THE INFLUENCE OF POSTEMERGENCE HERBICIDE ON THE MAIN YIELD COMPONENTS IN WHITE LUPIN (*Lupinus albus* L.) – cv. "RUXANDRA"

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Abstract

White lupin (*Lupinus albus* L.) is an underutilized crop that started to become extremely interesting for bio and conventional farmers due the high protein content of the seeds and, mainly, due the nitrogen fixation capacity. Nowadays, challenging economic environment and changing climate conditions had led to a bust in fertilizers prices worldwide. Identification and utilization in crop rotation systems of crop with nitrogen fixation capacity is an optimal alternative. One of the biggest problem in the white lupin cultivation technology is caused by the special sensitivity of this species at postemergence herbicide. This sensibility makes weed control a very difficult task for farmers. In this paper we present results obtained in 2022 season at the Ezăreni Farm, Iasi, Romania. Principal yield components were studied and compared among postemergence herbicide variants. Comparative studies were done using the cultivar RUXANDRA, obtained and registered by us.

Key words: *Lupinus albus*, postemergence herbicide, biotic and abiotic stress

The white lupine variety "Ruxandra" is one of the three varieties of white lupine listed in the Official Catalog of cultivated plant varieties in Romania for the year 2022 (https://istis.ro), all three varieties being created in the Plant Breeding Department at the Iasi University of Life Sciences.

Since the respective varieties are new creations of a species whose assortment is limited in Romania to three varieties, and in the European Union to 30 varieties (https://ec.europa.eu), for its expansion in culture it is necessary to adjust the optimal cultivation technology, in relation to the assortment of approved herbicides for the species of legumes for grains.

Because the white lupine is a leguminous species where the plants, in the first phases of vegetation, can withstand, for short periods of time, negative temperatures of up to -4^{0}C (Römer P., 2007) or even -6^{0}C (Simioniuc D.P. *et.al*, 2021), sowing is done in early spring, in the months of March-April. The delay in sowing made the plants to face periods of drought in one of the most sensitive phenophases, namely stages 60 and 70 of the BBCH scale (Hack H. *et al*, 1992, Römer P., 2007), when flowering and fruit set take place.

Since it is known that the white lupine achieves the complete coverage of the field late (Clark S., 2014, *figures 1 and 2*), the competitiveness against weeds is quite reduced until the flowering and branching stage (*figure 3*), it turns out that fighting them, on of mechanics and chemistry, is very important.

In Romania, there are only three approved herbicides for leguminous crops, in which the lupine crop is also explicitly mentioned.

The pre-emergent herbicides Challenge 600 SC with aclonifen 600 g/l (https://www.cropscience.bayer.ro/) and Sharpen 33 EC with pendimethalin 330 g/l (https://enochemie.ro/), which are effective against monocotyledonous weeds and some dicotyledonous weeds, can also be applied after sowing, but no later than the BBCH 08 scale (Challenge) or a maximum of three days after sowing (Sharpen), the recommended dose being 4 l/ha.

For post-emergence application, the only approved herbicide for the lupine culture is Fusilade Forte with 150 g/l fluazifop-P-butyl (https://nufarm.com/), against monocotyledonous weeds, in a dose of 0.8-1.6 l/ha, which can be administered until before the crop blooms (scale BBCH 50).

Other post-emergent herbicides, with selectivity for some leguminous crops, are the BASF products Basagran (480 g/l bentazon) and Corum (480 g/l bentazon +22.4 g/l imazamox) and Stratos Ultra (100 g/l cyloxidim) (https://www.agro.basf.ro/).

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MATERIAL AND METHOD

In order to test the effect of post-emergence herbicide on the productivity components of white lupine, the variety "Ruxandra" was used as biological material. This variety was created at USAMV Iasi, registered in 2021 and patented in 2022.

Two variants were tested, namely V1, non-herbicid post-emergence and variant V2, in which the post-emergence herbicide was carried out with Basagran, in a dose of 2l/ha, applied a week before the beginning of flowering.

