EFFECT OF WEED MANAGEMENT SYSTEMS ON TOMATO (LYCOPERSICON ESCULENTUM MILL.) YIELD IN HERAT PROVINCE, AFGHANISTAN

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ABSTRACT

Various weed management techniques were compared for efficacy and effect on tomato yield in 2014 field studies in Herat, Afghanistan. All weed management treatments resulted in lower dry weights of weeds compared to the untreated weedy control. Weed weights in plots treated with metribuzin were significantly higher than those in other management treatments but lower than in weedy plots. All management treatments, except metribuzin, resulted in higher yields than in unweeded. Hand weeded tomatoes had the highest yield which was significantly greater than yield from tomatoes in the metribuzin, organic mulch and unweeded treatments but similar to black plastic mulch and glyphosate. Major weeds were Amaranthus retroflexus, Solanum nigrum, Portulaca oleracea, Chenopodium album, Cyperus esculentus, grasses and Convolvulus arvensis. The best control of these weeds was with glyphosate and the mulches (organic and black plastic), however, only glyphosate controlled C. esculentus and metribuzin was weak on S. nigrum and grasses.

INTRODUCTION

Tomato, Lycopersicon esculentum Mill., is one of the most important vegetable crops in Afghanistan. The 2014 ADCUS (Afghan Data Collection and Utilization Program) Horticulture Survey conducted by the Ministry of Agriculture, Irrigation and Livestock (Altai, 2014) indicated that 25% of all Afghan farmers produce tomatoes with 42-57% of farmers in warmer southern provinces growing tomatoes. Nearly half (48%) of tomato growers produce for home consumption while 48% sell about 50% of their production and 99% indicated tomatoes were important to very important to household welfare both for household diets and as an important cash crop. The average tomato production area was 0.1 hectare per farm with average yield being 17,850 kg*ha-1 and the crop returns 13 AFAs*kg-1 ($0.22*kg-1). Weed competition can be a limiting factor in production of most vegetable crops and especially in tomato as Ghoshe et al. (2010) found that tomato yield losses can be as high as 35% when weeds are not properly controlled. Since most weed management is by expensive hand removal, any technique to improve efficiency of weed management could be a valuable income improvement strategy. Approximately 70% of the Afghanistan population is involved in agriculture and in the past there was a reliable and inexpensive labor supply available so hand-weeding crops was usually the management method of choice (Ghafoori, 2017). Since most tomatoes are now grown in small gardens, hand weeding by family members is usually the technique employed. However, as the Afghanistan economy grows and tomato production area increases, reduced availability of inexpensive manual labor will occur and it will become necessary to adopt alternative, effective and less labor intensive weed control methods (Ahmadi, 2016). Some common weeds that occur and must be controlled in tomato production in Herat Province include redroot pigweed (Amaranthus retroflexus L.), black nightshade (Solanum nigrum L.), common purslane (Portulaca oleracea L.), common lambsquarters, (Chenopodium album L.), field bindweed (Convolvulus arvensis L.), annual grasses and yellow nutsedge (Cyperus esculentus L.). Except for yellow nutsedge and field bindweed, the other weeds are annuals and propagate from seed, especially redroot pigweed, black nightshade, common lambs quarters, common purslane and annual grasses. However, common purslane can also spread vegetatively after cutting/hoeing which necessitates complete removal of all vegetative parts from a field after weeding (Saidak, 1981). Yellow nutsedge belongs to the family Cyperaceae and is a difficult to control perennial weed that reproduces by starchy nutlets (tubers) and field bindweed can spread from its extensive spreading root system. Organic mulches are a viable option for providing weed suppression by covering the soil and preventing light from impinging on the soil thus reducing germination of many weed seeds. When
weeds germinate, the mulch can inhibit maximum growth (Bakht and Ahmad Khan, 2014). Wheat is a common grain crop in Afghanistan and since wheat straw biomass is readily available it is a common organic mulch that most farmers can use. Another mulch option is black plastic mulch, if available, that is a common method used in developed countries to manage weeds and assist in water management in vegetable crops (Bakht and Ahmad Khan, 2014). Glyphosate is an herbicide option that could be used in tomato culture as a spot treatment applied to emerged weeds and applied to avoid contact with the crop. Glyphosate is a systemic broad spectrum foliar applied herbicide used after emergence of weeds and is the most widely used herbicide in the world (Masabni, 2007). Glyphosate controls both annual and perennial weeds and is commonly used in fruit orchards, vineyards, sugarcane fields, in GMO agronomic crops, in cultivated lands after harvesting and as a directed spot treatment in many crops (Stoddard, 2012). It is absorbed by vegetative parts of the plant and is translocated to hypogeal organs (root, rhizome and tuber) within the plant and is effective against most annual and perennial weeds... Metribuzin is a common herbicide used throughout the world in tomato production as both a soil preemergent after first plowing and prior to tomato transplanting or post emergent application and is effective for control of many annual broadleaf weeds (Robinson et al., 2006). This study was designed to 1) compare the efficacy of weed control in tomato using hand weeding, plastic and organic mulches, and two herbicides, glyphosate and metribuzin and 2) determine treatment effect on tomato yield.

