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Using biological agents in combination with reduced rates of verdict for controlling broad leaf weeds

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[2]*This experiment was conducted at Moscow Institute of Agriculture, Nemchinovka, Odintsovskiy region, Russia*

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Abstract

Experiment was carried out to evaluate the effect of biological agents combined to reduced rates of new generation herbicide 'Verdict' in four levels involving: 0, 0.2, 0.3 and 0.5 kg ha^{-1} for suppressing weeds in wheat (*Triticum aestivum* L.), study was laid out in a randomized, complete block design with four replications in Moscow research institute of agriculture, Nemchinovka, Odintsovskiy region, Russia. Herbicide rate 0.5 kg ha^{-1} as a labeled-dose plus biological components was desirably effective in controlling broad leaf weeds namely *Viola arvensis* and *stelaria media*, mentioned weeds also were suppressed by the using of intermediate Verdict dose as 0.3 kg ha^{-1} plus biological agents.

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Introduction

Biological weed control is determined as an environment-friendly process, utilizing host-specific control agents towards targeted weeds that prevent damage to non-target crops or native plants (Pleban and Strobel, 1998). Weed management by the using of biological agent is practiced through either the classical or augmentative methods. The classical strategy is an ecologic approach that involves an initial inoculation of weed populations with self-sustaining agent (Zimdahl, 1993; Sheley *et al.*, 1998). The augmentative approach utilizes bioherbicidal annual application of endemic or foreign agents similar to herbicide applications (Goeden, 1999). Thus, optimizing biological weed suppression happen in stages (Coombs *et al.*, 1999). Patzoldt *et al.* (2001) indicated that high concentrations and the alteration of formulations are essential to improve biological herbicide activity.

Biological weed control by plant pathogens has received much interest in the last decades (Frantzen, 1994; Charudattan and Dinoor, 2000; Hasan and Ayres, 1999). Moreover, application of bioherbicide in weed control involves overwhelming weeds with single or multiple applications of a pathogen (Hoagland, 2001). Most countries require bioherbicide registration in accordance with pesticide laws prior to initial use. This might be a limitation to development as bioherbicide markets are not large adequate to restore registration prices in a proper period of time (Scheepens *et al.*, 2001). Appropriate weed suppression can often be obtained by using herbicides at lower rates than recommended ones (Fernandez-Quintanilla *et al.*, 2000; O'Donovan *et al.*, 2004; Zhang *et al.*, 2000) while maintaining satisfactory crop yields (Fernandez-Quintanilla *et al.*, 2000; Barros *et al.*, 2005, 2007 and 2008). Recently, the aim of weed management is to keep the weed population at a proper level, rather than to keep the crop totally free of weeds. Some studies have demonstrated satisfactory weed management and desirable crop yields, while herbicides are applied at lower than recommended rates (Hamill *et al.*, 2004; Fernandez-Quintanilla *et al.*, 1998; Zhang *et al.* 2000; Brian *et al.*, 1999; Bostrom and Fogelfors, 2002). Lower dose of herbicide may control most of the target weeds under desirable 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 (Medd *et al.*, 2001).

Various researches on several crops and under different environmental conditions by Zhang *et al.* (2000) demonstrated substantial variations in weed management efficacy applying different herbicide doses. The same research indicated that weed control efficacy tended to be lower and varied more at reduced doses than recommended ones, but remained within the 60-100% range in over 90% of the cases. In more cases, weed control was over 70% at doses between 30% and 60% of the recommended dose (Zhang *et al.*, 2000).

Weed density should be reduced to tolerable levels. The negative effect of weeds on crops can be limited not only by reducing weed density, but also by minimizing the resource consumption, growth, and competitive ability of each surviving weed. The aim of this study was to evaluate the biological component efficacy in combination with reduced rates of new generation herbicide Verdict on weeds control.