The experiment was established on 09.05.2022 at the Ezareni farm within the Didactic Station of USV Iasi, on a chernozem type soil, after autumn wheat as the preceding plant. Sowing was done mechanized, at a distance between rows of 70 cm and a distance between grains per row of about 5.5 cm. After sowing, a pre-emergent herbicide was applied - Challenge 600 SC (4 l/ha), and after the plants had fully emerged, a mechanical weeding was carried out (*figure 1*).

Figure 1 **First stages of white lupine growing after mechanical hoeing (01.06.2022)**

To perform the biometric determinations on the quantitative characters, the plants were harvested from two linear meters in a row, in six repetitions from randomly chosen points for each individual variant.

For each sample, the plants were counted and biometric measurements were made on the following characters: plant height, insertion height of the first pods, height with pods, number of pods per plant, length and average width of pods, weight of pods, number of seeds per plant and the weight of seeds per plant.

The evaluation of the phenotypic variability was carried out by determining the coefficient of variability, and the statistical processing through the analysis of the variant allowed highlighting the differences that appeared as a result of the post-emergence herbicide. The determination of the significance of the differences compared to the control variant, not postemergent, was achieved by the "limit differences" method (Saulescu N.A., Saulescu N.N., 1967).

RESULTS AND DISCUSSIONS

The soil water reserve was well below the multi-year average in the months preceding sowing, but in May 2022 the total amount of precipitation was double (80.6 mm) compared to the multi-year monthly average (*table 1*), this aspect allowing a quick and uniform start of the white lupine culture.

The application of pre-emergence herbicide and the performance of mechanical weeding contributed to the elimination of weed competition in the first phases of vegetation, for both tested variants (*figures 2*). Later, the application of post-emergence herbicide led to the recording of some positive differences, statistically ensured, for the quantitative characters directly involved in determining plant yield (*table 2*), even if there was a new reinfestation with some weed species, as: *Xanthium strumarium, Amaranthus retroflexus, Convolvulus arvensis, Chenopodium album, Setaria viridis, Sorghum halepense* and *Echinochloa crus-galli* (*figure 3*).

Although the rainfall deficit recorded in the months preceding sowing (January-March) was compensated by double the amount of precipitation falling in the month preceding the sowing date, in the period May-August the precipitation was around 40% of the multi-year average of the interval. Regarding average monthly temperatures, they exceeded the multiannual average of May by 0.4^0C and in the June-August period, the average temperature increase exceeded the average by about 2^0C.

As a result, the white lupine plants faced a major and prolonged stress throughout the vegetation period, which was reflected in the end by very low values of the plant height and the component elements of the yield capacity (*figure 4*).

The processing of the average values of the quantitative characters demonstrated an increase in them in the case of the post-emergence herbicide variant (*figure 5*).

The number of seeds per pod registered the greatest differences, very significant, followed by the height of the plants and the weight of the pods per plant, where the differences recorded were distinctly significant. The number of pods per plant and the weight of the seeds per plant registered significant differences compared to standard variant.

Table 1

Weather conditions at Ezareni Farm in 2022

Temperature (^{0}C)										
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
Average	0.7	3.6	3.1	10.3	16.5	21.6	23.0	22.8	15.6	13.3
Min.	-10.5	-6.9	-9.6	-3.8	2.1	9.2	8.6	13.6	3.0	4.8
Max.	13.1	16.7	23.1	26.3	31.9	37.0	35.8	34.8	28.3	27.2
Multi-annual average	-3.6	-1.9	3.3	10.1	16.1	19.4	21.3	20.6	16.3	10.1
Departure from normal	4.3	5.5	-0.2	0.2	0.4	2.2	1.7	2.2	-0.7	3.2
Rainfall (mm)										
Sum	14.4	16.4	16	80.6	24	24.6	20.4	53	78	5.4
Multi-annual average	28.9	27.4	28.1	40.3	52.5	75.1	69.2	57.6	40.8	34.4
Departure from normal	-14.5	-11	-12.1	40.3	-28.5	-50.5	-48.8	-4.6	37.2	-29
Relative humidity (%)										
Average	25.83	48.25	63.52	51.07	36.96	43.49	63.59	77.77	30.98	35.46

Table 2

The influence of the postemergence herbicide treatment on the main yield components of white lupine "Ruxandra" cv.

