeted BBCH 12-14 of the crop followed by a second application of BELKAR 0.25 L/ha at targeted BBCH 16 of the crop

## Discussion

Dow AgroSciences has developed the new herbicide Arylex™ active, which targets broadleaf weeds in various crops such as cereals and oil seed rape. For specific use in winter oilseed rape, the product BELKAR is developed. BELKAR combines the two active ingredients Arylex and picloram. The characteristic of BELKAR is that it will be applied in winter oilseed rape as post-emergence treatment in autumn.

BELKAR can be applied as a sequential application from crop stage of BBCH 12 at rates of 0.25 L/ha followed by a second application from crop stage BBCH 16 with dose rates of 0.25 L/ha or it can be applied as a single late application with 0.5 L/ha from crop stage BBCH 16.

When applied at a sequential application, BELKAR provides control of a wide range of broadleaf weeds including cruciferous species such as *Capsella bursa-pastoris*, *Thlaspi arvense* and *Descurainia sophia* but also *Centaurea cyanus*, *Galium aparine*, *Papaver rhoeas*, *Geranium* spp., *Lamium* spp. and *Matricaria chamomilla*.

When applied as a single late application from crop stage BBCH 16, BELKAR still provides a high level of control of key weed species. But as it can be seen from the field data, specific weeds, such as *Capsella bursa-pastoris* or *Thlaspi arvense*, are better controlled by a sequential application of BELKAR vs. a single late application.

When applied by a sequential application, the tank mix combination of the active Aminopyralid plus BELKAR at the first application expands the spectrum of activity against dicotyledonous weeds. The efficacy against specific weeds, such as *Matricaria* spp., *Papaver rhoeas* or *Centaurea cyanus* increases to above 98% efficacy. Furthermore *Viola arvensis* is controlled with more than >75% efficacy. As a new concept, the tank mix combination BELKAR with the active ingredient Aminopyralid provides an alternative to pre-emergence herbicide application in winter oilseed rape.

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## References

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