WEEDS RESPONSE TO THE BIOCONTROL AGENTS IN INTEGRATION WITH REDUCED RATES OF HERBICIDE

M. Zargar

Department of genetics, planting and plant protection
Russian People's Friendship University
Miklucho-Maklay str., 8/2, Moscow, Russia, 117198

Field experiment was conducted to study the biological agents efficacy in combination with reduced doses of new generation herbicide (Verdict) in four rates (0, 0,2, 0,3 and 0,5 kg/ha) to control weeds in winter wheat (*Triticum aestivum L.*), trial was laid out in a randomized complete block design with four replications at Moscow research institute of agriculture, Nemchinovka, Russia. Result indicated that recommended dose as 0,5 kg/ha in combination with biological agents was quite effective in reducing density and dry weight of *Viola arvensis* and *Poaceae*. Thus, intermediate Verdict rate as 0,3 kg/ha + biological agents also had appropriate effect in reducing dry weight and density both of *V. arvensis* and *Poaceae*. *Stelaria media* was affected and diminished by each three of treatments desirably compared to control.

Key words: weed control, reduced herbicide dose, biological agent.

Introduction. Try to weeds control by the using biological management methods have been gaining momentum entire the world, especially in the recent past [14]. Biocontrol agents would appear to be the proper solution for control of weeds in conventional agricultural systems [10]. Biological weed suppression is presented through either the classical or augmentative approaches. The classical method is an ecologic strategy that includes an initial inoculation of weed densities with self-sustaining agent [24]. Biocontrol of weed is described as a selective, environment-friendly process, utilizing host-specific control agents towards targeted weeds that prevent damage to non-target crops or native plants [22; 6]. The augmentative or inundative method utilizes bioherbicidal annual application of endemic or foreign agents similar to herbicide usage [15; 21] reported that high concentrations and the alteration of formulations are essential to improve biological herbicide activity. The biological control of weeds by plant pathogens has also received so much interest in the last decades [5; 9; 17]. Thus, bioherbicides application for reducing weeds includes overwhelming weeds with single or multiple applications of a pathogen [18].

An effective weed control can be obtained by using herbicides at below-labeled [12; 27] while maintaining satisfactory crop yields [14; 2]. Several studies have showed satisfactory weed control and acceptable crop yields, while herbicides are used at lower than recommended doses [16; 13; 8; 7]. Recently, the aim of weed control is to keep the weed density at a proper level, rather than to keep the crop totally free of weeds. Medd et al. [20] reported that a general principle, a lower rate of herbicide can suppress most of the weeds under appropriate conditions; however, under less favorable conditions, a higher rate will be required, and in unfavorable conditions even the highest rate of herbicide may still give unsatisfactory results in weed management. Other studies of several crops and under various environmental conditions [27] indicated substantial variations in weed control efficacy applying different herbicide doses. In a few investigations, applying labeled doses, they achieved a weed control only 20—40%, whereas a weed management efficacy of 70% and higher was obtained with herbicide rates as low as 20% of the labeled one. The objective of this experiment was to consider the biological agent efficacy (Biofertilizer and growth regulator, Bioherbicide and Phytosporin: biological fungicide with an anti stress activity to weather conditions and chemical treatments and growth regulator activity) in integration with reduced doses of new generation herbicide verdict for weeds suppression in winter wheat.

Material and methods. Trial was conducted at Moscow institute of agriculture, Nemchinovka, Odintsovskiy region, (55° 45′ N, 37° 37′ E and 200 m altitude), during 2011—2012, the soil was typically loamy soil with 1,73% organic matters and a pH level of 5,3.

The field was plowed before sowing seeds and basal fertilizers doses 40 kg N, 40 kg P_2O_5 and 40 kg K_2O ha^{-1} in the depth of 10—15 cm were incorporated into the soil by spreader, Organic fertilizer was also added to the soil into the rate of 50 t/ha, the seedbed was prepared by roller harrowing before planting, disk operation was also conducted, due to changing soil pH, Dolomik powder 5 t/ha was added to the soil, the net plot size was 2 m × 20 m, wheat cv. Moscovskaya 39 was planted in 29th of August 2011 using a seed rate of 150 kg/ha, to protect seeds against pests and diseases, seeds were mixed with fungicide and insecticide before planting.

Experiment was laid out to study of weed suppressive activity of biocontrol components [bioherbicide (3 L/ha) + biofertilize & growth regulatore (1 L/ha) + biofungicide with anti stress activity to climate conditions, chemical treatments and growth regulator activity (1 L/ha)] in combination with reduced doses post emergence herbicide ‘Verdict’ (0, 0,2, 0,3 and 0,5 kg/ha), surfactant 0,5 L/ha was also mixed to verdict as a tank mix, experiment was conducted in a randomized, complete block design [RCBD] with four replicates, the herbicides were applied by a knapsack sprayer which had flat fan nozzles (Nozzle number 11002), all agents were applied at the early stem stage of wheat. Detailed description of the treatment combinations is presented in Table 1.