Characters and units	Variant (herbicide treatment)	Average	Coefficient of variability (s%)	Differences of standard variant	Meaning of the differences	LD 5%, 1%, 0,1%
Plants height (cm)	V1 - Std, Untreated	60.47 ± 1.50	13.33	4.51	**	2.81 4.40 7.49
	V2, Treated	64.99 ± 1.40	12.88			
Insertion height of the first pods (cm)	V1 - Std, Untreated	50.64 ± 1.24	13.17	3.03		3.92 6.15 10.48
	V2, Treated	53.67 ± 1.03	11.55			
Height with pods (cm)	V1 - Std, Untreated	8.97 ± 0.49	29.03	1.01		1.19 1.87 3.18
	V2, Treated	9.98 ± 0.48	28.85			
Number of pods/plant (no.)	V1 - Std, Untreated	3.01 ± 0.27	47.65	0.32	*	0.31 0.49 0.84
	V2, Treated	3.33 ± 0.21	38.11			
Pod length (cm)	V1 - Std, Untreated	6.11 ± 0.22	19.37	0.41		0.45 0.70 1.19
	V2, Treated	6.53 ± 0.20	18.96			
Pod width (cm)	V1 - Std, Untreated	1.13 ± 0.03	12.53	0.04		0.07 0.11 0.19
	V2, Treated	1.17 ± 0.02	12.44			
Pod weight/plant (g)	V1 - Std, Untreated	2.98 ± 0.36	64.41	0.80	**	0.49 0.77 1.30
	V2, Treated	3.78 ± 0.35	55.19			
Number of seeds/plant (no.)	V1 - Std, Untreated	9.43 ± 1.06	60.66	1.53	***	0.51 0.79 1.35
	V2, Treated	10.96 ± 0.86	47.44			
Seed weight/plant (g)	V1 - Std, Untreated	2.15 ± 0.26	64.89	0.45	*	0.31 0.48 0.82
	V2, Treated	2.59 ± 0.24	55.62			
Seed production (t/ha)	V1 - Std, Untreated	0.45		0.23	***	0.07 0.11 0.19
	V2, Treated	0,68				

Figure 2 **The effect of herbicide treatment in pre-flowering stage of white lupine (16.06.2022**)

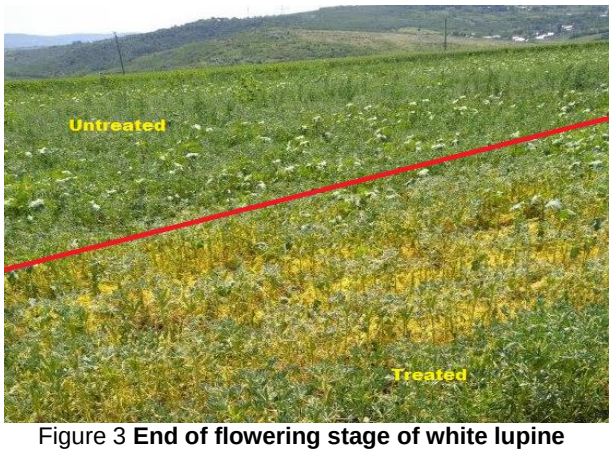

Figure 3 **End of flowering stage of white lupine (27.06.2022)**

Figure 4 **Manual harvest of plants samples (26.09.2022)**

For the other four quantitative characters, namely the insertion height of the first pods, the height with pods, the length and width of the pods, the herbicide did not lead to statistically significant increases.

Regarding the variability of the quantitative characters, it turned out that the post-emergence herbicide determined, for all the quantitative characters, the reduction of the values of the coefficients of variability (*figure 6*), even if, with both variants of herbicide, they keep the same class of variability.

The biggest reductions (over 20%) of the values of these coefficients were recorded for the number of pods and the number of seeds per plant, and for the weight of the pods and the weight of seeds per plant, post-emergence herbicides determined the reduction of the values of the coefficients of variability by about 14 %.

Since the conditions for the growth and development of the plants in 2022 were very unfavorable, the average productions of the two variants were extremely low, of only 0.35 t/ha in the variant without post-emergence herbicide, and 0.68 t/ha in the variant with post-emergence weed control.

