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Original article

Application of the Herbicides Wing P and Stratos Ultra for Weed Control in Newly-Planted Vineyard [1]

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Abstract

At the Experimental Base of the Institute of Viticulture and Enology, Pleven, Bulgaria it was carried out a three-year planting (2014, 2015 and 2016) of a vineyard for chemicals testing for weed control. Each variant included 20 Cabernet Sauvignon vines grafted to Berlandieri X Riparia Selection Oppenheim 4 (SO 4) rootstock as it was repeated every year of the study.

A single spray with Wing P (pendimethalin 250 g/l + dimethenamid P 212.5 g/l) at doses of 0.4 and 0.6 l/da was performed immediately after planting the vines and once with Stratos Ultra (100 g/l cycloxydim) at a dose of 0.2 l/da during the active vegetation stage of the wheat weeds. It was not found a negative impact on the bud germination and the shoot growth and maturation. Applied at a dose of 0.6 l/da, Wing P showed the best control over one-year weed vegetation in the vineyard as the treated vines had more intensive development and mature growth of greater length and mass.

Keywords: Newly-planted vineyard, Weeds, Herbicides, Pendimethalin, Dimethenamid, Cycloxydim.

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INTRODUCTION

In the young vineyards associations of earthed-up species are formed and representatives of the late spring weeds predominate. In some cases, perennial rhizome and root-sprouting weeds may also be observed - *Cynodon dactylon* (L.), *Sorghum halepense* (L.) Pers., *Agropyron repens* (L.), *Convolvulus arvensis* L, *Sonchus arvensis* L., etc. (Kolev, 1963; Beuret et Neury, 1987; Moreira, 1994; Encheva, 2003; Tonev et al., 2007). It has been recommended the chemical weed control to be applied to the intra-row stripe and the distance between the rows to be treated mechanically. Phytotoxicity caused by herbicides to young vines has been common and has serious consequences, so it is necessary the active substances to be selected according to the age of the plantation and the nature of the weed vegetation. Some soil herbicides had effective action in vineyards below 4 years of age - butralin, isoxaben, napropamide, orisalin and propyzamide. Herbicides with foliar action are recommended for graminaceous weeds control: setodixim, quizalofop ethyl, cycloxidim, haloxyfop R. Aminotriazole and glyphosate are toxic to young vines and could be applied only preventively by repeated treatment of the areas during the previous year (Groupe de travail regional Midi-Pirenèes, 2002; Chambre Regionale d'agriculture Langedoc Roussillon, 2014; Chambre d'agriculture Charente – Maritime, 2017). Trifluralin, oryzalin, oxyfluorfen etc. could be applied for weed control, which, although with good effect, were not sufficiently efficient against perennial weeds (Lange et al., 1970; Spasov et al., 1999; Tonev, 2000). Pendimethalin, napropamide, s-metolachlor had shown a high herbicidal effect (without damaging the vines) immediately after planting (Bordelon, 2011).

The objective of this study was to establish Wing P and Stratos Ultra efficiency in the specific climatic conditions and their impact on the growth and development of vines in the year of planting.

Material and Method

Plant Material

Vines of Cabernet Sauvignon variety grafted to Berlandieri X Riparia Selection Openheim 4 (SO4) rootstock were used in the experimental work. The propagation material was produced for this purpose at the IVE, Pleven in 2013, 2014 and 2015. By the time of planting it was stored in a specialized room under controlled conditions.

