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CERCETĂRI PRIVIND EFICACITATEA UNOR ERBICIDE POST-EMERGENTE ÎN COMBATEREA BURUIENILOR ÎN LIVEZILE DE MĂR PE ROD
RESEARCHES ON USE OF SOME POST-EMERGENT HERBICIDES TO CONTROL WEEDS IN THE BEARING APPLES ORCHARDS

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Abstract

Mono and dicotyledonous weeds are the competitors of fruit species, in terms of growth, bearing and fruit quality. Therefore, in fruit growing, the aim is to keep the spectrum of weeds below the economic damage threshold (EDT). In this sense, different methods are used: biotechnical (mulching), mechanical (mowing), agrotechnical (black field worked, weeding between rows) or chemical (pre- or post-emergent herbicide use). The paper presents the results of research undertaken between 2019-2021 on the effectiveness of 6 post-emergent herbicides (4 total, based on glyphosate and 2 including other molecules - cycloxidim 100 g / l and oxifluorfen 240 g / l). The application of the products was carried out in an experimental module with the apple varieties 'Jonathan / M9' and 'Idared / M9', 5-7 years old, in variants and replications arranged randomly. Observations and determinations were performed according to the European Weed Research Society (EWRS) scale showed that, from the whole spectrum of weeds followed in the experimental device, the most difficult or difficult to control were the dicotyledonous weeds such as: *Equisetum arvense* (note 8-9), *Cirsium arvense*, *Gallium aparine*, *Galinsoga parviflora*, *Malva neglecta*, *Matricaria chamomilla*, *Ranunculus repens, Rumex* spp., *Stelaria media* (note 5). Among the monocotyledons difficult to control were: *Agropyron repens*, *Lolium perene* and *Cynodon dactylon*, requiring the application of herbicides twice vegetation season, or the integrated control of weeds.

Cuvinte cheie: măr, buruieni, combatere, erbicide.
Key words: apple, weeds, control, herbicides.

1. Introduction

In Europe, the average productions of pome fruits are 8,238,585 t apples and 429,340 t pears / year, harvested from 989,294 respectively 163,815 ha. On the continent, the most important apple producing countries are: Poland, Italy, France, and Germany. Romania is producing in average 488,773 t apples, from 54,970 and respectively 51,972 t pears from 3,137 ha (FAOSTAT, 2014-2019).

The weeds produce important damages to the fruit growers due their competition with the trees, sometimes the losses might reach up to 60%, therefore, the proper use of herbicides lead to the balance of the trees-weeds competition for water and nutrients and to the substitution of a high amount of labor to control them, with a more convenient technological sequence (Perianu et al., 2004).

In order to better control the weeds, is important to know the weeds biology, the products composition, the way of action into the weeds and the interaction between the herbicides (as regard solubility, volatility, persistence etc.), soil and its physico-chemical characteristics, and fruit trees. (Ghinea et al., 2004).

If herbicides are properly used, at the right dose and time, the eventually accepted residues levels can drop up to 22 times at the crop harvest moment. Today, the main goal, is to improve the crop protection and technology, to control the infestation with weeds under the economic damages threshold (EDT), as well as protect the environment and natural resources. (Sallai et al., 2000; Polesny, 2000, Perianu et al, 2004).

In the last five years, for safety reason, many active ingredients and plant protection products, including herbicides were banned and now only few are now allowed to be used in bearing orchards and nurseries.

The paper presents the research conducted at Research Institute for Fruit Growing Pitesti Romania, between 2019-2021 on the effectiveness of 6 post-emergent herbicides, in order to find the minimum efective dose, the right timing and the overall efficacy in control of the problematic mono- and dicotiledonatae weeds growing in the young bearing apples orchards.

2. Material and methods

During 2019-2021 field trials were conducted into an experimental apple orchard module with the apple varieties 'Jonathan / M9' and 'Idared / M9', aged 5-7 years, trained as slender spindel at the density of 1,904 trees/ha. The area where the researches were done belongs to national second climatic area, with solar radiation 114-128 Kcal/cm^2, mean temperatures between 9.8-11.2°C, 3400-4100 degrees over 0°C, 2,800-3,500 degrees over 10°C, mean precipitations 450-700 mm, in dry years, from April until October. The experimental plots were located on poor loam-clay soil with over 30% clay (albeluvisoil). Deep into the profile, the soil has sandy structure and includes a variable amount of coarse material. Soil surface is prismatic and friable. The soil organic matter represents 1.8% and drop with the deep. The soil is poor in nitrogen and phosphorus (nitrogen index 0.33-1.43; PAL 1.3-2.5 mg per 100g) and potassium supply is good up to 40 mg per 100g. The cationic exchange capacity (CEC) was 68.4, the water holding capacity was 50 and the soil solution pH 5.6. The variants and replicates with post-emergent herbicides were arranged randomly having a good level of infestation with mono- and dicots weeds populations.

6 post-emergent herbicides (4 total, based on glyphosate and 2 including other molecules - cycloxidim 100 g / l and oxifluorfen 240g / l). The application of the products was carried out in stripes of 1 m wide, along the trees rows, using a backpack sprayer with a flat fan fitted to work between 1.0-1.5 atm, aiming at a uniform soil and weeds coverage in the treated variants. The untreated control was used as reference.

Observations and determinations regarding the post emergent herbicides efficacy were performed according to the European Weed Research Society (EWRS) scale, where 1=total action on weeds, 2=destruction of weeds 85-95%, 3=destruction of weeds 75%, 4-5=50% damage, 6=destruction of weeds 25-50%, 7-8=destruction of weeds 5-20%, 9=no effect.

The experimental data were stored, processed and graphic represented using the facilities of MSExcel 2010.

3. Results and discussions

During the years of studies and in the years before, the data collected indicated that in South-Eastern Romania, the orchard microclimate of last years was favorable to weeds development and competition with the fruit trees growing and bearing process. In order to better control the weeds, is important to know the weeds biology, the products composition and way of action and the interaction between the herbicides soil and its characteristics, weeds spectrum and fruit trees species.

Glyphosate based herbicides are post-emergent, unselective, killing a broad spectrum of weeds growing in many cultures, including the ones growing in the apple orchards. It is a systemic product with absorption by leaves and rapid translocation in weeds roots rhizomes and runners, acting against annual and perennial monocots and dicots by cell division inhibition. There are a wide range of herbicides based on glyphosate, their efficacy is pretty similar but sometimes differ according the soil water reserve from precipitation, some co-formulants, weeds development stages, soil and weeds coverage with the product, etc.

Cletodim based herbicides are selective, acting against many species of annual and perennial monocot weeds. The active ingredient is fast absorbed by leaves, and translocated into underground and upper parts of the weeds. It acts as an inhibitor of fatty acids metabolism.