The data were analyzed statistically by an analysis of variance (ANOVA), using the general linear model procedure of SAS Institute [25]. The differences among the means were detected using LSD Range test ($P < 0,05$).

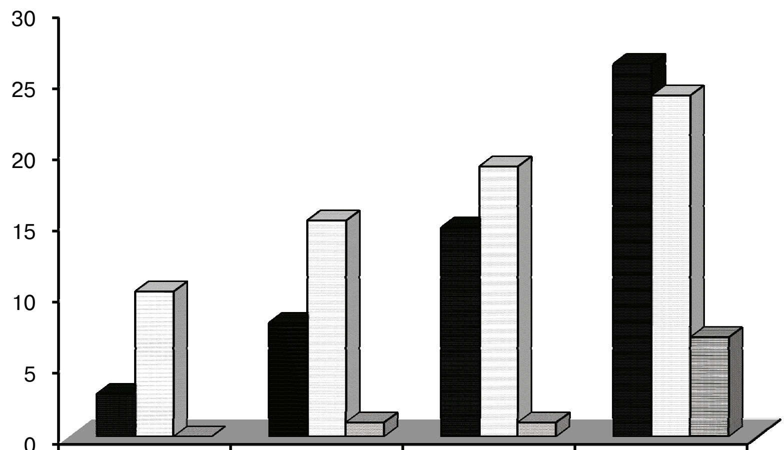
Table 1

Treatment combinations details in the trial

Variant	Treatment combination
V1B	Verdict 0,5 L/ha + (biofertilizer&growth regulator+bioherbicide+biofungicide with anti stress activity)
V2B	Verdict 0,3 L/ha + (biofertilizer&growth regulator+bioherbicide+biofungicide with anti stress activity)
V3B	Verdict 0,2 L/ha + (biofertilizer&growth regulator+bioherbicide+biofungicide with anti stress activity)
Control	Control (without treatment)

Results and discussion. *Dry weight and density of weeds.* Results showed that treatment significantly affected density of *Viola arvensis*, *Poaceae* and *Stelaria media* ($p < 0{,}01$; Table 3). Weeds density reduction was mainly due to the effect of the reduced doses of verdict in integration with biological agents. Weeds control efficacy decreased more for verdict 0,5 kg/ha + biocontrol agents in comparison with other treatments (Fig. 1), the results of the trial indicated that a proper control of *Poaceae*, *Viola arvensis* and also *Stelaria media* might be achieved with below-labeled herbicide dose as 0,3 kg/ha, as it has been stated by [14; 27; 12; 7; 2; 3; 4].

The higher efficacy was obtained with the maximum rate of verdict 0,5 kg/ha + biological agents but the difference was not high compared to the intermediate herbicide dose 0,3 kg/ha, the lowest herbicide dose 0,2 kg/ha + biological agents had a significantly lower control efficacy on suppress of *Viola arvensis* and *Stelaria media*. This result can be due to the integration of biological components, additionally, the aim of biological weed control is not to eradicate them but to reduce and regulate weed density below levels that cause economic injury.



	V1B	V2B	V3B	Control
V. arvensis	3	8	14,7	26,2
Poaceae	10,2	15,2	19	24
S. media	0	1	1	7

Fig. 1. Effect of reduced doses of verdict belongs with biological agents on reducing total weeds density

Table 2

Statistical significance levels for weeds density

Source of variations	df	F ratio		
		Density		
		V. arvensis	Poaceae	S. media
Replications	3	23 ns	22,0 ns	0,5 ns
Treatment (Verdict + biological agents)	3	135,4**	135,4**	41**
Error	9	14,3	17	0,2
Total	15	—	—	—
CV (%)	—	28,2	24,1	23,21

Note. Ns and ** are non-significant and significant at 1% probability level, respectively.

