ESCAPE TO TINY BUG (*NYSIUS SIMULANS* STÅL) ATTACK ACROSS PLANTING DATE ADJUSTMENT IN SUNFLOWER HYBRID SEED CROPS FROM SOUTHERN BUENOS AIRES PROVINCE, ARGENTINE.

Juan P. RENZI [12], ***Omar REINOSO*** [1], ***Matias BRUNA*** [1], ***Martín AVALOS*** [3], ***Miguel A. CANTAMUTTO*** [12]

[1] *Instituto Nacional de Tecnología Agropecuaria, 8142 Hilario Ascasubi, Argentina*
[2] *Departamento de Agronomía, Universidad Nacional del Sur, San Andrés 800, 8000 Bahía Blanca, Argentina*[3] *Advanta Seeds*
[*] *renzipugni.juan@inta.gob.ar*

ABSTRACT

During 2014-15 growing season, tiny bug (*Nysius simulans* Stal.) became a serious plague in the Southern Buenos Aires Province, Argentine. The insect reach an incidence level >900 individuals per head (i/head) and seriously decreased the yield of sunflower hybrid seed. Insecticides could reduce pollinator activity during R4-R6 stage, and did not reach the floral involucres at R7-R9 stage. A sample of 32 commercial plots (≈1000 ha, 5 female lines) with early (EP = October) or late (LP = November) planting dates was studied. At the peak of plague attack, during last week of January, the EP crops showed R7 stage and incidence was > 75 i/head. At the same time, the LP crops showed R4 stage, incidence was < 50 i/head and never overcome this level. In spite of average 2-3 insecticide applications, hybrid seed yield of EP crops was (**) less than a half of LP (1.1 t/ha). This fact was associated with increase (> 10%) of seed set (*) and seed biomass (**). In spite the bug herbivory did not affect the tetrazolium test (> 94%), it produces small holes which decreases germination across a reduction of normal seedlings. Germination of EP seed (88%) was 9% less (**) with respect to LP. At planting time, the field emergence of hybrid seed obtained by EP was 17% less (**) than the obtained with LP (87%). Under plague attack risk, it is recommended to escape the tiny bug peck by means of planting date adjustment.

Key words: *Nysius* sp., Seed quality, Pest escape.

INTRODUCTION

The valley of Colorado River, in southern Buenos Aires province (VBRC), is a healthy area which constitutes the main sunflower seed production area from Argentina (Cantamutto et al. 2008). The valley comprises ca. 90,000 ha with gravitational watering, devoted to onion and forage crops (Lucanera et al. 2014). Sunflower hybrid seed production comprises around 10% of the irrigated acreage.

In South America, tiny bug, *N. simulans* Stål (Hemiptera: *Lygaeidae*) is distributed in Paraguay, Uruguay, Peru, Brazil and Argentina. This polyphagous species was registered feeding several crops and broadleaf weeds in Argentina (Molinari and Gamundi 2010). While the tiny bug had been present in the VBRC for more than a decade ago, no history was documented about its direct impact on crops (Dughetti et al. 2015).

Nysius simulans is a polyphagous suctorial insect that draws water and nutrients. Their saliva transmits toxins and spreads pathogens (Dalazen et al. 2014). Usually, the plague invades crops after host senesce at the end of summer (Demirel and Cranshaw 2006, Charleston 2013), as had been observed on the *Conyza* sp./soybean complex in Brazil (Dalazen et al. 2014). At northern and central regions of Argentina, tiny bug attacks generally account during early crops stages of soybean or sunflower (Molinari and Gamundi 2010). The *Nysius* sp. attacks at advanced growth stages of sunflower had been registered in Australia (Forrester and Saini 1982) and Pakistan (Kakakhel and Amjad 1997).

During December 2014, the VBRC was suddenly affected by this new biotic threat to regional crops. Although the tiny bug attack was first observed feeding horticultural crops, soon it became extremely notorious on sunflower crops. This paper examines the seasonal effect of *N. simulans* on sunflower hybrid seed production and seed quality during the spring-summer cycle 2014-15.

MATERIALS AND METHODS

The population dynamic of *N. simulans* was monitored on two sunflower crop planted at early (EP = October 12 2014, 39°24´S, 62°38´W) or late (LP = November 15 2014, 39°18´S, 62°32´W) dates. Both crops were sampled at weekly intervals since pre-flowering (R4, Schneiter and Miller 1981) until physiological maturity (R9), during January to April 2015. Sampling was done on thirty plants, randomly selected in each crop. Adults and nymphs of *N. simulans* were separated from the heads by hand and the number recorded as individuals per head (i/head).