Cycloxidim based herbicides are selective, acting against many species of monocot weeds being absorbed by their green parts and fast translocated ascendant and descendent within 1-2 h period. The active ingredient disrupts the meristematic cell division, and the weeds growth.

Oxyfluorfen based herbicides has contact and residual activity, is absorbed by hypocotyl, which lead to the weeds dessication. As post-emergent herbicide has a contact action against the weeds leaves which are more exposed.

Assessment carried out during three vegetation seasons (2019-2021), revealed that both monocots and dicots weeds were present in the experimental device with an average coverage degree ranging between 50% to 75% (EWRS note 3-4), (Fig. 1) which justify the need of herbicides application.

Applied at a rate of a rate of 5 L/ha, once per season, the herbicide Clinic 360 SL provided a good control of the weeds. Among the monocots, dog tooth grass-*Cynodon dactylon*, cat grass-*Dactylis glomerata*, and couch grass-*Agropyron repens* and from the dicot weeds like birdweed-*Polygonum arviculare*, creeping buttercup-*Ranunculus repens*, patience doc-*Rumex patientia*, were 75% killed (EWRS note 3), except the horse tail-*Equisetum arvense* on which 25% of weeds escapes from the herbicide action (EWRS note 6) (Fig. 2). The same product applied at a rate of 3 L/ha, twice per season (Fig. 3), lead to a very good control of the weeds except the horse tail -*Equisetum arvense*, which was 50% damaged (EWRS note 5).

Displayed at a rate of a rate of 5 L/ha, once per season, the herbicide Roundup provided a good control of the weeds. Among the monocots, dog tooth grass-*Cynodon dactylon*, cat grass-*Dactylis glomerata*, and bent grass-*Agrostis tenuis* and from the dicot weeds, like creeping thistle-*Cirsium arvense*, common mallow-*Malva neglecta*, dull-seed-*Polygonum convolvulus*, pink weed-*Polygonum arviculare*, were 75% killed (Fig. 4). The same product displayed at a rate of 3 L/ha, twice per season (Fig. 5), lead to a very good control of the weeds except the horse tail-*Equisetum arvense*, which was 50% damaged (EWRS note 5).

Applied at a rate of a rate of 5 L/ha, once per season, the herbicide Leo Green provided a good control of the weeds. Among the monocots, ryegrass-*Lolium perene* and bent grass-*Agrostis tenuis* and from the dicots knot weed-*Polygonum arenaria* and creeping buttercup-*Ranunculus repens* were 75% killed (Fig. 6). Some creeping thistle-*Cirsium arvense* were 50% damaged (EWRS note 5) but horse tail-*Equisetum arvense* were 20% damaged (EWRS note 7).

The same product applied at a rate of 3 L/ha, twice per season (Fig. 7), lead to a very good control of the weeds except the horse tail-*Equisetum arvense*, which was 38-40% damaged (EWRS note 6).

Displayed at a rate of 1 L/ha, once per season, the herbicide Select Super provided a very good control of the weeds. Among the monocots, ryegrass-*Lolium perene* was 75% killed. As regard the dicots weed, hairy vetch -*Vicia villosa* was always difficult to be controlled (EWRS note 5.5) (Fig. 8).

Displayed at the same rate twice per season the herbicide Select Super provided a good control of the weeds, also hairy vetch-*Vicia villosa* was damaged 85-95% as well (Fig 9).

Applied at a rate of 1 L/ha, the herbicide Galigan 240 EC provided a fair control of the weeds. Even smooth brome-*Bromus inermis* and dog tooth grass-*Cynodon dactylon* were damaged more than 95% (EWRS note 1-1.5). Among the dicots chamomil-*Matricaria chamomila* and dull-seed-*Polygonum convolvulus* were 85% damaged (EWRS note 2). Also, creeping thistle-*Cirsium arvense* was damaged 75% (EWRS note 3) (Fig. 10).

The same product applied at a rate of 1 L/ha, twice per season provided a very good control of all weeds spectrum. Also, creeping thistle-*Cirsium arvense* was 90% damaged (EWRS note 2) (Fig. 11).

Displayed at a rate of 2 L/ha, once per season, the herbicide Stratos Ultra provided a very good control of monocots weeds. common grass-*Agropyron repens*, bent grass-*Agrostis tenuis*, smooth brome-*Bromus inermis*, dog tooth grass-*Cynodon dactylon*, wilde millet-*Setaria glauca* and green wilde millet-*Setaria viridis* were totally damaged (EWRS note 1).

4. Conclusions

Today the main goal, in control of the infestation with weeds in the apple bearing orchard, is to keep them under the economic damages threshold (EDT), as well as protect the environment and natural resources.

In our area, the most feasible orchard floor maintenance system in the apple bearing orchard is ‘with trimmed grass cover between the tree rows and cleaned with herbicides along the trees rows’. Application of the herbicides might start since the weeds are in the BBCH stages 12-14, then when they reach no more than 15-20 cm high.

Problematic dicots weeds as: *Equisetum arvense*, *Cirsium arvense*, *Gallium aparine*, *Galinsoga parviflora*, *Malva neglecta*, *Matricaria chamomilla*, *Ranunculus repens, Rumex* spp., *Stelaria media* and the monocots like: *Agropyron repens*, *Lolium perene* and *Cynodon dactylon*, were difficult to control requiring the application of herbicides twice per vegetation season, or the integrated control of weeds.

In the case of *glyphosate* based herbicides it seems more reliable to apply them twice per season, at a rate of 3L /ha together with an adjuvant, in order to speed up their degradation into the soil.

The selective herbicides based on *cletodim* (Select Super), or *oxifluorfen* (Galigan 240 EC) if applied twice per season at a rate of 1 L/ha, clean the tree rows from the weeds escaped from the unselective herbicides.

Selective *cycloxidim* based herbicides applied once per season, at a rate of 2 L/ha clean the tree rows from the problematic monocots weeds, escaped from the unselective herbicides.

The tested selective and total herbicides are safe can be complementary and used in conjunction with the mechanical sequences for weeds and grass control in the apple bearing orchards.