Herbicides

Table 1. Herbicides, their doses and time of application

	Herbicides applied (formulated product)	Time of appl.	Active substance (g /l)	Doses (l/da)
1	Wing P (Basf) Stratos ultra (Basf)	preem postem	212.5 g/l dimethenamid P + 250 g/l pendimethalin 100 g/l cycloxidim	0.4 0.2
2	Wing P (Basf) Stratos ultra (Basf)	preem postem	212.5 g/l dimethenamid P + 250 g/l pendimethalin 100 g/l cycloxidim	0.6 0.2

Setting of the Trial

Vines were planted in stages in the spring of 2014, 2015 and 2016 (the first ten days of May). Protective piles of soil with a thickness of 5 - 6 cm were formed above each one (Abrasheva et al., 2008). The distance between the rows was 3 m, while the intra-row distance – 1.2 m. The trial was set by the long plots method in 5 replicates. Each replicate had a plot size of 5 m2 and included 4 vines (20 vines per variant).

Application Details

The herbicides (Table 1) were introduced into the intra-row stripe once, with a backpack sprayer, at a consumption rate of working solution 40 l/da and the nozzle pressure Pmax 300 kPa. The treatment with Wing P was carried out immediately after the planting of the vines and the formation of the protective piles, without incorporation. For the eradication of Johnson grass germinated from seeds and partially preserved rhizomes during the vegetation, spraying with the recommended for use in young vineyards Stratos ultra between the thirties and the sixtieth day after the vine planting was carried out. The distances between the rows were treated mechanically 4 times during the year. In the years prior to planting (2013, 2014 and 2015), the areas were pretreated preventively with NASA (*360 g/l glyphosate*) at a dose of 1 l/da.

Analysis

The herbicides impact and the applied doses on weeds were assessed by the quantitative method, taking into account the dynamics of the weed density (pc./m^2) in the permanently marked parcels in the individual replicates of 1 m^2 every thirty days (Tonev et al., 2002; Zhelyazkov et al., 2017).

Their impact on the vines was determined by recording buds germination in dynamics (average number of shoots per vine) and shoot growth dynamics (cm). The data showing the herbicides selectivity to the young vines were processed by analysis of variance.

Soil and Climate Characterization of the Region

The study was carried out at the Experimental Base of the Institute o Viticulture and Enology, Pleven, Bulgaria. The vineyard was located at 43.42°N 24.62°E and 140 m altitude.

The soil type where the plantation was located was leached chernozem, formed on clay loess. By mechanical composition it was heavy sandy loam, with good aquatic physical properties, fully satisfying the biological requirements of the vine (Krastanov and Dilkova, 1963). This type of soil was defined as the most suitable for cultivation of varieties intended for the production of red table wines (Kurtev et al., 1979).

Data on precipitation and temperature changes were obtained from METOS WEATHER data 000003 CA station, located on the territory of the Production Experimental Base of IVE – Pleven. The period from April to the end of September 2014 was characterized by significant precipitation (total 406 mm), the maximum being in April (131 mm) and in July (122 mm). For the same period in 2015, almost twice less precipitation was measured – 206 mm. The drought was particularly severe in July (27.4 mm) and during the month of May (30.4 mm) – critical for the plantation. That, along with the higher average monthly temperatures recorded in 2015 for all months except April, made it as less favorable for the young vines growth. Poor precipitation rates were recorded for 2016 too – in June 97.4 mm, July 10.4 mm and August 35.8 mm.

Results and Discussion

In 2014, 12 weed species were observed: Amaranthus blitoides L., Amaranthus retroflexus L., Chenopodium album L., Convolvulus arvensis L., Heliotropium europaeum L., Portulaca oleracea L., Polygonum convolvulus L., Portulaca oleracea L., Reseda lutea L., Sinapis arvnsis L., Solanum nigrum L., Sorghum halepense (L.) Pers. and Xanthium strumarium L. The perennial weeds were represented by two species (Convolvulus arvensis и Sorghum halepense), while from the annual – the late spring ones were prevailing.

The effect of Wing P was weakened as early as the 30th day, and sixty days post treatment an increase of the annual weeds was observed (Table 2). In addition to Reseda lutea L. and Xanthium strumarium L., that did not exhibit susceptibility to the combination of dimethenamid PI and pendimethalin, Portulaca oleracea L. and Solanum nigrum L. were found in the trial plots. The perennial species were not sufficiently affected by the applied soil herbicide. At a dose of 0,6 l/da the tested combination of active substances suppressed the germination of their seeds and that resulted in a lower density of these species in V2. The decrease in the density of Sorghum halepense recorded in both variants on the sixtieth and the nineteenth day was due to the treatment with Stratos Ultra.