The impact of plague feeding on sunflower hybrid seed production and quality was measured on 32 commercial lots during 2014-15 growing season. The sunflower hybrid seeds lots were produced under controlled conditions for private companies. The geographical distribution of the studied lots was representative of the VBRC agroecological conditions (Fig. 1). Planting date, insecticide applications and unitary yield of each lot (kg ha^{-1}) were registered. The study comprises 5 female lines, with 20 to 100 ha per lot surface, totalizing ≈1000 ha. After physiological maturity a samples of heads were random hand harvested (n = 8), air dried and threshed in the laboratory. Each head were evaluated for 1000-seeds weight (14% moisture basis) (ISTA, 2013). Achenes were manually separated into empty and nonempty (filled). Seed setting efficiency (seed set) were calculated according eq. 1.

Seed set = (nonempty achenes / (nonempty + empty achenes)) x 100 (eq. 1)

Germination was evaluated immediately after harvest, during February to March of 2015. Nonempty (filled) seeds were submitted to method for dormancy breaking. Achenes were dried at ambient condition (28°C±2°C; 72 h) and soaked 24 h between towels wetted with a gibberellic acid (GA_3) solution at 0.05% in water (Seiler 1998). Germination test was carried out in sand in groups of 100 seeds (n = 3) in a climate-controlled chamber at 20°C during the 12 h dark period and 30°C during the 12 h light period (ISTA, 2013). Final value of germination was measured at 10 days.

At the same time, seed viability was estimated by tetrazolium test on samples of 50 achenes (n = 3). Embryos were separated from achenes after 17 h of water hydration. Embryos were placed in a 0.5% tetrazolium solution during 4 h and classified as completely dyed (viable), partly dyed, or not dyed (inviable) seeds. Location, size of undyed areas, and intensity of dyeing was considered according to ISTA (2013). Small undyed spots of some tissues due by *Nysius* damage were registered.

The seed were stored at 10±2°C (≈ 50% H°) since harvest up to planting season during seven months (October 29 2015). Thereafter, field emergence was assessed in a sandy loam soil (pH = 7.5, soil organic matter = 1.2 %, available P Bray & Kurtz = 24 mg kg^{-1}) at field capacity (21%) located in Hilario Ascasubi Experimental Station. One hundred seeds were manually sown at 30 mm deep in single row plots, 1.5 m long and 0.2 m apart, under a randomized block design with three replicates. Emergence (V2 stage) was counted at 8 and 14 days after sowing.

Analysis of Variance (ANOVA) considering early (EP = October) and late (LP = November) planting dates factors was performed using InfoStat software (2014). The relationship between valuable parameters was analyzed by regression analysis (GraphPad 6.0, San Diego, California, USA).

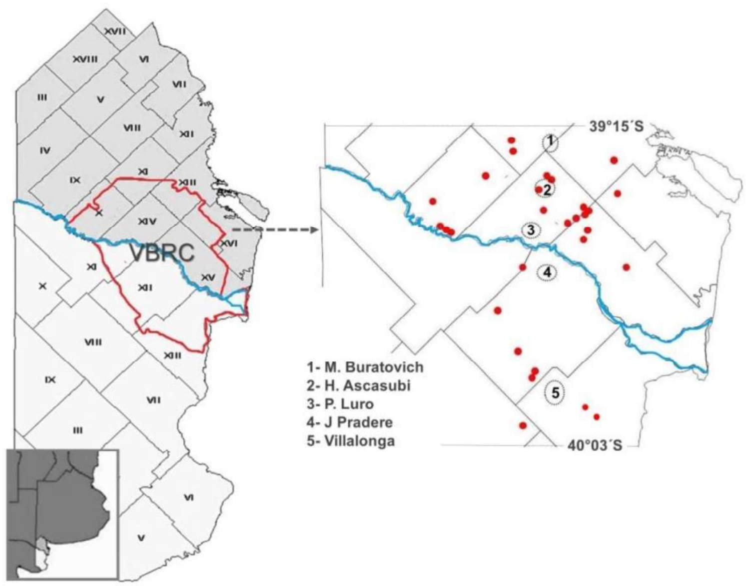

Figure 1. Geographical distribution of the sunflower hybrid seed production lots studied in the VBRC during 2014-15 growing season.