The influence of post-emergence weeding on the white lupine variety "Ruxandra" is particularly important, the current experience showing a very significant increase in seed production, by about 50%, compared to the untreated post-emergence variant.

The question remains whether the impact of post-emergence herbicides, on soils known to have a large reserve of weed seeds, remains as strong under favorable conditions for crop, especially in terms of sufficient water supply.

CONCLUSIONS

The year 2022 was a year with strong climatic stress on all crops, including white lupine.

The flowering period of the white lupine plants of the “Ruxandra” variety overlapped with a period of time in which the accumulation of very high temperatures and the lack of precipitation determined a dramatic reduction in seed production.

As a result, late sowing is not recommended, especially in the northern part of Romania, where drought is more and more present in recent years.

The post-emergence herbicide, on the soils heavily infested with weed seeds, determined an increase in the uniformity of the quantitative characters, with direct favorable implications both on the actual mechanized harvesting process and on seed production.

Since the range of herbicides that can be applied post-emergence to leguminous crops, in general, is quite limited, we consider that testing the reaction of white lupine plants to these herbicides is necessary.

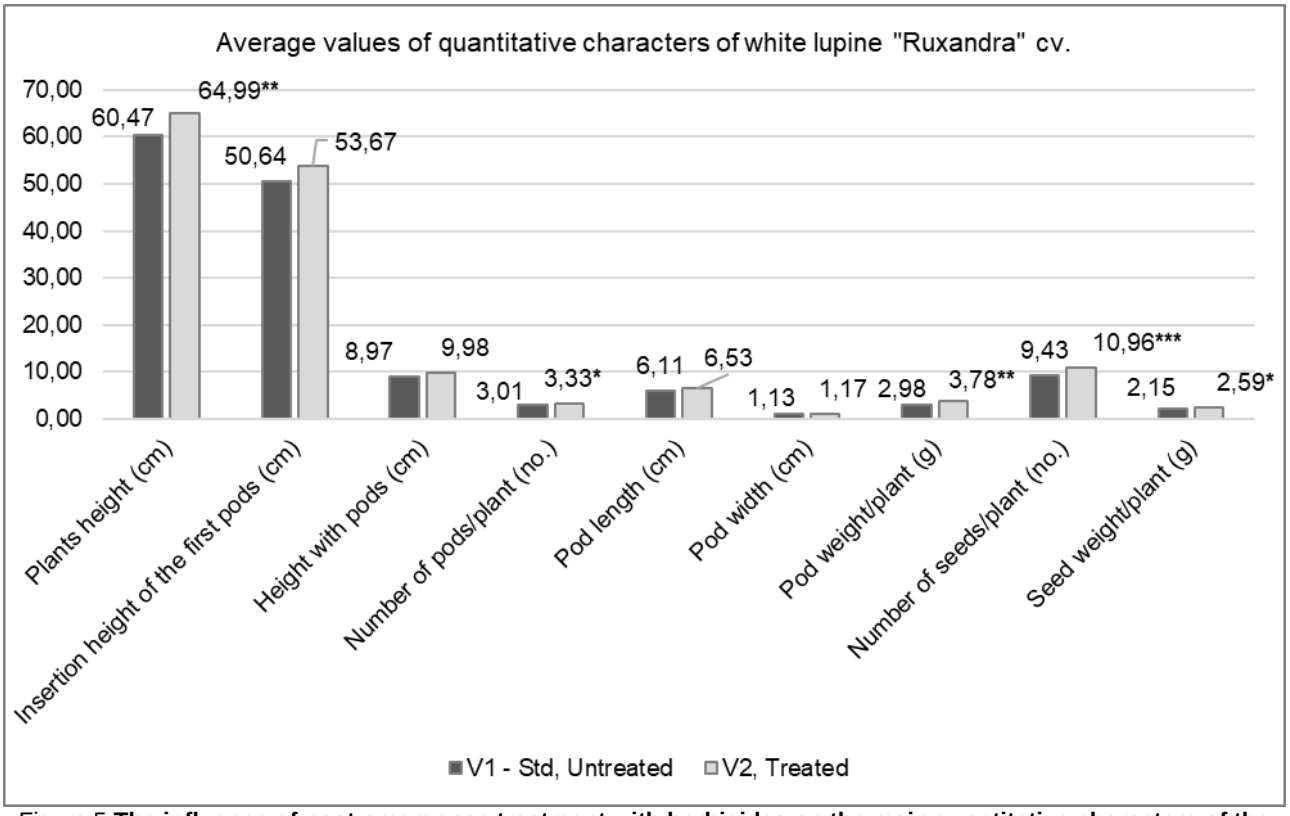

Figure 5 **The influence of post-emergence treatment with herbicides on the main quantitative characters of the ”Ruxandra” white lupine variety**