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Tables and Figures

Table 1. Dynamic of some meteorological parameters in 2019 vegetation period RIFG Pitesti-Maracineni Lat. N 44,513; Long. E 24,52; Alt 287 m

Year 2019 / Month	Maximum temperature (*C)	Minimum temperature (*C)	Average Temperature (*C)	Leaf wetnes (h)	Days with wetness (n)	Precipitations (l/m^2)	Days with precipitations (n)	Wind speed (km/h)	Wind gust (km/h)
April	26.3	-0.1	10.8	54.8	22	35.6	11	2.5	22.5
May	28.2	2.4	15.7	107.0	27	46.3	19	1.9	20.1
June	32.2	11.2	21.2	188.3	30	197.1	19	1.0	20.9
July	34.9	7.9	21.1	135.8	26	93.4	10	1.0	17.2
August	35.1	10.2	22.8	32.8	12	9.7	3	1.0	17.7
September	33.0	1.3	17.5	41.3	13	11.9	5	1.4	18.4
October	27.9	9.0	12.2	63.3	29	34.1	14	1.2	18.1
Average	***31.09***	***5.99***	***17.33***	***89.60***	***22.71***	***61.16***	***11.57***	***1.43***	***19.27***
Std. deviation	*3.5812*	*4.6477*	*4.6682*	*56.9539*	*7.4322*	*66.0810*	*6.2678*	*6.2678*	*0.5736*
Variance	*11.5203*	*77.6287*	*26.9395*	*63.5646*	*32.7205*	*108.0511*	*54.1664*	*54.1664*	*40.1539*

Table 2. Dynamic of some meteorological parameters in 2020 vegetation period RIFG Pitesti-Maracineni Lat. N 44,513; Long. E 24,52; Alt 287m

Year 2020 / Month	Maximum temperature (*C)	Minimum temperature (*C)	Average Temperature (*C)	Leaf wetnes (h)	Days with wetness (n)	Precipitations (l/m^2)	Days with precipitations (n)	Wind speed (km/h)	Wind gust (km/h)
April	25.3	-3.9	10.9	11.3	6	21.1	6	2.3	20.8
May	30.13	4.3	15.0	79.0	21	104.1	14	2.6	18.6
June	32.8	4.3	19.6	168.8	27	166.2	14	4.0	18.8
July	35.3	11.6	22.0	98.3	21	52.0	11	2.5	15.0
August	33.9	11.0	22.0	94.0	17	29.0	10	3.8	18.4
September	33.8	6.2	18.9	81.0	19	68.2	6	1.3	17.2
October	27.4	-0.4	12.4	177.8	30	92.7	15	2.6	17.8
Average	**31.23**	**4.73**	**17.26**	**101.46**	**20.14**	**76.19**	**10.86**	**2.73**	**18.09**
Std. deviation	*3.7374*	*5.6249*	*4.5144*	*56.9795*	*7.7121*	*50.1068*	*3.7607*	*0.9196*	*1.7620*
Variance	*11.9661*	*118.9547*	*26.1594*	*56.1612*	*38.2869*	*65.7693*	*34.6380*	*33.7036*	*9.7427*

Table 3. Dynamic of some meteorological parameters in 2021 vegetation period RIFG Pitesti-Maracineni Lat. N 44,513; Long. E 24,52; Alt 287m

Year 2021 / Month	Maximum temperature (*C)	Minimum temperature (*C)	Average Temperature (*C)	Leaf wetnes (h)	Days with wetness (n)	Precipitations (l/m^2)	Days with precipitations (n)	Wind speed (km/h)	Wind gust (km/h)
pril	25.3	-3.3	8.6	8.3	22	38.4	12	2.4	22.4
May	28.4	2.5	15.6	132.0	25	65.4	16	1.8	20.0
June	34.0	7.0	19.3	225.0	29	104.0	18	1.0	20.8
July	36.8	12.5	23.5	66.0	18	33.5	9	1.0	17.1
August	36.4	9.0	22.4	82.3	16	74.0	9	1.0	17.6
September	30.4	2.7	15.6	62.3	27	14.3	6	1.3	18.3
October	22.7	-2.0	8.6	29.5	23	36.1	9	1.1	18.0
Average	**30,57**	**4,06**	**16,23**	**86,49**	**22,86**	**52,24**	**11,29**	**1,37**	**19,17**
Std. deviation	*5,4622*	*5,7657*	*6,0218*	*72,6180*	*4,6701*	*30,4643*	*4,3095*	*0,5376*	*1,9431*
Variance	*17,8670*	*142,1114*	*37,1063*	*83,9653*	*20,4315*	*58,3129*	*38,1851*	*39,2023*	*10,1355*

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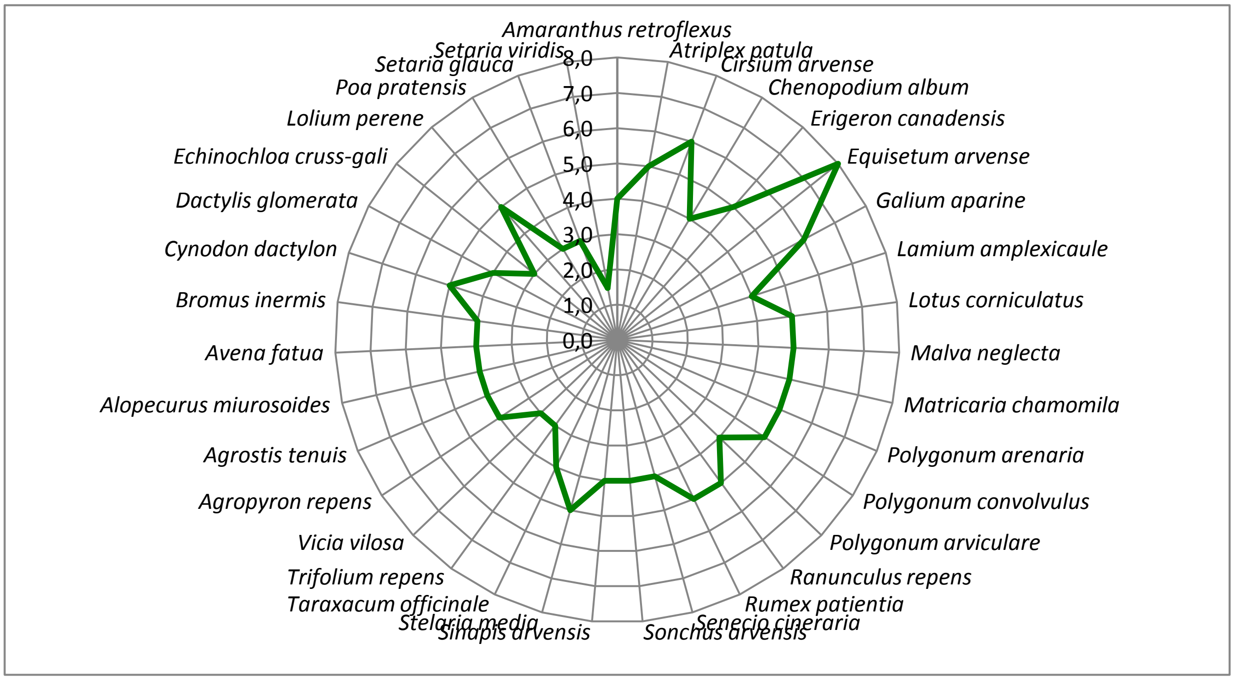

Fig. 1. Untreated control variant (V1)

