Effects of N fertilizer and a bioherbicide on Egyptian broomrape (Orobanche aegyptiaca) in a tomato field

M. Ghaznavi, S. A. Kazemeini*, R. Naderi

1Department of Crop Production and Plant Breeding, College of Agriculture, Shiraz University, Shiraz, I.R. Iran

* Corresponding Author: akazemeini@shirazu.ac.ir

ABSTRACT- This study aimed to investigate the effects of bioherbicide and nitrogen fertilizer on Egyptian broomrape in tomato field. An experiment was conducted in 2014 at research field of Shiraz University. Treatments consisted of nitrate ammonium (0, 100, 200 and 300 kg ha-1) and biofertilizer as the first factor and bioherbicide (seedling root soaked with the bioherbicide), bioherbigation and control (no bioherbicide) as the second factor. Application of 200 kg ha-1 nitrate ammonium caused a decrease in broomrape height and biomass by 18.7 and 33.7 %, respectively. However, it caused an increase in tomato yield by 26.8%. Bioherbigation also caused a significant decrease in broomrape height and dry biomass by 44.5 and 58.6 %, respectively. Our results showed that application of 200 kg ha-1 nitrate ammonium along with bioherbicide can be a promising strategy to decrease the detrimental impact of broomrape and to increase tomato yield.
RESULTS AND DISCUSSION

Effects of Bioherbicide and Fertilizer on Broomrape Growth

Bioherbicide had a significant effect on broomrape density (p<0.01), but fertilizers had no effect on broomrape density (p>0.05). Bioherbigation and seedling root treated with bioherbicide significantly decreased Orobanche density about 25 % and 51 %, respectively compared to control (Table 1). Bioherbigation was more efficient than seedling root treated with bioherbicide to reduce Orobanche density (51 % vs 25 %). It has been reported that soil application of a simple granular formulation of the fungus *Fusarium oxysporum* f.sp. orthoceras caused a reduction of approximately 80 % in total cropping of *O. cumana* (Habimana et al., 2014). Results of laboratory and greenhouse studies also showed that *F. oxysporum* could control *O. cumana* in sunflower (*Helianthus annuus* L.) properly (Habimana et al., 2014). Cohen et al. (2002) in greenhouse experiments found a reduction in *O. aegyptiaca* attached to tomato using host-specific strains of *F. oxysporum* and *F. arthrosorpioides*.

Bioherbicide affected plant height of broomrape significantly (p<0.01), however fertilizer had no significant effect on broomrape height (p>0.05). Bioherbigation and seedling root treated with bioherbicide caused a significant reduction in broomrape height (Table 1). However, bioherbigation was able to reduce broomrape height more than seedling root treated with bioherbicide (44 % vs 23 %). There was no significant bioherbicide × fertilizer interaction (p>0.05).

Broomrape biomass was affected significantly by bioherbicide (p<0.01). Bioherbigation and seedling root treated with bioherbicide significantly decreased Orobanche biomass about 35 % and 58 %, respectively compared to control (Table 1). Bioherbigation and seedling root treated with bioherbicide caused a reduction of 58 % and 35 % in broomrape biomass, respectively. Boari and Vurro (2004) has reported that use of *F. oxysporum* reduced the number of emerged broomrape shoots by about 70% compared to the control. It also reduced the fresh and dry weights of shoots. Hodosy (1981) obtained excellent results with isolates of *Fusarium oxysporum* which they could reduce more than 90% of broomrape, without any damage to the tomato hosts.

Fertilizer had also a significant effect on broomrape biomass (p<0.05). Application of 300 kg ammonium nitrate ha⁻¹ led to a reduction of 49 % in broomrape biomass. Although other fertilization treatments could also decrease broomrape biomass, 300 kg ammonium nitrate was the superior to the other treatments (Table 3). Mesbah et al. (2012) reported that increase in nitrogen fertilizers could decrease the amount of broomrape germination. It has been also reported that as ammonium nitrate and ammonium sulfate rates increased, shoot number and dry weight of branched broomrape decreased (Mariam and Rungsit, 2004). Since high levels of nitrogen fertilizer or chicken manure showed a suppressive effect on broomrape, its control seems to be associated with less fertile soil conditions (Habimana et al., 2014).

Bioherbicide × fertilizer interaction was significant for broomrape biomass (p<0.05). The lowest amount of broomrape biomass was found in bioherbigation plots which received 200 kg ammonium nitrate ha⁻¹ and the highest was found in control plots (Table 3). This showed that application of ammonium nitrate together with bioherbicide can reduce broomrape growth (Table 3).