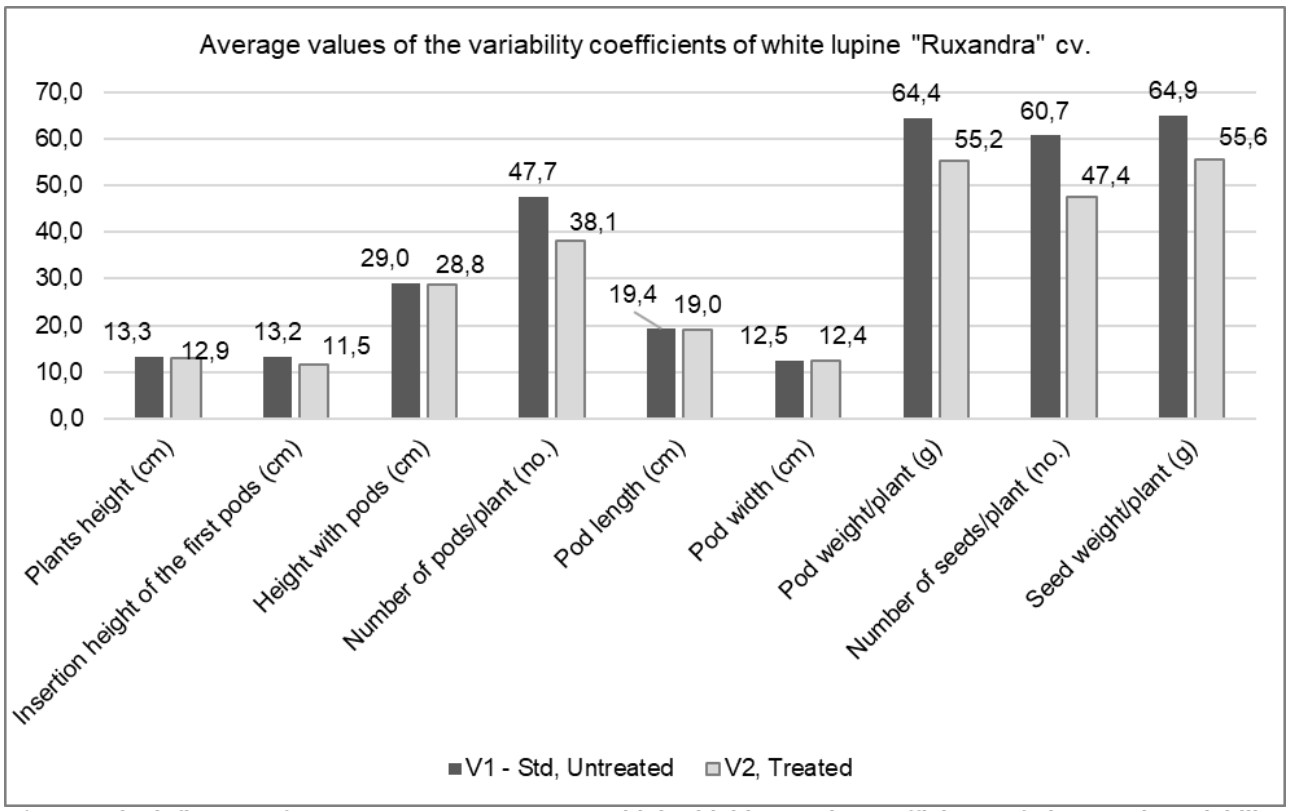

Figure 6 **The influence of post-emergence treatment with herbicides on the coefficients of phenotypic variability in the ”Ruxandra” white lupine variety**

ACKNOWLEGMENTS

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