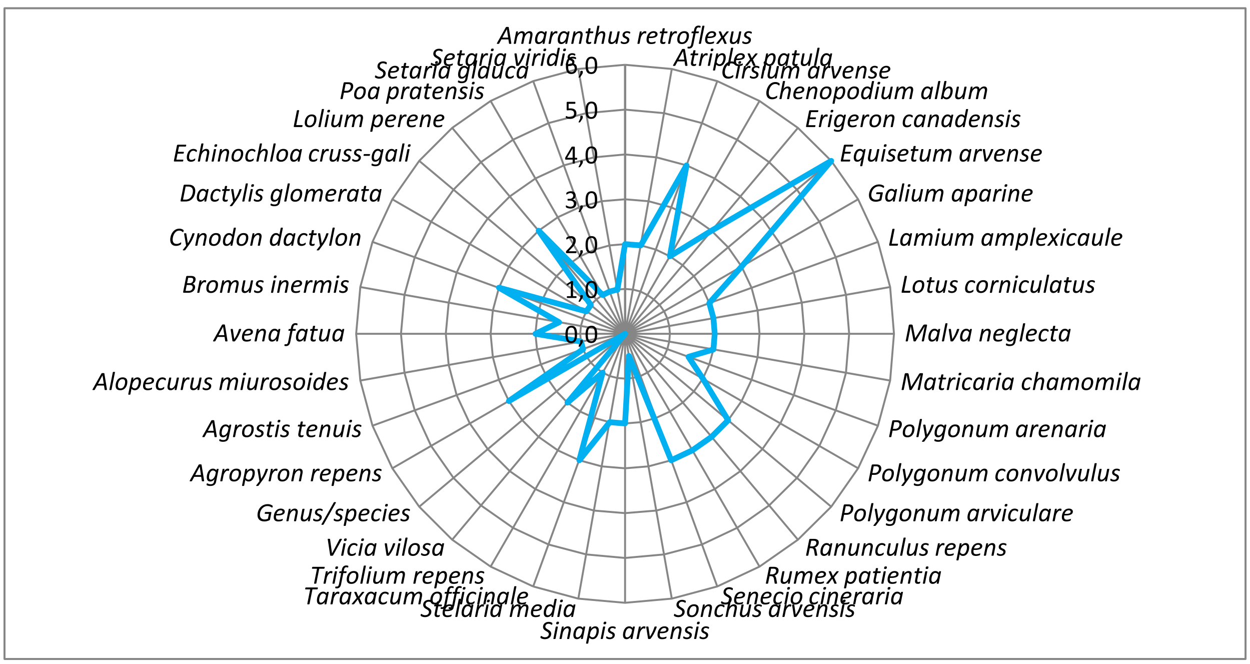

Fig. 2. Clinic 360 SL 1x 5L/ha (V2)

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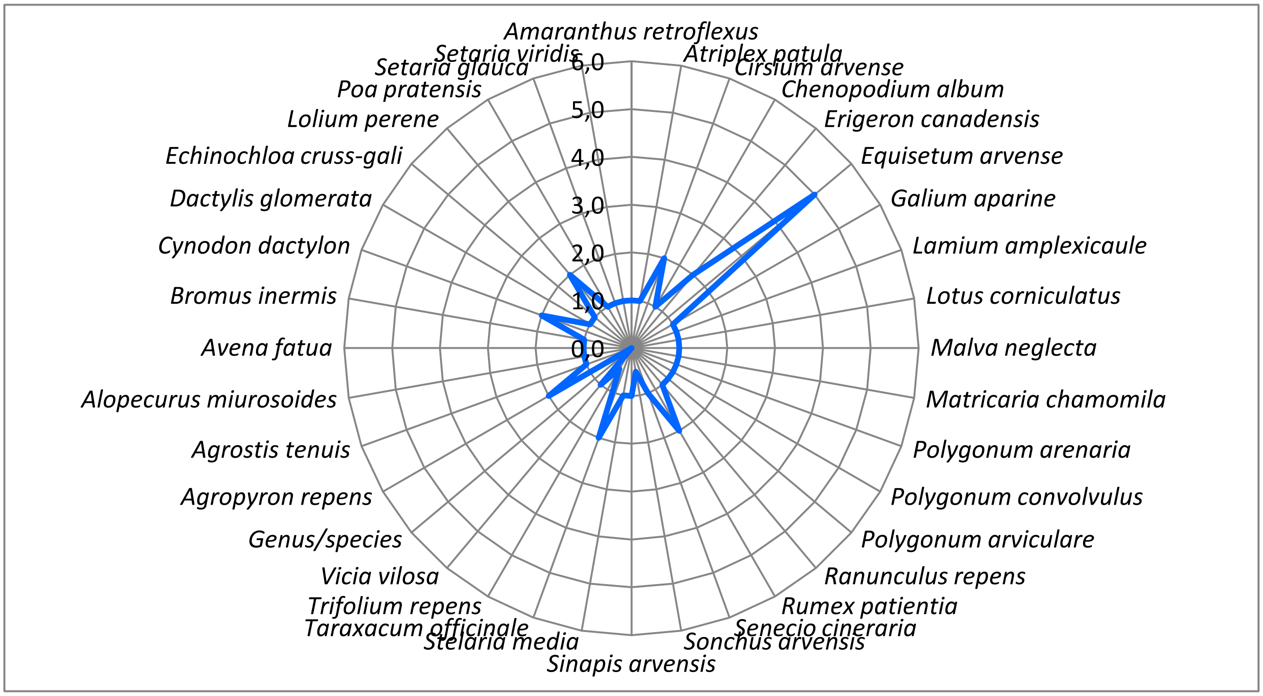

Fig. 3 Clinic 360 SL 2x 3L/ha (V3)