Table 2. Dynamics of weed growing per species in 2014

Weed species	Density (pc./m^2)								
	V1			V2			K		
	30th day	60th day	90th day	30th day	60th day	90th day	30th day	60th day	90th day
Amaranthus blitoides L	-	-	-	-	-	-	-	1.0	-
Amaranthus retroflexus L.	-	-	-	-	-	-	0.7	0.3	0.7
Chenopodium album L.	-	-	-	-	-	-	-	1.3	0.3
Convolvulus arvensis L.	6.7	11.3	14.3	4.0	9.0	12.7	12.7	13.0	5.7
Heliotropium europapaeum L.	-	-	-	-	-	-	-	0.3	-
Polygonum convolvulus L.	-	-	-	-	-	-	0.3	-	-
Portulaca oleracea L.	-	0.3	0.3	-	0.3	0.3	-	0.7	1.3
Reseda lutea L.	0.3	0.3	0.3	0.7	0.7	0.7	0.2	-	-
Sinapis arvnsis L.	-	-	-	-	-	-	0.7	-	-
Solanum nigrum L.	-	0.3	1.3	-	0.3	0.3	-	0.7	0.3
Sorghum halepense (L.) Pers	61.0	11.7	-	18.0	5.7	-	56.0	80.7	54.7
Xanthium strumarium L.	3.3	3.7	3.7	5.3	5.7	5.7	7.0	1.0	-
Σ	***71.3***	***27.6***	***19.9***	***28.0***	***21.7***	***19.7***	***77.6***	***99.0***	***63.0***

In the plot, planted in 2015, only six species were found from different weed groups. The perennial were represented by *Convolvulus arvensis* L. and *Sorghum halepense* (L.) Pers. All annual species belonged to the group of the late spring ones – *Heliotropium europapaeum* L., *Setaria viridis* L., *Xanthium strumarium L.* and *Reseda lutea* L. The latter species was usually hibernated, but in the trial it appeared as a late spring.

The three-fold accounting of the weed infestation, analogous to the 2014 data, showed that Wing P effect was weakened even after the thirtieth day and sixty days post treatment an increase in the annual weeds was observed (Table 3). With Wing P at a dose of 0,4 lda (V1) on the thirtieth day, they were 4.64% of the total density, on the sixtieth day they went up to 37.78% and on the nineteenth they reached 62.67%. At a dose of 0,6 l/da (V2), a lower density of these species was reported. The decrease in the density of *Sorghum halepense* recorded in all variants on the sixtieth and the nineteenth day was due to the efficient action of Stratos Ultra. The plants of *Setaria viridis* L., found after the sixtieth day, had emerged after treatment with cycloxydim.

Table 3. Dynamics of weed growing per species in 2015

Weed species	Density (pc./m^2)								
	V1			V2			K		
	30th day	60th day	90th day	30th day	60th day	90th day	30th day	60th day	90th day
Convolvulus arvensis L.	3.0	4.8	6.0	2.0	5.6	5.6	15.6	13.0	4.6
Heliotropium europaeum L.	-	-	-	-	-	-	0.8	0.8	1.0
Reseda lutea L.	0.8	0.8	0.8	0.8	0.8	0.8	6.0	3.0	-
Setaria viridis L.	-	1.0	6.6	-	1.4	7.0	1.4	7.0	3.2
Sorghum halepense (L.) Pers	19.6	-	-	35.0	-	-	60.0	53.5	9.8
Xanthium strumarium L.	2.0	2.6	3.0	1.0	1.2	1.6	6.2	4.6	1.4
Σ	***25.4***	***12.6***	***21.4***	***38.8***	***9.0***	***15.0***	***98.0***	***81.9***	***20.0***