Material and methods

Location

Field Experiment was conducted at Moscow institute of agriculture, Nemchinovka, Odintsovskiy region, (55°45′ N, 37°37′ E and 200 m altitude), Russia, during 2012-2013, soil sample was collected before crop sowing to a depth of 15 cm and analyzed for different characteristics, the soil was typically loamy soil with 1.73% organic matter and a pH level of 5.3.

Field preparation and treatments

Field experiment was plowed before planting seeds and basal fertilizers doses 40 kg N, 40 kg P2O5 and 40 kg K2O ha^{-1} in the depth of 10 to15 cm were incorporated into the soil by spreader 'Amazon', Organic fertilizer was also added to the soil into the rate of 50 t ha^{-1}, the seedbed was prepared by roller harrowing before planting, disk operation was also conducted, due to changing soil pH, Dolomik powder 5 t ha^{-1} 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^{-1},to protect seeds against pests and diseases, seeds were mixed with fungicide and insecticide before sowing. The study was carried out to investigate the weed control activity of biological components [biological herbicide (3 l/ha^{-1}) + growth regulator (1 l/ha^{-1}) + biofungicide with anti stress activity to weather conditions, chemical treatments and growth regulator activity (1 l/ha^{-1})] in combination with reduced rates of new generation post emergence herbicide 'Verdict' (0, 0.2, 0.3 and 0.5 kg ha^{-1}), surfactant 0.5 L ha^{-1} was mixed to herbicide as a tank mix.

Experiment was carried out in a randomized, complete block design with four replications, the herbicides were sprayed post-emergence by a knapsack sprayer which had flat fan nozzles (Nozzle number 11002), and all agents were used at the early stem stage of wheat. Other cultural practices were typical of those used for commercial winter wheat production in Moscow region.

Sampling and statistical analysis

Total number of weeds from 0.25 m^2 area (weeds density) of each net plot were counted 12 days after application of experimental treatments by the using 50 × 50 cm^2 quadrate regarding to the method of European Weed Research Society (*EWRS*), the whole weeds were dried in an oven at 70° C until constant weight was obtained for dry weight.

All the recorded data were tabulated according to treatment influence under four replications, analysis of variance was used to assess the variation of the data, LSD tests at $P < 0.05$ were used to compare the means and determine the significance of differences between variables using SAS for windows.

Result and discusion

Weeds density

Results showed the significant effect of herbicide plus biological components on density of both weed sorts; *Viola arvensis* and *Stelaria media* ($p < 0.01$; Table 1). Table 2 shows that herbicide verdict 0.5 kg ha^{-1} plus biological components was more effective on decreasing weeds density compared to other treatments, experimental data illustrated that both weed varieties; *Viola arvensis* and *Stelaria media* favorably diminished when the below-labeled verdict dose 0.3 kg ha^{-1} was sprayed, mentioned results are in agreement with findings noted by Fernandez-Quintanilla *et al.* (2000), Zhang *et al.* (2000), Boström and Fogelfors (2002) and Barros *et al.* (2005, 2007, 2008). Reduction in herbicide dose implemented can be beneficial economically for the farmers and purchasers as well as environmentally and perhaps, in some cases without decreasing weed control efficiency. This reduction in rate of applied herbicides should be lowering longer periods of efficiency for chemical herbicides. The best weeds reduction result was achieved with the maximum dose of herbicide 0.5 kg ha^{-1} plus biological component but the difference was not high significant compared to the below-labeled herbicide rate 0.3 kg ha^{-1} plus biological components. The worst control efficacy on suppressing about both weeds namely *Viola arvensis* and *Stelaria media* was for the lowest herbicide dose 0.2 kg ha^{-1} plus biological components. Hence, the main objective of biological weeds management is not to eradicate but rather to diminish weed densities below levels that cause economic injury. Reduced doses of herbicide are often sufficient to control weed population at or below the threshold levels and below-labeled herbicide doses in combination with some other weed control have proven to be an effective way of reducing herbicide input to cropping systems (Barros *et al.*, 2005).