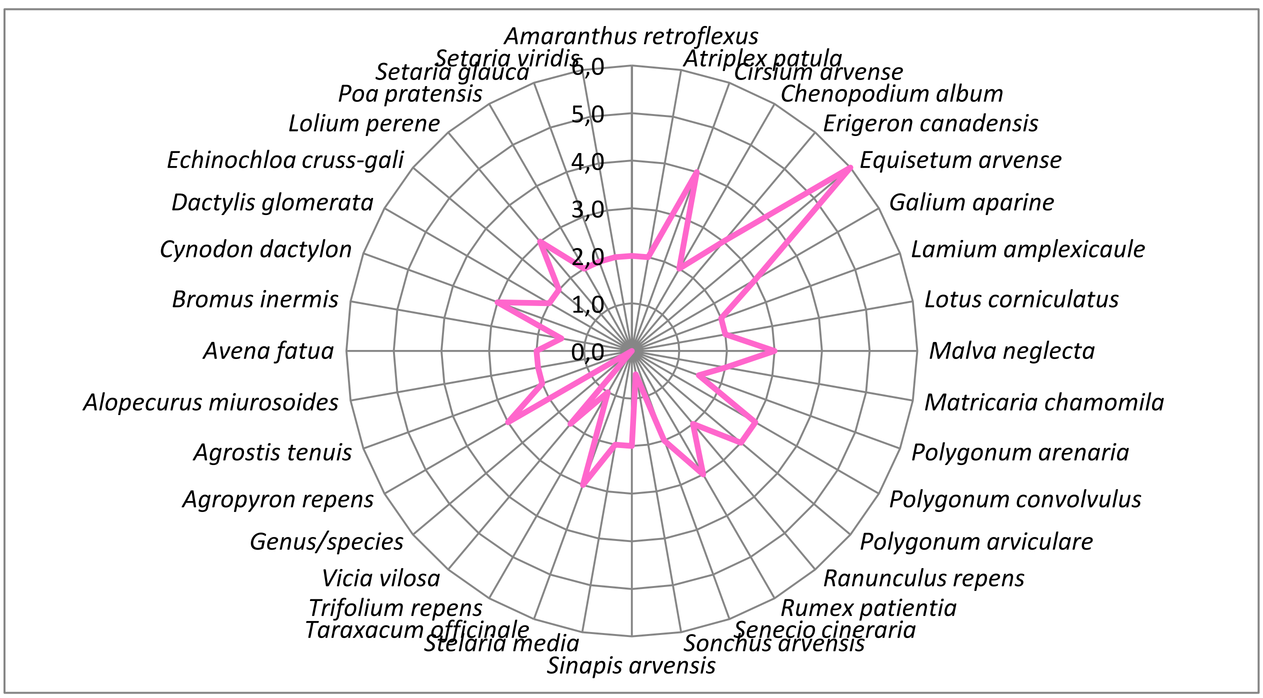

Fig. 4. Roundup 1x 5L/ha (V4)

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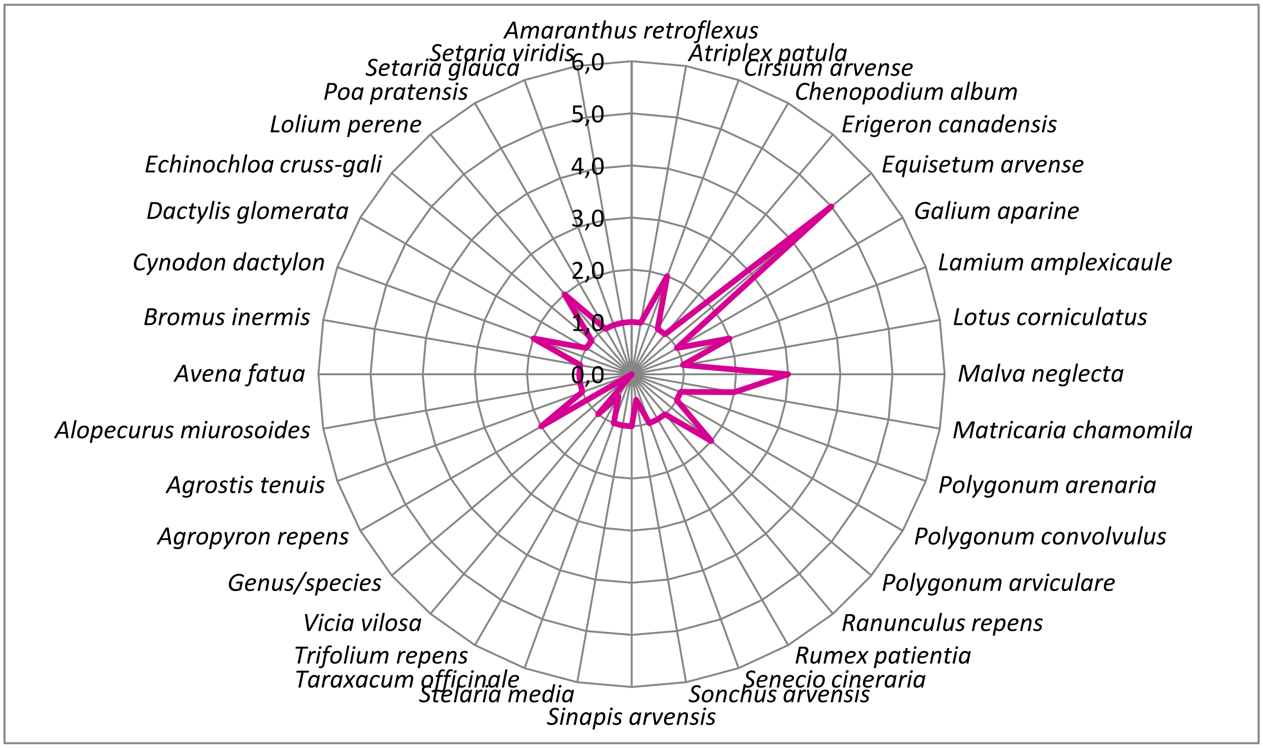

Fig. 5. Roundup 2x 3L/ha (V5)

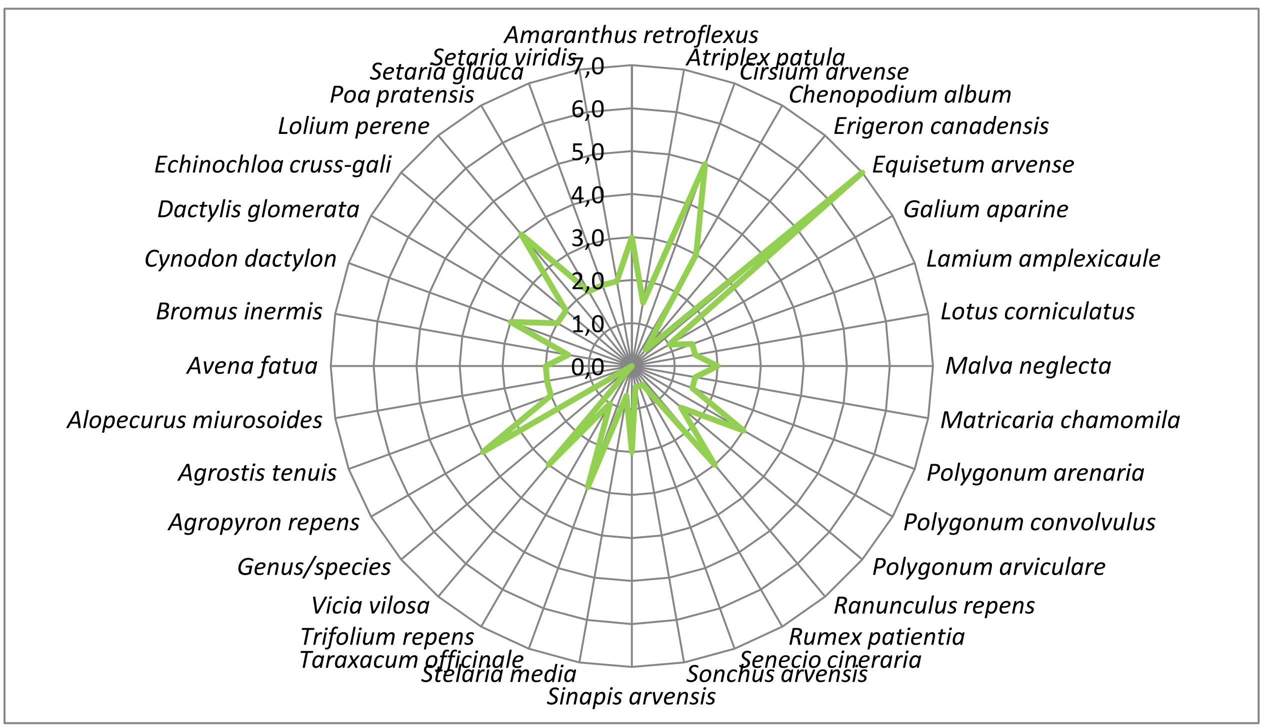

Fig. 6. Leo Green 1x 5 L/ha (V6)