In the plot, planted in 2016, 13 weed species were recorded. Two of them were perennial (*Convolvulus arvensis* L. and *Sorghum halepense* (L.) Pers.) and they were observed during all three years of the study, regardless the preventive treatment with glyphosate in 2013, 2014 and 2015. The presence of 2 early spring species was found – *Sinapis arvensis* L. and *Galeoppsis tetrahit* L., represented by non-herbaceous plants. The rest of the species – *Xanthium strumarium L.*, *Hibiscus trionum* L,*Solanum nigrum* L., *Heliotropium europaeum* L., *Coniza Canadensis* L., *Datura stramonium* L., *Setaria viridis* L., *Reseda lutea* L. and *Chrosophora tinctoria* L. emerged as late spring weeds.

Typical of *Chrosophora tinctoria* L. was that the minimum soil temperature required for its seed germination was 25°C. This has been a limiting factor for its spread. It was described in the 1960s and 1970s as a non-economic threat, which occurred only in some areas of Southern Bulgaria. Currently, it has been spread with significant density throughout Northern Bulgaria (Assyov et al., 2006). The requirement for a high soil temperature has determined the emergence of *Chrosophora tinctoria* L. after the effect of Wing P have expired and did not allow the effect of the herbicide on this species to be accounted.

The results on the dynamics of weed growth within the area in 2016 showed that in all treated variants the perennial weeds were prevailing as they did not respond to the tested soil herbicide. Their density, established immediately prior to spraying with Stratos Ultra (on the sixtieth day after planting) was 70.11% of the total in V1 and 87.1% in V2 (Table 4). At that point in the control they were 53.54% of the total density, revealing relative uniformity in the density of the annual and perennial weeds. The major annual weed in the treated variants that year was again *Xanthium strumarium* L. On the thirtieth day after planting and introducing the soil herbicides, that species accounted for 100% of the annual weeds in V1, V2. The efficiency of Stratos Ultra was 97.14% for V1, 100.0% for V2, respectively. On the average, it was 98.57% for the treated area, or between good and ideal by EWRS scale.

Table 4. Dynamics of weed growing per species in 2016

Weed species	Density (pc./m²)								
	V1			V2			K		
	30th day	60th day	90th day	30th day	60th day	90th day	30th day	60th day	90th day
Chrosophora tinctoria L.	-	-	0.2	-	-	-	-	-	0.6
Convolvulus arvensis L.	4.4	4.8	6.2	2.6	3.8	3.8	4.8	5.2	1.0
Datura stramonium L.	-	-	-	-	0.8	0.8	-	-	-
Galeoppsis tetrahit L.	-	0.4	0.4	-	-	-	-	-	0.4
Heliotropium europaeum L.	-	-	-	-	-	-	-	-	0.8
Hibiscus trionum L.	-	-	-	-	-	-	0.2	-	-
Reseda lutea L.	-	0.2	0.2	-	0.6	0.6	0.2	-	-
Setaria viridis L.	-	1.2	-	-	-	-	6.8	7.0	-
Sinapis arvnsis L.	-	-	-	-	-	-	1.2	-	-
Solanum nigrum L.	-	-	-	-	-	-	0.2	-	0.2
Sorghum halepense (L.) Pers	18.4	21.0	0.6	43.2	44.8	-	34.6	8.4	-
Xanthium strumarium L.	8.2	9.2	9.2	5.4	5.8	5.8	11.0	4.8	2.2
Σ	***31.0***	***36.8***	***16.8***	***50.9***	***55.8***	***11.0***	***59.0***	***25.4***	***5.2***

The density of monocotyledonous weeds after treatment was indicative of the action of Stratos Ultra. During the last recording of the weed growth dynamics (90 days after planting of the vines and soil herbicide treatment) on the average for the period of the study, the monocotyledonous weeds were 2.4 pcs/m² for V1 and 2.3 pcs/m² for V2 – equality due to the applied same dose of Stratos Ultra in both variants (Figure 1). The dicotyledonous weeds prevailed in the treated variants as their density was determined by Wing P dose – at 0,4 l/da it was 16.6 pcs./m² and at 0,6 l/da - 12.9 pcs./m². The mechanical treatments in the control changed that ratio and the density of the monocotyledonous species was 22.6 pcs./m² and the dicotyledonous – 6.8 pcs./m².

