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Influence of Potassium, Micronutrients, and Their Combinations as Foliar Applications to Suppress Soybean Stem Fly, *Melanagromyza sojae* (Diptera: Agromyzidae) on Four Soybean Common Varieties

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ARTICLE INFO

Article History

Received: 10/6/2017
Accepted: 20/8/2017

Key words:
Potassium, micronutrients, soybean stem fly, Qalubiya Governorate

ABSTRACT

The present studies followed the main study which was carried out at the experimental farm of the Faculty of Agriculture, Benha University, Qalubiya Governorate, during two successive seasons: 2014 and 2015. The influence of potassium, micronutrients, and their combinations as foliar applications to suppress soybean stem fly, *Melanagromyza sojae* (Zehnt.) (Diptera: Agromyzidae) on four soybean common varieties was studied. The experimental design was a split plot with four replications, main plots (i.e., the cultivars Crowford, Giza-22, Giza-35, and Giza-111) and sub plots were assigned to eight. Four soybean cultivars and eight foliar application treatments (potassium silicate, potassium sulphate, potassium hydroxide, micronutrients (Fe, Zn, and Mn), potassium silicates + micronutrients, potassium sulphate + micronutrients, potassium hydroxide + micronutrients and control) were evaluated. The study showed that (potassium silicates + micronutrients) reduced the most impact from the soybean stem fly as indicated by the tunneling length and the number of larvae inside the plant with no significant differences among varieties. There were significant differences in relative increases of seed and stover yield with potassium silicates + micronutrients (25% of the seed yield and 0.30% as an average per two seasons compared to the control). Results also showed a significant increase in the total uptake of potassium with micronutrients for the rest of the treatments; especially with potassium silicate, and perhaps for this reason micronutrients increase the absorption of potassium allowing the plant to build the restoration after the infection. The percentage of lignin content in soybean dry plants resulted in significant increase in all treatments compared with control especially in potassium silicates + micronutrients. Increasing in lignin contents lead to the increase in the secondary xylem and decrease in the pith diameter and then lead to hamper the growth of larva in the pith.
INTRODUCTION

Soybean is the world’s most grown oilseed, grown on over 95 million ha. worldwide, representing 60% of the world annual production of the 530.6 million MT of all oil crops (FAO, Food outlook May 2015). 90% of its production is concentrated in the US, Brazil, Argentina, China, and India (FAOSTAT 2013). Egypt cultivates about 8,000.00 ha of soybeans per year, and its average productivity is 3.5 Mt/ha versus the world average of 2.38 Mt/ha (FAOSTAT 2013). Soybean stem fly *Melanagromyza sojae* (Zehnter), (Diptera: Agromyzidae), is a serious pest in Asia, North East Africa, Russia, and South East Asia, frequently causing 100% infestation of soybean and other cultivated legumes and heavy economic losses especially as a vector of virus diseases. The redescribtion of *Melanagromyza sojae* was done as follows: *Agromyza sojae* Zehntner (1900); *Agromyza squamata* (Becker,1903); *gromyza prolific* (Malloch, 1914); *Agromyza product* (Malloch, 1914; Singh & Ipe, 1973); and *Melanagromyza sojae* (Zehntner) (de Meijere 1922; Sasakawa, 1961; Singh & Ipe,1973; Thapa, 1991). (Thapa 2012).

Potassium deficiency can lead to the reduction of both the number of leaves produced and the size of individual leaves and finally on yield and quality production where the pods had the greatest impact on yield but seed mass was also an important constituent as effectuation macronutrient William et al. (2008) and Andrew et al. (2009).