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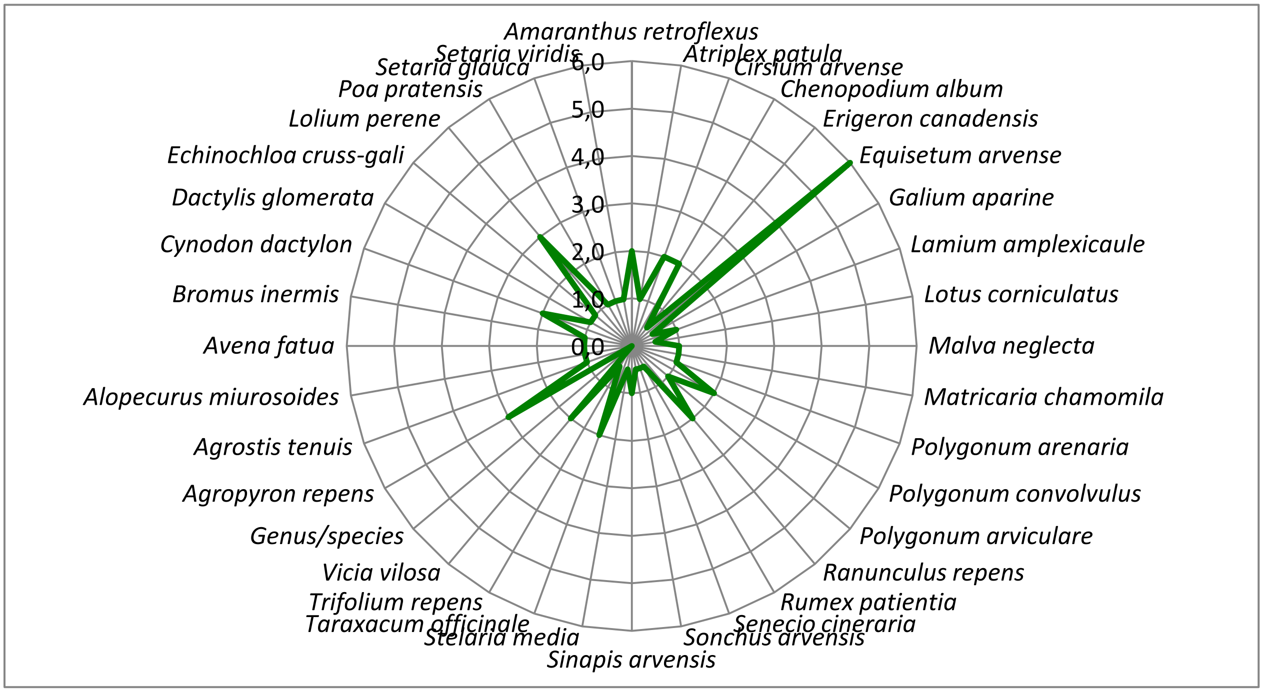

Fig. 7. Leo Green 2x 3 L/ha (V7)

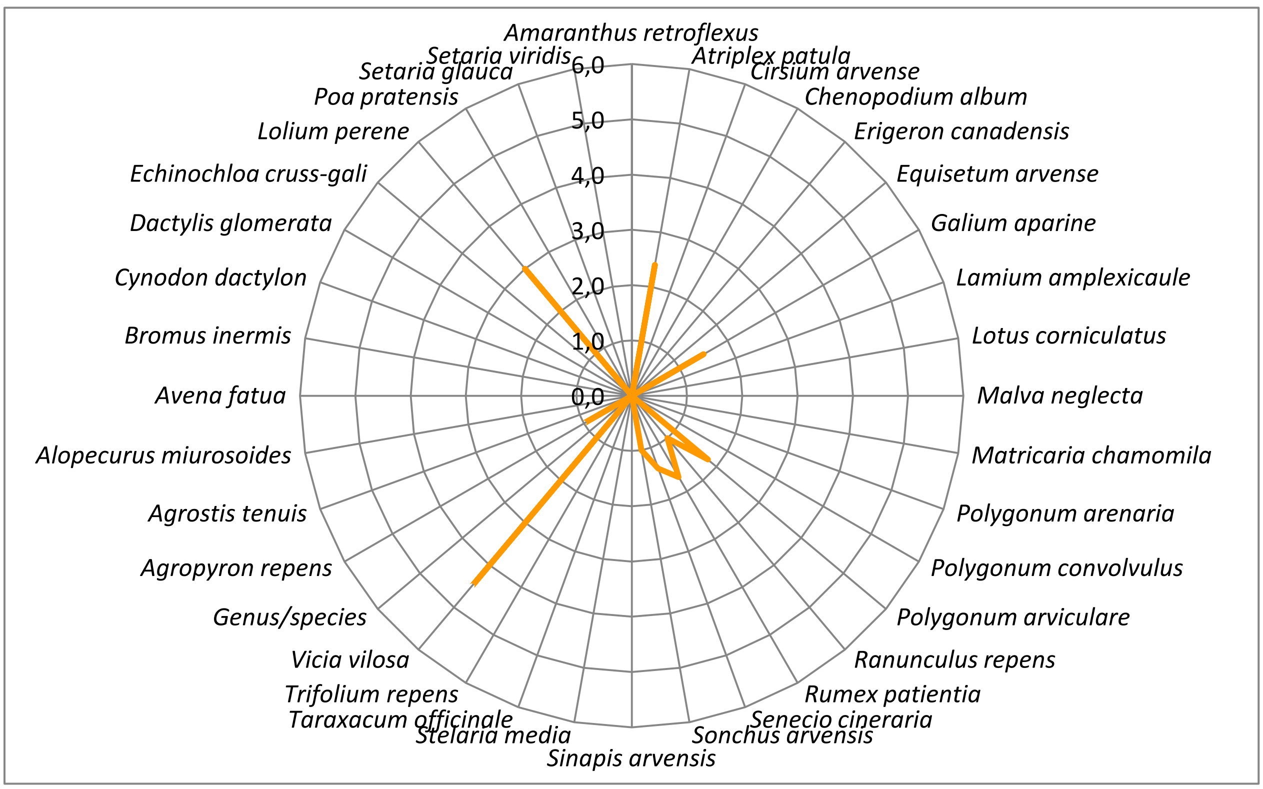

Fig. 8. Select Super 1x 1L/ha (V8)