RESULTS AND DISCUSSION

During 2014 winter only 17 frosts at ground level were recorded (Renzi et al. 2015). This value was equivalent to less than half of the observed in the previous two winters, which not tiny bug attacks was happened. The fewer frost number could have reduced the field mortality of winter resistant individuals. Moreover, the conditions for winter growth of annual weeds, with 28% more rainfall in relation to the historical average (1960-2013) were excellent. Thus, an initial high population size at the end of the winter could have been possible the extreme values observed and outbreak of the pest. *Nysius* sp. is highly mobile, and can migrate from alternative crops or no-cultivated habitats to sunflower and congregate upon them causing significant injury (Demirel and Cranshaw 2006).

The tiny bug was detected on sunflower during the first half of December 2014 and the highest incidence of pest was recorded during January and early February 2015. The highest density of pest individuals was concentrated in the head, reaching extremes values over 900 i/head. Individuals mainly refuge between paleas of disk flowers. To a lesser extent, individuals were located between head bracts, upper leaves and in the stem segment near the head.

The infestation pattern dynamic of *N. simulans* on the sunflowers in the VBRC was consistent with those described by Smith and McDonald (1982). According Charleston (2013) the damage threshold ranks between 10-50 adult bugs per plant, depending of growth stage. In the VBRC, during 2014-15 season adults invaded the sunflower at the flowering stage and suddenly overcome these values in EP crops. During seed filling period (R6-R9) of EP crop the plague reached incidence levels over 75 i/ head, but it was less than 25 i/head at LP (Figure 2). As the plants senesce and dry off, there was a general incidence declination. Presumably adults began to disperse away searching for overwintering refuges, in response to the photoperiod and temperature decreases (Smith and McDonald 1982). Understanding the lifecycle of *Nysius* sp. is extremely necessary to adjust the chemical control decisions (Charleston 2013).

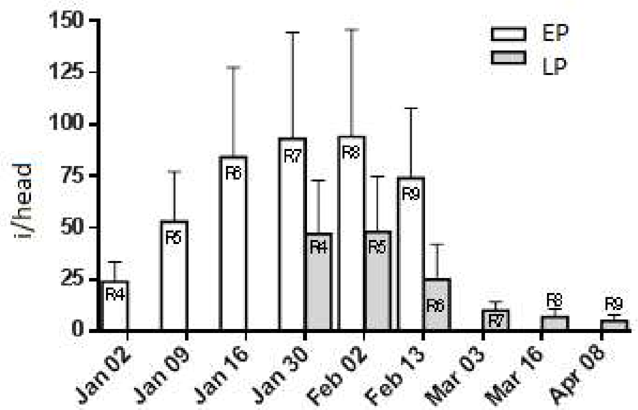

Figure 2. Incidence of *Nysius simulans* (Stål) on sunflower heads (i/head) under EP (October 12 2014) or LP (November 16 2014) planting dates. Rn means sunflower growth stages (Schneiter and Miller 1981)

Given the re-infestation of the plague, it was recorded cases with more than three insecticides applications during the R5-R6 stages, with a higher number of applications under EP (Table 1). The insecticide applications slightly reduced the set efficiency (R^2 = 0.04 *), probably due for the insecticide effect on pollinators activity. It was observed a general improvement of hybrid seed yield with LP dates (November). This improvement was associated with a declination of pest density during the flowering and fruit filling stages (Figure 3). With the delay of planting date (November), the yield improvement was associated with an increase of seed set and 1000-seed weight (Table 1).

The tiny bug feeding reduced the development of the embryo and achene, affecting germination (Kakakhel et al. 2000). However in this evaluation, bug herbivory did not affect the tetrazolium test (> 94%), but produces small holes which decreases germination value due a reduction of normal seedlings. Germination of EP seed (88%) was 9% less (**) with respect to hybrid seed harvest in plots planted during November (Table 1). Also the field emergence at 8 and 14 days after planting was higher when hybrid seed was harvest on LP crops.

Due climate change, tiny bug might challenge sunflower hybrid seed production activity in the near future. It was observed a general improvement of yield and seed quality at late planting date (November), possibly because the flowering occurred when the population pest density decreased. Under plague attack risk, it could be recommended to escape the tiny bug population peck by means of planting date adjustment.