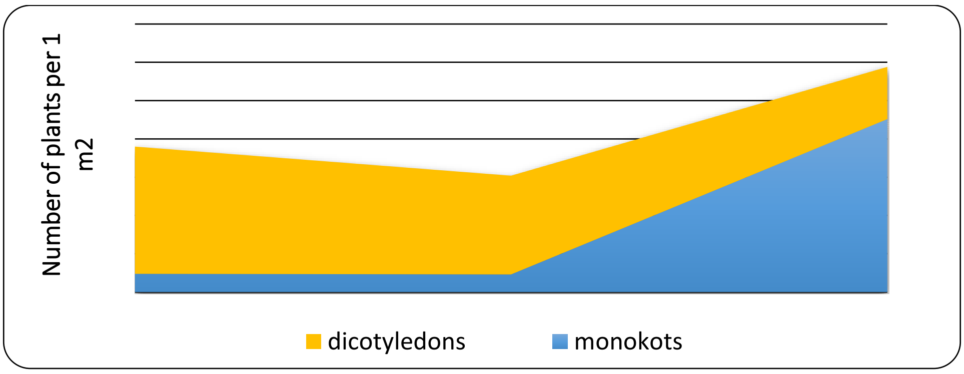

Figure 1. Density of monocotyledonous and dicotyledonous weeds 90 days after planting of vines and soil herbicide treatment – on the average for 2014-2016

The opportunities of Wing P application for weed control in a newly planted vineyard were determined by its impact on vines. Researches of us have proven that it exhibited a high selectivity in the production of vine propagation material (Prodanova-Marinova, 2015; Prodanova-Marinova, 20151; Prodanova-Marinova, 2016). The results of this study were analogous – Wing P herbicide at doses of 4 and 6 l/ha did not cause inhibition of the bud growth after planting. On the average for the period 2014-2015, the highest number of shoots germinated per vine were recorded for V2, but there was no proven difference between the control and the lower dose variant (V1) in the analysis of variance – Table 5. During the different periods the number of shoots germinated in the treated variants and the control varied – some died and were substituted by others developed from secondary buds, but the changes were due to the weather factors rather than the herbicidal action of the tested products.

Table 5. Average number of germinated shoots per vine for the period 2014 – 2016

V	Number of germinated shoots									
	30 day		40 day		50 day		60 day		70 day	
	No.	Signi-ficance	No.	Signi-ficance	No.	Signi-ficance	No.	Signi-ficance	No.	Signi-ficance
V1	1.4	ns	1.7	ns	1.8	ns	1,8	ns	1,8	ns
V2	1.6	ns	1.8	ns	2.0	ns	1,8	ns	1,8	ns
K	1.2	*	1.8	*	1.9	*	1,5	*	1,5	*
	GD(5.0%) = 0.537 GD(1.0%) = 0.890 GD(0.1%) = 1.665		GD(5.0%) = 0.444 GD(1.0%) = 0.736 GD(0.1%) = 1.376		GD(5.0%) = 0.614 GD(1.0%) = 1.018 GD(0.1%) = 1.904		GD(5.0%) = 0.632 GD(1.0%) = 1.048 GD(0.1%) = 1.961		GD(5.0%) = 0.632 GD(1.0%) = 1.048 GD(0.1%) = 1.961	

The growth dynamics for each year of the study should be analyzed because of the different climatic characteristics. The specific conditions led to changes in the growth intensity during the individual ten-day periods of the growing season but did not change the overall trend.