Anuradha and Sharma (1995) found that the application of supplementary potassium increased the chlorophyll content, nitrate reductase activity, seed protein, and oil content in soybean. Several other studies have evaluated response of soybean to foliar fertilizer mixtures (Garcia and Hanway, 1976; Mallarino et al., 1991, Haq and Mallarino, 1998; Parker and Boswell, 1980; Mortezaiefard, 2010; and hanan alfy et al., 2016). At the same time, Hoeft et al., (2000) noted that high potassium levels will reduce yield by inducing a shortage of magnesium. In addition, the attacks of insects like blue beetle, grey semilooper, girdle beetle, and stem fly were clearly reduced with potassium applications, increasing yield (Bansal et al., 2001).

Therefore, my study sought to investigate the role of potassium silicate and other micronutrients as foliar applications to suppress soybean stem fly.

MATERIALS AND METHODS

In this experiment, the drier powder of the previous samples of eight treatments - which were carried out at experimental farm of the Faculty of Agriculture, Benha University, Qalubiya Governorate inside the compass, throughout 2014 and 2015 seasons with the title “Suppress Of Soybean Stem Fly, *Melanagromyza Sojae* (Zehnt)”. By Spraying Of Potassium, Micronutrients, And Their Combination As Foliar Application On Four Soybean Varieties”. The percentage of lignin contents was used to know how the nutrients affect the plant to make recovery after the damage causes by *M. sojae*. Determination of lignin by the method of (Browning 1967).

Statistical Analysis:

Because there was no significant difference between four varieties in infection (Crowford, Giza-22, Giza-35, and Giza-111) as in Hanan Alfy et al., 2016, the variety Giza 111 was taken as a common recommended one. Lignin levels associated with the various treatments were analyzed by analysis of variance for a randomized complete block design. The obtained results were statistically analyzed according to (ANOVA).
RESULTS AND DISCUSSION

Data in the first experiment Hanan Alfy et al., 2016 showed that foliar application of potassium and micronutrients especially potassium silicate has a great effect in decreasing the damage occurred by *M. sojae*. Many benefits can be gained by using a good Potassium Silicate product in the feeding program. Increased tolerance of environmental stress, heat, cold, drought, water, and soil toxicity or deficiency improved growth rate in both the root zone and in the plant and its foliage. By using Potassium Silicate increase secondary xylem, which specifically reduces the diameter of the pith cavity, and the differentiation and development of lignified xylem fibers are associated with overall physical hindrance effects which seem to contribute significantly to soybean resistance to the bean fly species, *Melanagromyza sojae*, which feeds exclusively in the pith. Potassium Silicate is a natural fungicide, it helps build the plants defense from attacks by insects and fungi. Potassium Silicate helps the plant growth by depositing itself epidermal cell walls and enhancing the plant’s ability to keep the leaves pointed towards the light source. It also increases the stem strength, making it easier to hold up more weight. As the plant builds itself up with Potassium Silicate, it helps with balancing nutrient uptake and distribution, and increased concentration of chlorophyll and RUBP carboxylase in leaves. Manganese aids in chlorophyll production, Synthesis of phenols (Plants natural defense) and Biosynthesis of Lignin also “ nutrition, always has been an important factor in disease control” Don Huber (Purdue) 2004.

All four varieties had no significant difference by infection because varieties indicate that the underlying tissue contains specific traits for resistance to the agromyzid bean fly. The anthocyanin malvidin was identified as the cause of the purple color. This situation demonstrates interrelationships among this flavonoid and lignins and polyphenols which contribute to insect resistance in the stem of soybean (Hsih-Shin Chiang and Dale M. Norris 1984). So that the height of lignin value is one of indictors of the plant’s resistance against *M. sojae*. Table (1) reveals the value of lignin in all treatment