Effects of Bioherbicide and Fertilizer on Tomato

Bioherbicide had a significant effect on tomato plant height (p<0.05). The highest plant height obtained in bioherbigation. There was no significant difference between root treated bioherbicide and control. Fertilizer had also a significant effect on tomato plant height (p<0.01). Plants received 300 kg ammonium nitrate had the highest height (Table 2). However, bioherbicide × fertilizer interaction was no significant for tomato plant height (p>0.05).

Number of fruit per plant was affected significantly by both bioherbicide (p<0.01) and fertilizer (p<0.01) but the interaction of biofertilizer × fertilizer was not significant (p>0.05). There was no significant difference between root treated and bioherbigation for number of fruit per plant (Table 1).
Application of 200 kg nitrate ammonium ha\(^{-1}\) caused the greatest number of fruit per plant (Table 2). Fruit yield of tomato was significantly affected by bioherbicide (p<0.01) (Table 1). Fertilizer had also a significant effect on tomato fruit yield (p<0.01) (Table 2). Bioherbicide× fertilizer interaction was significant for tomato fruit yield (p<0.05). The greatest tomato yield obtained in plots received 200 kg nitrate ammonium and bioherbigation, which was not significantly different from 200 kg nitrate ammonium and bioherbigation treatment (Table 4). Since most of the damage to host crops occurs while the parasitic weed is still underground, application of soil-borne biocontrol agents like *Fusarium* spp. can improve crop yield by destroying the parasite at its early developmental stages (Habimana et al., 2014). Mariam and Rungsit (2004) also found that application of ammonium nitrate and ammonium sulfate increased the yields of tomato linearly while they had also a decrease effect on broomrape growth. Ozores-Hampton et al. (2012) total marketable fruits yields showed positive response to N rates.

**Table 1.** Effects of bioherbicide on broomrape and tomato characters

<table>
<thead>
<tr>
<th>Bioherbicide</th>
<th>Weed density</th>
<th>Weed height (cm)</th>
<th>Weed biomass (g/plant)</th>
<th>Tomato height (cm)</th>
<th>No. fruit/plant in tomato</th>
<th>Tomato fruit yield (Mg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>7.8(^{a})</td>
<td>13.49(^{a})</td>
<td>6.3(^{a})</td>
<td>43(^{b})</td>
<td>13.52(^{b})</td>
<td>16.47(^{b})</td>
</tr>
<tr>
<td>Root treated</td>
<td>5.86(^{b})</td>
<td>10.36(^{b})</td>
<td>4.06(^{b})</td>
<td>42.86(^{b})</td>
<td>18.82(^{a})</td>
<td>20.61(^{a})</td>
</tr>
<tr>
<td>Bioherbigation</td>
<td>3.8(^{c})</td>
<td>7.48(^{c})</td>
<td>2.61(^{c})</td>
<td>44.8(^{a})</td>
<td>17.21(^{a})</td>
<td>21.89(^{a})</td>
</tr>
</tbody>
</table>

\(^{†}\) In each column, means with the same letters aren’t significantly different at α=0.05 by Duncan multiple range test

**Table 2.** Effects of N fertilizers on broomrape and tomato characters

<table>
<thead>
<tr>
<th>N fertilizer</th>
<th>Weed biomass (g/plant)</th>
<th>Tomato height (cm)</th>
<th>No. fruit/plant in tomato</th>
<th>Tomato fruit yield (Mg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 kg NH(_4)(_2)O(_3) ha(^{-1})</td>
<td>5.92(^{a})</td>
<td>40.74(^{c})</td>
<td>13.48(^{c})</td>
<td>17.51(^{a})</td>
</tr>
<tr>
<td>100 kg NH(_4)(_2)O(_3) ha(^{-1})</td>
<td>4.43(^{b})</td>
<td>42.14(^{c})</td>
<td>14.91(^{c})</td>
<td>19.53(^{b})</td>
</tr>
<tr>
<td>200 kg NH(_4)(_2)O(_3) ha(^{-1})</td>
<td>3.92(^{c})</td>
<td>44.98(^{c})</td>
<td>19.38(^{c})</td>
<td>23.91(^{c})</td>
</tr>
<tr>
<td>300 kg NH(_4)(_2)O(_3) ha(^{-1})</td>
<td>2.98(^{c})</td>
<td>48.01(^{c})</td>
<td>17.72(^{c})</td>
<td>19.8(^{c})</td>
</tr>
<tr>
<td>Biofrtilizer</td>
<td>4.38(^{b})</td>
<td>41.88(^{c})</td>
<td>17.09(^{c})</td>
<td>17.54(^{c})</td>
</tr>
</tbody>
</table>