Thirty days after application of the soil herbicide in 2014, the average length of the shoots in the treated variants was 22.8 cm (V1) and 19.6 cm (V2) – fig. 2. The minimum reduction in length compared to the control (K = 20.0 cm) recorded in V2 was overcome around the 40th day and at the end of the vegetation significantly longer shoots were accounted than the control. In V1 the length was equal to that of the untreated vines. The reason was the higher density of weeds in V1, which was almost equal to the control in the first 60 days after planting. The probability of the difference in shoot lengths between V2 and V1 and between V2 and the control (K) was good at (GD (5.0%) = 12.445; GD (1.0%) = 18.107 and GD (0.1% 27,206).

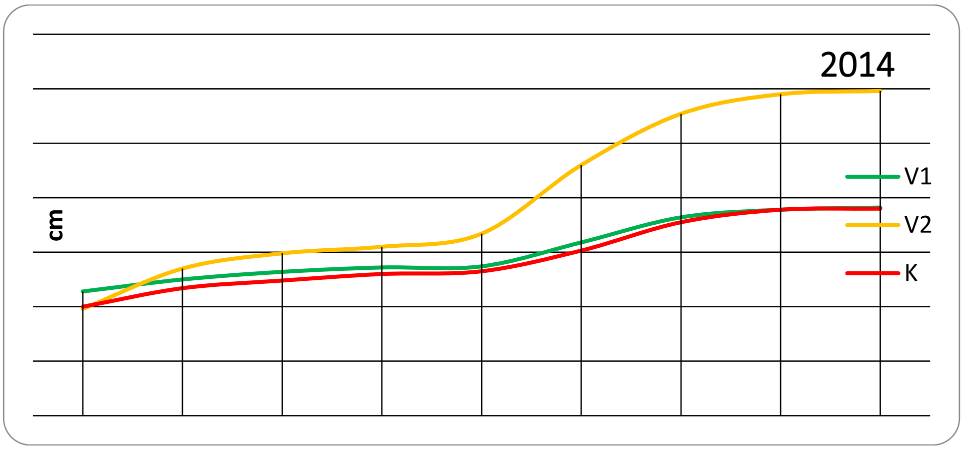

Figure 2. Dynamics of vine growth – 2014

In the climatically less favorable year 2015, thirty days after the application of Wing P, the average length of the shoots in the treated variants was 13.4 cm (V1) and 17.4 cm (V2) – fig. 3. At the end of the vegetation, the greatest shoot length was reported again in V2, but the difference was no-significant (GD (5.0%) = 6.191; GD (1.0%) = 9.007 and GD (0.1% 13.533). In V1, the growth was suspended already at about the fortieth day, and the vines from this variant remained with the smallest shoot length. The last changes in the rates of this indicator for V2 were found on the seventieth day after planting and treatment, indicating that growth had stopped at the end of July. In the untreated control that happened at about the sixtieth day.