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Percentage of lignin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min. – Max.</td>
</tr>
<tr>
<td>P1 (Potassium silicate)</td>
<td>7.19 – 7.33</td>
</tr>
<tr>
<td>P2 (Potassium sulphate)</td>
<td>6.34 – 6.57</td>
</tr>
<tr>
<td>P3 (Potassium hydroxide)</td>
<td>6.23 – 6.45</td>
</tr>
<tr>
<td>M (Fe, Zn and Mn)</td>
<td>6.42 – 6.73</td>
</tr>
<tr>
<td>P1 +M</td>
<td>7.99 – 8.90</td>
</tr>
<tr>
<td>P2 +M</td>
<td>7.14 – 7.37</td>
</tr>
<tr>
<td>P3 +M</td>
<td>7.09 – 7.29</td>
</tr>
<tr>
<td>P0M0 (control)</td>
<td>6.15 – 6.21</td>
</tr>
<tr>
<td>F (p)</td>
<td>77.945 (&lt;0.001)</td>
</tr>
</tbody>
</table>

F: F value for ANOVA test

Different superscripts are statistically significant at p<0.05.

*: Statistically significant at p ≤ 0.05
Fig. (1): Comparison between the different studied groups according to the percentage of lignin.

From the data in Figure (1), we can determine that lignin value is the highest in treatment of (P1M). So, increasing in lignin contents lead to the increase in the secondary xylem and decrease in the pith diameter and then lead to hamper the growth of larva in the pith.

As a conclusion, it has been shown that Potassium silicate is an active ingredient to be used as an insecticide and also as an excellent foliar nutrition application tool to deliver micronutrients when the Soybean plant needs it the most.

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تأثير البوتاسيم والعناصر الصغرى والدمج بينهما كمغذيات ورقية على الحدمن الاصناف بذبابة صائعة انفاق
فول الصويا على أربعة اصناف من فول الصويا

حنان الفي

معهد بحوث ومقاومة النباتات – مركز البحوث الزراعية

تأتي الدراسة الحالية كبحث ثاني متتالي على دراسة اجريت بالمزرعة التجريبية لكلية الزراعة – جامعة
بنها – محافظة القليوبية خلال المجموعين المتتاليين: 2014، 2015 وذلك لدراسة تأثير الرش الورقي للبوتاسيم في
صور مختلفة وبعض العناصر الصغرى والدمج بينهما على الاصناف بذبابة ساق فول الصويا على أربعة اصناف
من فول الصويا هي (كروافورد- جزءة 22- جزءة 35- جزءة 111) وذلك من خلال تفاعل معاملات هم (سلكات
البوتاسيم – كريبتات البوتاسيم – هيدروكسيد البوتاسيم - خليط من العناصر الصغرى (أصداء، منجنيز، زئبق
- سراجات البوتاسيم- العناصر الصغرى - كريبتات البوتاسيم+ العناصر الصغرى - هيدروكسيد البوتاسيم+،
عناصر الصغرى،الكنترول). أوضحت النتائج أن المعاملة بسلكات البوتاسيم والعناصر الصغرى معاً أدت إلى
تلقيل الاصناف إلى أقصى حد كما تبين من خلال طول الانفاق وعدد اليرقات داخل النبات مع عدم وجود فروق
معنوية بين الاصناف. و أوضحت النتائج وجود زيادة معنوية في محلول البذرة والقش بنسبة تصل إلى 25%،
30% على التوالي كمتوسط للمجموعين مقارنة بالكنترول. كما أوضحت النتائج زيادة معنوية في اجمالى
امتصاص البوتاسيم عند الخلط بالعناصر الصغرى عن باني المعاملات. ويرجع ذلك الى أن العناصر الصغرى
تعمل على زيادة امتصاص البوتاسيم مما يسمح باستعادة بذبابة ساق فول الصويا بعد الاصناف. كما أوضحت الدراسة الحالية
النسبة المئوية لمحتوى النباتات الناجمة من اللجنين اسفرت عن زيادة معنوية في جميع المعاملات مقارنة
بالكنترول خاصة المعاملة بسلكات البوتاسيم والعناصر الصغرى معاً وتؤدي الزيادة في محتوى اللجنين في
النباتات إلى زيادة الخشب الثانوي ويقلل من لب النبات مما يعوق نمو اليرقات داخل الساق.