\(^{†}\) In each column, means with the same letters aren’t significantly different at α=0.05 by Duncan multiple range test

**Table 3.** Interaction effects of bioherbicide × fertilizer on broomrape biomass (g plant\(^{-1}\))

<table>
<thead>
<tr>
<th>Bioherbicide</th>
<th>0 kg NH(_4)(_2)O(_3) ha(^{-1})</th>
<th>100 kg NH(_4)(_2)O(_3) ha(^{-1})</th>
<th>200 kg NH(_4)(_2)O(_3) ha(^{-1})</th>
<th>300 kg NH(_4)(_2)O(_3) ha(^{-1})</th>
<th>Biofertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>9.3(^{a})</td>
<td>5.48(^{a})</td>
<td>6.2(^{a})</td>
<td>3.32(^{a})</td>
<td>7.2(^{a})</td>
</tr>
<tr>
<td>Root treated</td>
<td>5.6(^{b})</td>
<td>5.08(^{a})</td>
<td>3.61(^{b})</td>
<td>2.91(^{b})</td>
<td>3.13(^{c})</td>
</tr>
<tr>
<td>Bioherbigation</td>
<td>2.86(^{c})</td>
<td>2.72(^{b})</td>
<td>1.95(^{b})</td>
<td>2.72(^{a})</td>
<td>2.82(^{a})</td>
</tr>
</tbody>
</table>

\(^{†}\) Means with the same letters in each column aren’t significantly different at α=0.05 by Duncan multiple range test

**Table 4.** Interaction effects of bioherbicide × Fertilizer on tomato yield (Mg ha\(^{-1}\))

<table>
<thead>
<tr>
<th>Bioherbicide</th>
<th>0 kg ha(^{-1})</th>
<th>100 kg NH(_4)(_2)O(_3) ha(^{-1})</th>
<th>200 kg NH(_4)(_2)O(_3) ha(^{-1})</th>
<th>300 kg NH(_4)(_2)O(_3) ha(^{-1})</th>
<th>Biofertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>13.75(^{b})</td>
<td>15.88(^{b})</td>
<td>18.25(^{b})</td>
<td>17.75(^{a})</td>
<td>16.75(^{a})</td>
</tr>
<tr>
<td>Root treated</td>
<td>22.56(^{c})</td>
<td>19.21(^{a})</td>
<td>25.3(^{a})</td>
<td>19.57(^{a})</td>
<td>16.42(^{c})</td>
</tr>
<tr>
<td>Bioherbigation</td>
<td>16.22(^{b})</td>
<td>23.5(^{a})</td>
<td>28.17(^{a})</td>
<td>22.08(^{a})</td>
<td>19.47(^{a})</td>
</tr>
</tbody>
</table>

\(^{†}\) Means with the same letters in each column aren’t significantly different at α=0.05 by Duncan multiple range test.
CONCLUSIONS

It has been reported that no single technique is able to provide complete control of *Orobanche*, therefore integrated approaches which combine several techniques seems to be more effective. Our results showed that application of 200 kg ha$^{-1}$ nitrate ammonium along with bioherbicide can be a promising strategy to decrease the detrimental impact of broomrape. This combined treatment could also increase tomato yield. Further works should investigate the combined effects of different management strategy such as chemical, physical, cultural and biological to ind the most efficient integrated weed management to reduce the detrimental effect of broomrape in southern Fars Province.

REFERENCES


چکیده این مطالعه با هدف بررسی اثر یک علف کنسنسرانی و کود نیتروژن دار بر گل جالیز در مزارع گوجه فرنگی (Orobanchec aegyptiaca) انجام شد. نتایج نشان می‌دهد که در تمام ابهام‌آوری‌ها برای کاهش نیاز به نیتروژن دولتوکاری که به آن علی‌البدلی، کاهش گل‌گذاری و میزان حاصله داده را بهبود بخشیده و باعث افزایش کیفیت گل جالیز و جایگزینی علف کنسنسرانی و کود نیتروژن دار شد. تحقیق و اصلاح نیاز به مطالعات بیشتری در این زمینه است. 

اطلاعات مقاله:

تاریخ دریافت: ۱۳۹۵/۶/۱۲
تاریخ پذیرش: ۱۳۹۵/۱۲/۱۴
تاریخ دسترسی: ۱۳۹۸/۵/۱۸

انتشارات کلیدی:

کشاورزی پایدار
مدیریت غیر شیمیایی علف هرز
نیتروژن دولتوکاری

محمد غزنوی، سید عبدالله کاظمی‌نیا، روح‌الله نادری