Integrated System for Plant Nutrition and Control of Pathogens in Sunflower Crop

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Abstract

The influence of different integrated control measures exerted on the attack frequency of phytopathogenic agent is presented in this paper. Measures with low or harmless influence on the environment are taken into consideration and some recommendations regarding several agrotechnical measures and fungicide application are made, aiming to reduce the input of toxic per hectar. With the same target, a *Azospirillum* bioinoculant is associated to these agrotechnical measures, the complex effect being exerted on plant growth and development, nitrogen nutrition and the control of main pathogens.
The authors consider that an integrated control management based on some associated agrotechnical and biological measures is very promising to diminish the environmental risks by decreasing chemicals use without their entire exclusion.

Introduction

The transition to the sustainable agriculture systems requires the development of new management practices implying an improved control of plant diseases, insect pests and other adverse factors along with a simultaneous and progressive reduction of chemicals utilization.
Based on the available knowledges, we consider that an efficient integrated pathogen control management could be developed in the benefit of an increased yield level and quality. The integration takes into account a large spectrum of measures, such as plant breeding, agrotechnical and biological measures.
The major role played by some management sequences, in diminishing, even eradicating of the main pathogens attack is well known (Carlos Alonso, 1988; Iliescu and Ionita, 1988; Kanyion and Friedt, 1993, Penaud, 1993; Siddique and Aslam, 1993). Along several years, our attention has been given to the influence extended by crop rotation, sowing time, plant density, genotype characteristics and the response to the chemical treatments on the phytosanitary state and yield level of sunflower crop (Jinga and al., 1993).
To some of the most favourable agrotechnical measures, special devised bioinoculants (based on bacteria able to induce complex benficial effects) have been associated in order to improve the plant growth and development, the nitrogen nutrition and the control of main pathogens in sunflower crop.

Materials and methods

Between the years 1992 - 1994 different polifactorial experiments have been carried on in field conditions (Cellam Amzacea in Southern part of the country, soil type chocolate-chernozem), the principal studied variables being represented by genotypes, plant density, seed inoculations with beneficial bacteria and chemical treatments. Every experiment was performed with randomely arranged treatments, each treatment in three replications with the plot area of 25.0 - 33.6 sqm. The bioinoculant was produced based on diazotrophic bacteria *Azospirillum brasilense* - strain Sp 001 (1×10^7 ufc/g) adsorbed on sterilized neutral peat. The rate of product application was of 250 g product per 100 kg seeds. The fungicides used for the control of the main pathogens were: Apron 35 SD

(metalaxyl), Sumilex 50 WP (procimidone) applied as seed dressings and Konker (vinclozolin + carbendazim) sprayed during vegetation, in recommended doses and half of these doses.The xylem proliferation following *Azospirillum* inoculation was studied by a histochemical method (Andrei and al., 1983).
The recommended parameters were: the attack frequency percentage, the percentage of lodged plants, the yield level and thousand kernels weight (TKW), function of experiment.
All experiments were performed under the background of natural contamination.
With the exception of the studied variables, the optimal management practices for sunflower crop were followed.

Results and Discussions

Following a previous experimental step in which several agrotechnical measures and chemical treatments have been investigated for their separate influence on pathogens attack reduction, these experiments have been orriented on the integration between some of these measures with seed inoculation with *Azospirillum*. Of several effects exerted by this bioinoculant on the plants, its capacity to control the pathogens attack was especially analysed in this paper.

TABLE 1. THE INFLUENCE EXERTED BY THE SUNFLOWER GENOTYPES, PLANT DENSITY AND INOCULATION WITH *Azospirillum brasilense* -Sp001 ON THE *Sclerotinia sclerotiorum* ATTACK FREQUENCY IN A THREE YEARS FIELD EXPERIMENT (CELLAM - AMZACEA)

Treat-ments (C)	Geno-types (A)	Density (pl.no./ha) (B)	Attack frequency (%)			Mean attack frequency (%)
			1992	1993	1994	
Non-inoculated	Turbo (SH)	45,000	1.4 d	0.7 hij	5.3 f	2.46 d-g
		65,000	0.9 fg	1.3 efg	2.6 g	1.60 e-h
		85,000	1.8 c	1.2 fgh	9.1 c	4.03 bcd
	Favorit (SH)	45,000	0.7 gh	1.8 dc	6.1 e	2.86 def
		65,000	1.2 dcf	1.3 efg	7.2 d	3.23 cde
		85,000	1.5 cd	2.9 c	11.3 b	5.23 b
	Record (OVP)	45,000	0.7 gh	0.3 ij	5.4 f	2.13 d-h
		65,000	2.3 b	3.9 b	9.4 c	5.20 bc
		85,000	2.8 a	5.1 a	19.5 a	9.13 a
Inocu-lated with Sp001	Turbo	45,000	2.3 b	0.3 ij	2.3 gh	1.63 e-h
		65,000	0.1 i	0.2 j	2.3 gh	0.86 gh
		85,000	0.5 h	0.6 ij	2.5 g	1.20 fgh
	Favorit	45,000	0.1 i	0.5 ij	0.6 i	0.40 h
		65,000	1.0 efg	0.2 j	1.8 h	1.00 fgh
		85,000	0.1 i	0.8 ghi	2.5 g	1.13 fgh
	Record	45,000	1.3 de	3.0 c	2.0 gh	1.43 e-h
		65,000	2.6 ab	1.7 def	0.8 i	1.70 e-h
		85,000	0.9 fg	1.9 d	0.7 i	1.16 fgh
	LSD	5%	0.31	0.52	0.63	1.99

The first studied interaction between sunflower genotypes, plant density and inoculation with the bioinoculant, under the natural infection with *Sclerotinia sclerotiorum* (*table 1*), shown that the seed inocualtion controlled significantly the attack frequency even at higher plant density as compared with the optimal one formerly established (45,000 plants/ha).