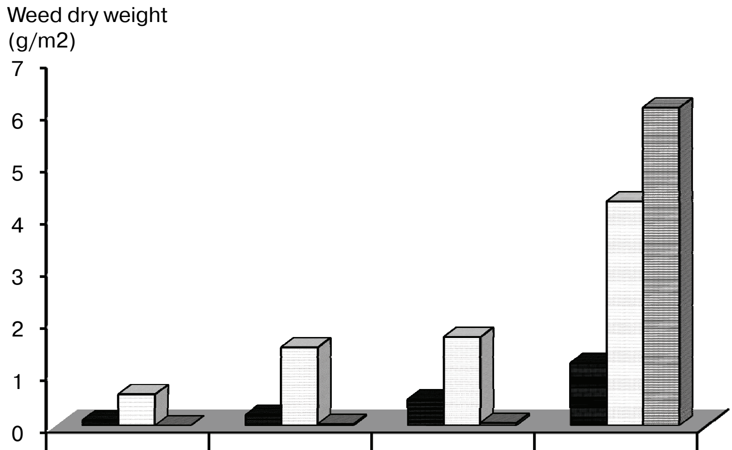
Table 3

Statistical significance levels for weeds biomass

Source of variations	df	F ratio		
		Dry weight		
		V. arvensis	Poaceae	S. media
Replications	3	0,1 ns	0,1 ns	0,00 ns
Treatment (Verdict + biological agents)	3	0,91**	10**	0,31**
Error	9	0,02	0,1	0,00
Total	15	—	—	—
CV (%)	—	26,52	17,29	25,2

Note. Ns and ** are non-significant and significant at 1% probability level, respectively.

Treatment significantly affected all biomass of three weeds species: *Viola arvensis*, *Poaceae* and *Stelaria media* (p < 0,01; Table 3). Fig. 2 shows differences between various rates of herbicide + Biological agents for weeds biomass, Verdict 0,5 kg/ha + biological agents was the most effective treatment on reducing dry weight of *Viola arvensis* and *Poaceae*, according to fig. 2, dry weight of *Stelaria media* was affected by each three of treatments desirably compared with control. Similar results are reported in [1]: significant weed suppression can be obtained with reduced herbicide rates and providing acceptable weed control during critical periods, it is not always necessarily to apply full herbicide rate [26] and there can be flexibility regarding herbicide doses depending on the weed spectrum, densities, their growth stage and environmental conditions of the site. Non-chemical weed control techniques as biological components can have desirable weed control efficacy in combination with herbicides [23]: biocontrol components can provide long-term benefits to natural areas as long as the potential risks from this approach are fully recognized and addressed. It can be suggested to reduce chemicals rates in combination with biological agents in ongoing weed control methods, bioherbicides should be integrated to other weed control methods [19].



	V1B	V2B	V3B	Control
V. arvensis	0,1	0,2	0,5	1,2
Poaceae	0,6	1,5	1,7	4,3
S. media	0	0,03	0,05	6,1

Fig. 2. Effect of reduced doses of verdict belongs with biological agents on reducing weeds

Conclusion. Overall, result showed that the higher efficacy was obtained with the biological agents integrated labeled rate of verdict as 0,5 kg/ha but, on the other hand, intermediate dose as 0,3 kg/ha was also obviously effective in weeds control in some cases, most weed density was presented in Control (without treatment) and 0,2 kg/ha combined with biocontrol agents respectively.

Acknowledgment. The author would like to thank the support from Elena Nikolaevna Pakina for extending her help during the entire field and laboratory trials.

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КОМПЛЕКСНОЕ ИСПОЛЬЗОВАНИЕ БИОПРЕПАРАТОВ СОВМЕСТНО С УМЕНЬШЕННЫМИ ДОЗАМИ ГЕРБИЦИДА ДЛЯ КОНТРОЛЯ ЧИСЛЕННОСТИ СОРНОЙ РАСТИТЕЛЬНОСТИ

М. Заргар

Кафедра генетики, растениеводства и защиты растений
Российский университет дружбы народов
ул. Миклухо-Маклая, 8/2, Москва, Россия, 117198

В статье представлены результаты полевого опыта для изучения эффективности комплексного действия биологических препаратов (производства компании Башинком) совместно с уменьшенными дозами гербицида нового поколения Вердикт (производства компании Байер) в четырех дозах (0; 0,2; 0,3 и 0,5 кг/га) для контроля сорной растительности на посевах озимой пшеницы (*Triticum aestivum L.*). Исследования проводились на опытных полях НИИ сельского хозяйства нечерноземной зоны РФ. Результаты показали, что применение рекомендованной дозы гербицида 0,5 кг/га совместно с комплексом биопрепаратов эффективно снизило численность сорняков семейства Мятликовые, а также *Viola arvensis*. В то же время доза гербицида 0,3 кг/га в комплексе с биопрепаратами также оказалась эффективной для подавления сорной растительности семейства Мятликовые и *Viola arvensis.* Все три испытанные дозы гербицида оказались эффективными для контроля *Stelaria media*.

Ключевые слова: контроль численности сорной растительности, уменьшенные дозы гербицида, биологические препараты.