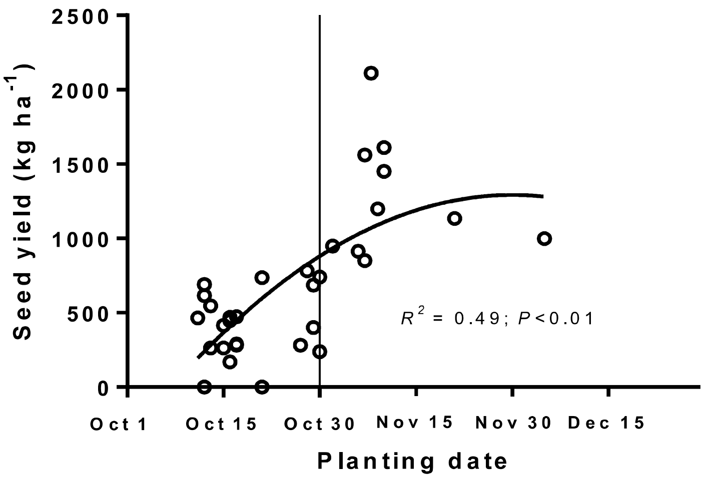

Figure 3. Effect of planting date on the yield of a sample of hybrid sunflower seed lots harvested in the VBRC during 2015. Vertical line (—) show the limit between early (= October) and late (= November) planting date.

Table 1. Effect of planting date on the seed yield, yield components and seed quality of sunflower hybrid seed

Traits	Planting date		
	EP (October)	LP (November)	
	Seed production lot		
Insecticides applications (n)	3.3	2.5	**
Seed set (%)	38	47	*
1000-seeds weight (g), at 14% H°	65	79	**
Seed yield (kg ha^{-1})	460	1147	**
	Produced seed		
Viability - tetrazolium test (%)	94	99	ns
Germination (%)	88	97	**
Field emergence, 8 days after sowing (%)	70	87	**
Field emergence, 14 days after sowing (%)	79	91	**

*, ** significant differences between planting dates at $P < 0.05$ and 0.01; ns not significant

LITERATURE

Cantamutto, M.A., Presotto, A., Renzi, J.P., Poverene, M. (2008). Preventing botanical contamination risk of sunflower hybrid seed in the Valle Bonaerense del Río Colorado, Argentina. 17th International Sunflower Conference. June 8-12, 2008, Cordoba-Spain.

Charleston, K. (2013). Sunflower insect pest management. Northern grains region. Queensland Department of Agriculture, Fisheries and Forestry. 35 pp.

Dalazen, G., Vanderlei, C.G.J, Carpintero, D.L., Stacke, R.F., Cagliari, D. (2014). Fluctuación poblacional de *Nysius simulans* asociado con soja y rama negra en Brasil. Interciencia, 6, 391-394.

Demirel, N., Cranshaw, W. (2006). Surveys of false chinch bug, *Nysius raphanus* (Howard) (Hemiptera*: Lygaeidae*) and their movement on cultivated crops and non-cultivated habitats throughout growing season in Colorado. Journal of Entomology 3, 149-155.

Dughetti, A.C., Zarate, A.O., Rivas, J.C. (2015). Comportamiento de la chinche diminuta (*Nysius simulans*) como plaga emergente del cultivo de quinoa en el valle bonaerense del Río Colorado. Informe Técnico 46. INTA EEA. H. Ascasubi.

Forrester, N.W., Saini, H.W. (1982). Effect of moisture stress on damage to sunflowers by Rutherglen bug (*Nysius vinitor*). In: Proc. 10th Int. Sunflower Conf., Suffers Paradise, Australia. Int. Sunflower Assoc., 130-132.

ISTA (2013) International Seed Testing Association. International Rules for Seed Testing. Bassersdorf, Switzerland.

Kakakhel, S.A., Amjad, M. (1997). Biology of *Nysius inconspicuus* Distant. and its economic impact of sunflower. Helia 20, 9-14.

Lucanera, G.M., Castellano, A.S., Barbero, A. (2014). Banco de datos socioeconómicos de la zona de CORFO – Río Colorado, Estimación del P.B.I. Agropecuario Regional.

Molinari, A.M., Gamundi, J.C. (2010). La "chinche diminuta" *Nysius simulans* en soja. Para mejorar la producción 45, 117-120.

Renzi, J., Reinoso, O., Bruna, M., Vasicek, J., Avalos, M., Oquiñena, A., Cantamutto, M. (2015). Impacto de la "chinche diminuta" (*Nysius* sp.) sobre el cultivo de girasol del valle bonaerense del Río Colorado durante 2014/15. Informe Técnico 43, EEA H Ascasubi INTA.

Schneiter, A.A., Miller, J.F. (1981). Description of sunflower growth stages. Crop Science 21, 901-903.

Seiler, G.J. (1998). Seed maturity, storage time and temperature, and media treatment effects on germination of two wild sunflowers. Agronomy Journal 90, 221-226.

Smith, A.M., McDonald, G. (1982). Seasonal abundance of the rutherglen bug (*Nysius vinitor*) on sunflowers and weeds in north-eastern Victoria. Proceedings of the International Sunflower Conference (USA) p 127-129.