Weeds biomass

Using herbicide plus biological components significantly affected both varieties of weeds dry weight '*Viola arvensis* and *Stelaria media*' and also total weeds biomass ($p<0.01$; Table 3). There are differences between doses of herbicide plus Biological components on weeds biomass, Verdict 0.5 kg ha^{-1}

combined to biological components was the most effective treatment on decreasing dry weight of both weeds varieties *Viola arvensis* and *Stelaria media* (Table 4).

Table 1. Statistical significance levels for weeds density 30 days after treatments in 2012-2013.

Sources	df	*F* ratio	
		Weed density	
		Viola arvensis	*Stelaria media*
Replication	3	2.06ns	2.06ns
Verdict combined to biological agents	3	185.06**	185.7**
Error	9	1.06	1.84
Total	15		
CV (%)		12.7	29.1

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

Table 2. Effect of reduced rates of herbicide combined to biological agents on weed density 30 days after treatment in 2012-2013.

Treatments	)Biomass (gr m^{-2}	
	V. arvensis	*S. media*
Verdict 0.5kg ha^{-1} plus biological components	2.50 c	0.00 c
Verdict 0.3kg ha^{-1} plus biological components	3.75 c	0.19 c
Verdict 0.2kg ha^{-1} plus biological components	8.50 b	3.50 b
Control 'no application '	17.5 a	14.50a

According to the data of total weeds biomass, it was determined that the various rates of herbicide plus biological components affected significantly total weeds dry weight, enhancing the verdict rates from the lowest dose to the highest one plus biological components favorably reduced the total weeds dry weight (Table 4).

Table 3. Statistical significance levels for weeds biomass 30 days after treatments in 2012-2013.

Sources	df	*F* ratio		
		Weed biomass		
		Viola arvensis	*Stelaria media*	Total
Replication	3	0.01ns	0.00ns	0.28ns
Verdict combined to biological agents	3	0.20**	1.20**	32.48**
Error	9	0.001	0.001	0.09
Total	15			
CV (%)		28.4	11.6	10.3

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

Despite the lowest weeds biomass was achieved with the maximum verdict rate 0.5 kg ha^{-1} plus biological components but it might be possible to recommend intermediate herbicide dose 0.3 kg ha^{-1} combined to biological components as effective for controlling broad leaf weeds. In some research, using recommended-rates, they obtained a weed suppression only 20 - 40%, whereas a weed suppression efficacy of 70% and higher was achieved with herbicide doses as low as 20% of the label recommendation dose, the same experiment illustrated that weed management efficacy tended to be lower more at decreased doses than labeled-ones. In many cases, controlling weeds was over 70% at rates between 30% to 60% of the labeled-dose (Zhang *et al.*, 2000). Hence, it is not always essential applying full doses of herbicides and there can flexibility according herbicide doses depending on the weed spectrum, their growth stage and also environmental conditions of the site (Talgre *et al.*, 2008). Moreover, amount of herbicide dose at lower than labeled-doses are appropriate to provide satisfactory weed control without sacrificing crop yields and increasing weed infestation in the following years (Zhang *et al.*, 2000; Boström and Fogelfors, 2002; Barros *et al.*, 2007).

Table 4. Effect of reduced rates of herbicide combined to biological agents on weed biomass 30 days after treatment in 2012-2013.

Treatments	)Biomass (gr m^{-2}		
	V. arvensis	*S. media*	*Total*
Verdict 0.5kg ha^{-1} plus biological components	0.11c	0.00 c	0.68 d
Verdict 0.3kg ha^{-1} plus biological components	0.13 c	0.04 c	1.23 c
Verdict 0.2kg ha^{-1} plus biological components	0.22 b	0.22 b	2.63 b
Control ‘no application ‘	0.58 a	1.19 a	7 a

Means in columns followed by the same letter are not significantly different at P = 0.05.

Conclusion

Results demonstrated that a favorable level of weed control was obtained with recommended-dose of verdict that was comparable to results with intermediate dose. Also, similar experiments need to be carried out under varying soil and environmental conditions in different field crops.

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