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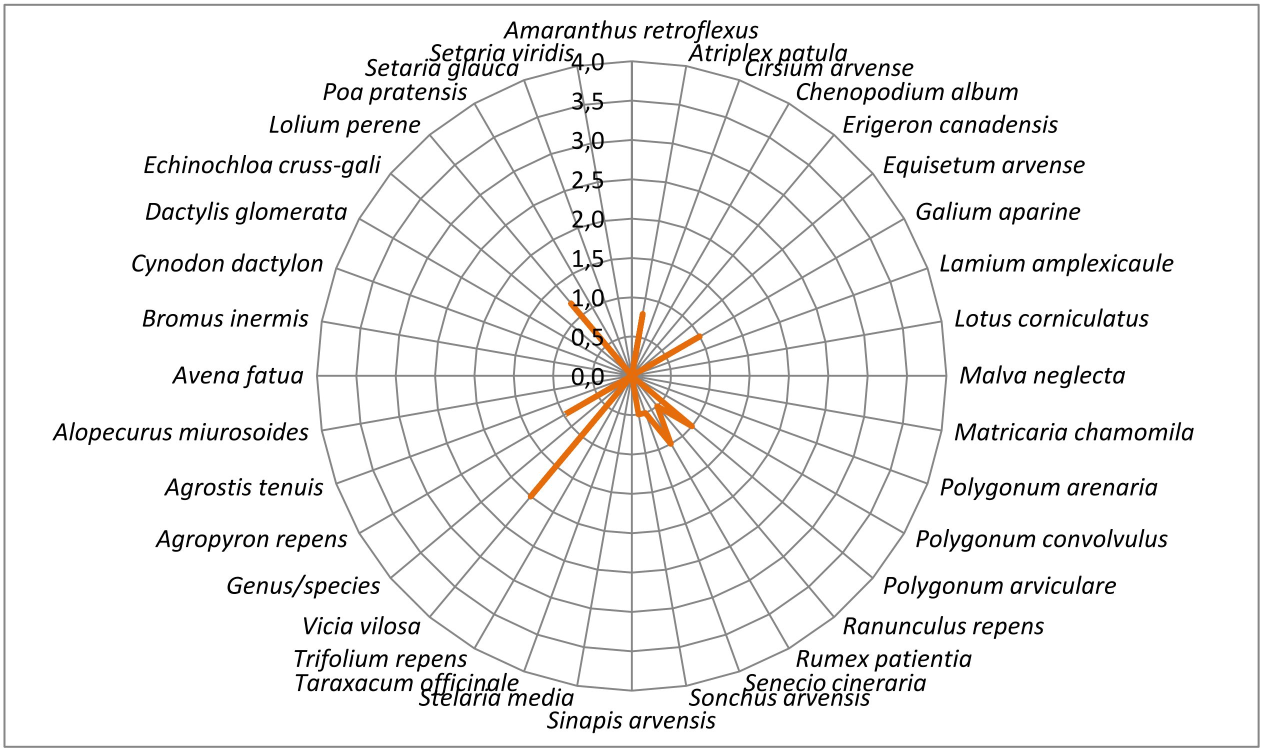

Fig. 9. Select Super 2x 1L/ha (V9)

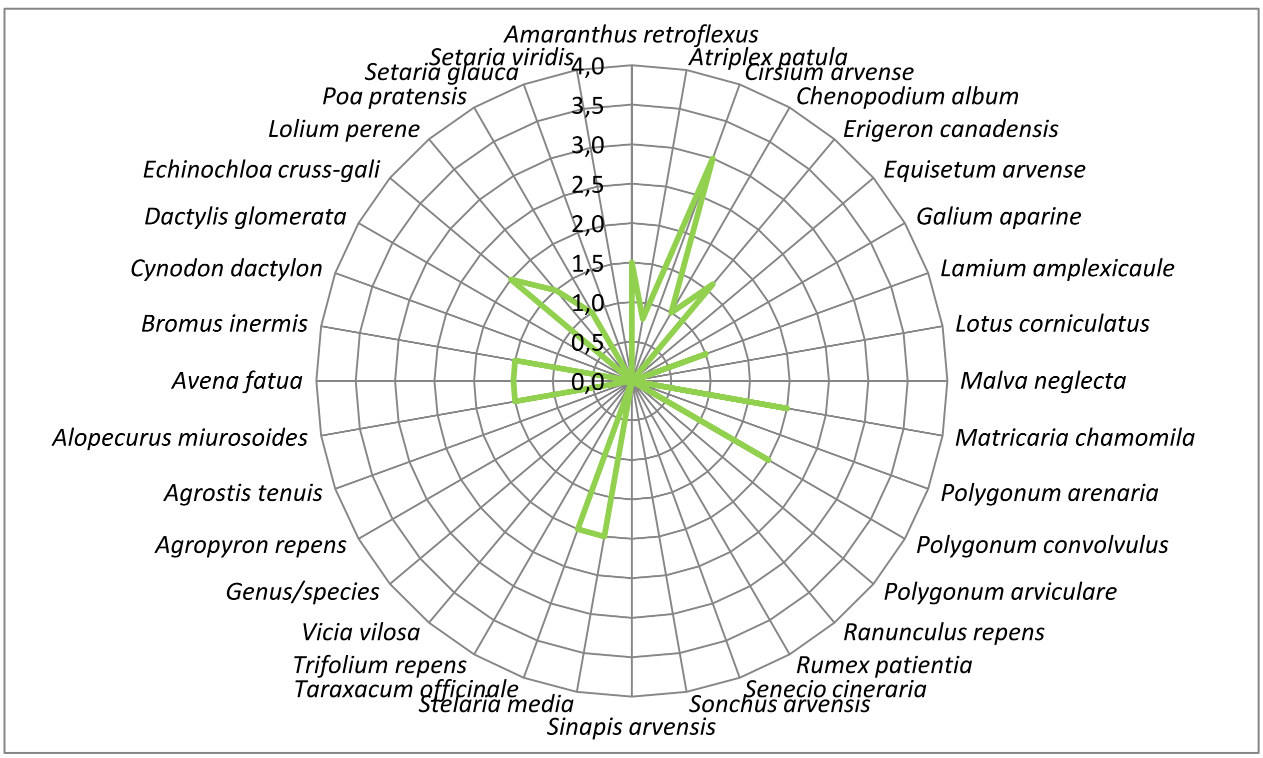

Fig. 10. Galigan 240 EC 1x 1L/ha (V10)