TABLE 2. THE CONTROL EXERTED BY SEED INOCULATION WITH *Azospirillum brasilense* - Sp 001 ON THE MAIN PATHOGENS OF TWO SUNFLOWER GENOTYPES (1992)

Sunflower genotypes (A)	Treatments (B)	Attack frequency (%)				*Phomopsis/ Diaporthe helianthi*		Xylem proliferation (%control)
		Ph. helianthi	*S.sclerotiorum*	*S. bataticola*	*Alternaria* spp.	% of lodged plants	Attack frequency(%)	
Turbo	Non-treated non-inoculated (control)	0 c	20.4 b	39.4 a	79.4 a	8.3 b	13.1 bcd	100.00c
	Non-treated + Inoculated	0 c	7.3 cd	5.6 bc	36.1 cd	3.6 c	9.0 cd	183.17b
	Inoculated + Apron 35SD + Sumilex 50WP	0 c	0.3 e	4.3 bc	30.4 cd	1.4 c	3.7 d	175.36b
Record (OPV)	Non-treated non-inoculated (control)	13.1 a	24.3 a	41.3 a	63.5 b	16.4 a	83.4 a	100.00c
	Non-treated + Inoculated	1.3 b	9.1 c	6.5 b	40.3 c	9.3 b	26.3 b	196.23a
	Inoculated + Apron 35SD + Sumilex 50WP	0 c	5.3 d	2.1 c	25.1 d	3.7 c	18.3 bc	203.84a
	LD 5% (A x B)	1.2	2.3	3.6	11.3	2.9	13.3	14,7

Apron 35 SD (metalaxyl) - 1/2 of recommended rate = 2 kg/t
Sumilex 50 WP (procymidone) - 1/2 of the recommended rate = 1 kg/t
Any nitrogen fertilization was applied. The results are mean values for 50 plants per each replication

The controlling effect of the main pathogens exerted by the inoculant on two sunflower genotypes was demonstrated in another field experiment (*table 2*). Significantly decreases in attack frequency were registered for all studied pathogens as compared with nontreated controls of the both sunflower genotypes, Turbo and Record (with one exception - the *Phomopsis helianthi* attack on Turbo). The combination of the seed *Azospirillum* inoculation and the seed treatment with Apron 35 SD and Sumilex 50 WP with reduced doses (1/2 of the recommended doses) resulted in an improved control of some pathogens, namely *Sclerotinia sclerotiorum* on the both genotypes and *Sclerotium bataticola, Alternaria* spp. and *Phomopsis helianthi* only on Record genotype. The controlling effect exerted by the Sp001 inoculation against *Phomopsis helianthi* on SH-311 was evidentiated by statistically ensured decreases of the natural attack as compared with non-inoculated control in another field experiment (*table 3*). As a consequence of Sp001 inoculation, the yield level and TKW were significantly increased. The application of the Konker fungicide during vegetation on non-

inoculated plants determined an improved control of *Phomopsis helianthi*, but the yield level and TKW increases were under the values registered for inoculated treatment.

TABLE 3. THE COMBINED EFFECT OF SEED INOCULATION WITH *Azospirillum brasilense* - Sp 001 AND CHEMICAL TREATMENTS* APPLIED DURING VEGETATION ON *Phomopsis helianthi* ATTACK AND CROP YIELD (SUNFLOWER GENOTYPE SH-311, 1993)

Treatment	*Phomopsis/Diaporthe helianthi*		Yield (kg/ha)	TKW (g)
	% of lodged plants	attack frequency (%)		
Control I (non-inoculated non-chemical treated)	8.3 a	31.6 a	1630 c	41.10 c
Control II (non-inoculated, treated with Konker at recomended rate)	0 c	5.9 d	2530 a	55.10 a
Control III (inoculated with Sp001, non-treated)	1.7 b	19.6 b	2110 b	50.60 b
Inoculated with Sp001+ treatment with Konker 1/2 of normal rate	0 c	11.3 c	2480 a	54.90 a
Inoculated with Sp001 + treatement with Konker at recommended rate	0 c	4.1 d	2610 a	56.40 a
LSD 5%	1.12	3.21	324	2.11

* Konker (vinchlozolin + carbendazim) - recommended rate = 1.25 l/ha
- reduced rate = 0.625 l/ha

Any nitrogen fertilization was applied.

The combination between seed inoculation with Sp001 and Konker applications in normal and reduced doses lead to a similarly improved control of the pathogen attack and benficial influence on yield formation. These data suggest that on integrated biological and chemical control with reduced fungicide doses could be recommended for sunflower crop.

Conclusions

The genotype behaviour to the attack of each of the main pathogens deserves great attention, because it represents a major element for a sustainable agriculture.
The agrochemical and chemical measures proved to be able to decrease the main pathogens attack on sunflower crop can be associated with bioinoculants characterized by multiple effects.
The seed inoculation with the Sp001 strain of *Azospirillum brasilense* controlled significantly the attack of *Sclerotinia sclerotiorum* even at higher plant density as compared with the optimal one.
The controlling effect of main pathogens attack exerted by seed inoculation with *Azospirillum* was significantly increased by the association with reduced doses of fungicides applied to the seeds and during vegetation.
The integration of chemical and biological measures could result in a sustainable agricultural management with diminished risks of environmental pollution.

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