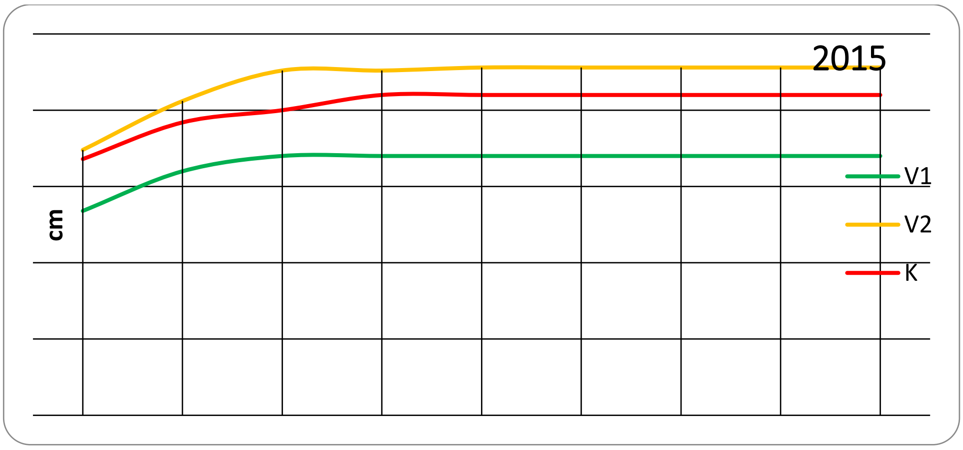

Figure 3. Dynamics of vine growth – 2015

In the third year of study on the thirtieth day the average shoot length in the treated variants was 10.2 (V1) and 12.2 cm (V2) – fig. 4. Both variants exceeded the control (9.6 cm). That tendency continued to the final ceasing of the growth, when again the vines of V2 had the greatest shoot length, but the difference versus the control and V1 (which practically became equal) was insignificant and unproven (at GD (5.0%) = 4.639 ; GD (1.0%) = 6.749 and GD (0.1%) = 10.141). In 2016, the last changes in the shoot length were established on the sixtieth day after planting and treatment, indicating that growth had stopped at the beginning of July. The reasons for this, as well as the relatively small length of the shoots, reached that year were the weather factors – especially the low precipitation in July (10.4 mm) and the relatively low humidity that month (58.3%). The highest intensity of growth was recorded in June, which coincided with the most significant rainfall during the growing season (97.8 mm).

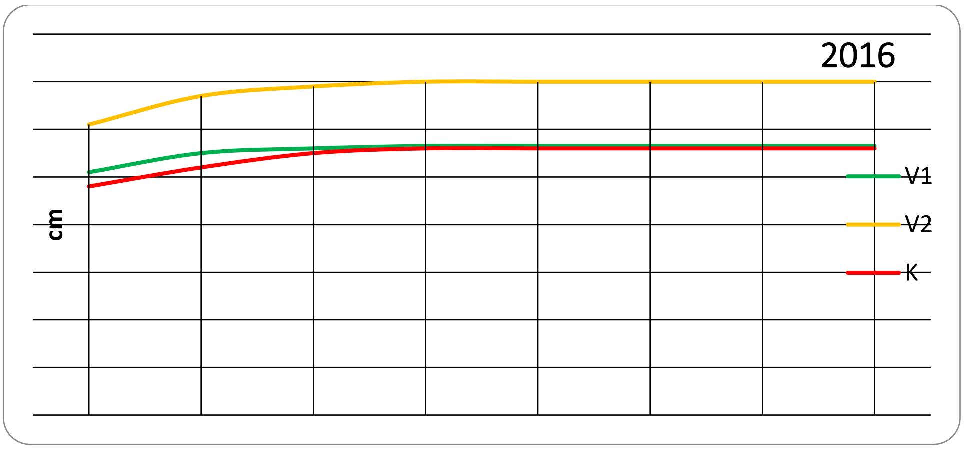

Figure 4. Dynamics of vine growth – 2016

Conclusions

With leached chernozem and climatic conditions characteristic of the region of Central Northern Bulgaria, the herbicide Wing P had an efficient action on the annual weeds during the first thirty days after treatment. From that moment on, it significantly weakened and disappeared entirely after the sixtieth day.

Applied at a dose of 0,2 l/da, Stratos Ultra completely destroyed Johnson grass grown form seeds and reduces to the minimum the plants emerged from the rhizomes.

The combination of the soil herbicide Wing P and Stratos Ultra did not inhibit the bud germination and did not cause a reduction in the number of shoots per vine.

The applied herbicides did not adversely affect the vine growth – the variant of Wing P at a dose of 0,6 l/da and Stratos Ultra at a dose of 0,2 l/da ensured better microclimate in the newly planted vineyard and created conditions for faster shoot growing.

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