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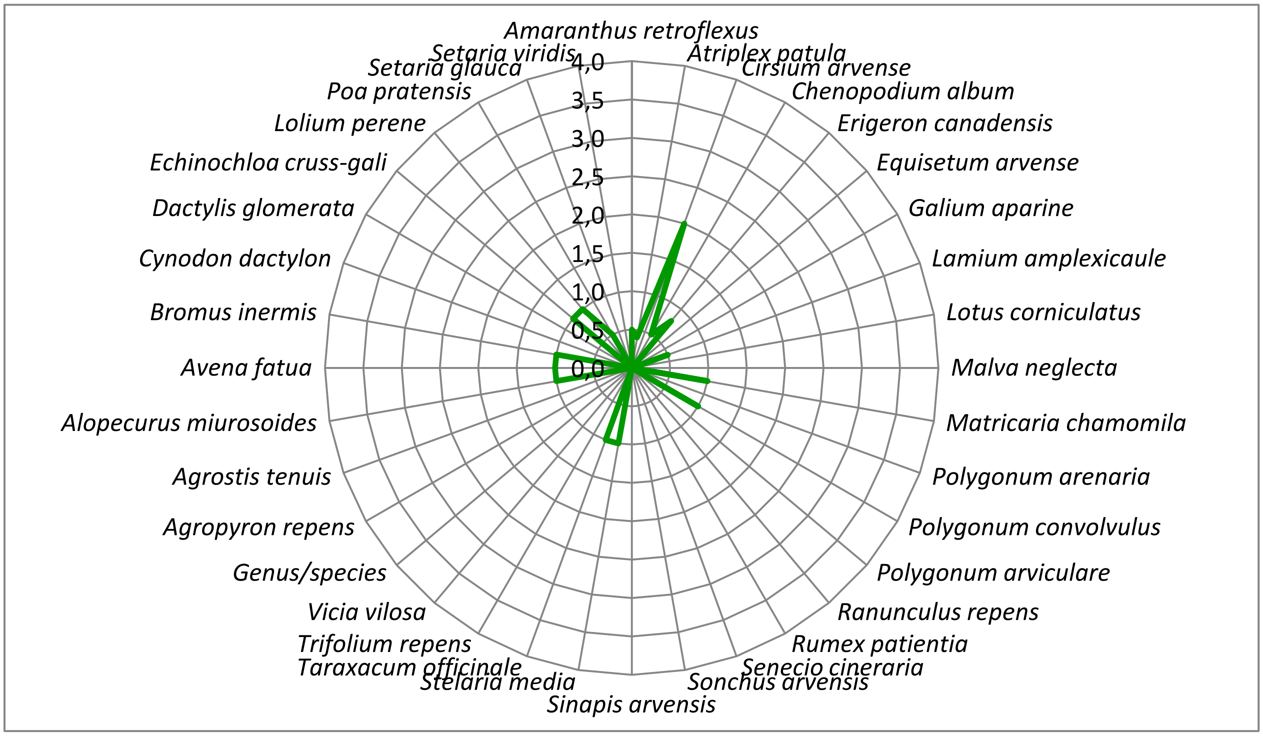

Fig.11. Galigan 240 EC 2x 1L/ha (V11)

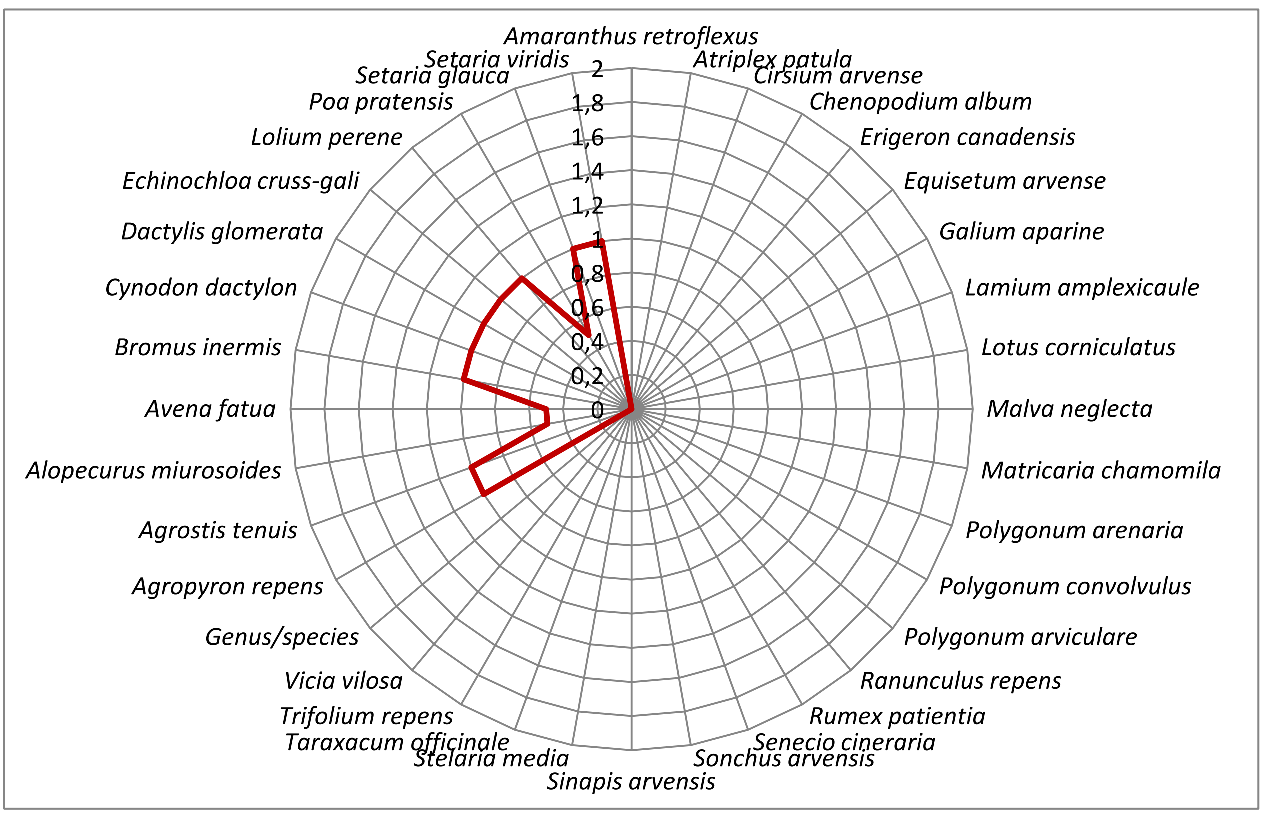

Fig. 12. Stratos Ultra 1x 2 L/ha (V12)