MATERIALS AND METHODS

The experiment was established in the summer of 2014 at the Faculty of Agriculture Research Farm at Herat University, Afghanistan. The experiment field soil properties is shown in the following table:

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>BD (ds m⁻¹)</th>
<th>pH</th>
<th>ECₑ (ds m⁻¹)</th>
<th>SAR (%)</th>
<th>N (mg kg⁻¹)</th>
<th>P (mg kg⁻¹)</th>
<th>K (mg kg⁻¹)</th>
<th>OC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy Loam</td>
<td>1.45</td>
<td>7.9</td>
<td>2.8</td>
<td>4.6</td>
<td>0.11</td>
<td>11.5</td>
<td>357</td>
<td>2.14</td>
</tr>
</tbody>
</table>

Source: (Soil laboratory of Agriculture faculty of Herat University, 2014)

RESULTS AND DISCUSSION

Results show that the various weed management treatments differed in total dry weights of weeds observed. The greatest weed biomass was in the weedy control followed by the metribuzin, while the two mulch and glyphosate treatments had the lowest weed biomass (Fig. 1). Metribuzin does not control grasses well so most of the dry weight of weeds in the metribuzin treatment was for grassy weeds and for black nightshade. Even though there were more weeds present in metribuzin treated plots compared to the other weed management treatments, all these treatments had fewer weeds than the weedy control plots. The mean tomato yields from each of the weed management treatments showed that the hand-weeded plots had the highest yields, although, they were statistically similar to the yields from tomatoes grown in black plastic mulch or tomatoes grown in plots treated with the glyphosate (Fig. 2). In terms of yield for the herbicide treated plots and the mulched plots, all tomatoes grown in these treatments had similar yields and all treatments whether hand...
The standard weed management practice in Herat Province in Afghanistan is hand removal of the weeds and this practice is viable as long as field sizes are small and inexpensive manual labor is readily available. If those conditions change, farmers may need to adopt a less labor intensive weed management strategy. Our results show that a pre-plant incorporated application of metribuzin applied alone, is not, as a stand-alone herbicide treatment, a viable strategy to reduce or eliminate all weeds. Metribuzin did a good job of controlling most broadleaf weeds present in this experiment but grassy weeds became a major problem. In the future, metribuzin should be applied with an herbicide that controls most annual grasses and this would be a more logical approach for acceptable weed management and good tomato yields. Our results showed that weed populations present in the metribuzin treated plots were at higher levels and tomato yields were lower than in the hand weeded plots, although, yields were not less than in the other weed management treatments. Although the organic mulch treatment provided excellent weed control, yields in those plots were suppressed to a level lower than the hand weeded plots. Further research would be needed to determine if this was the result of nutritional and/or moisture issues because of the mulch. The black plastic mulch and glyphosate plots both provided excellent weed control and tomato yields that were similar to the tomatoes grown in the hand weeded plots. Black plastic mulch is somewhat expensive which may be an economic barrier to adoption of this technology. Glyphosate, while an additional input cost, is relatively inexpensive to use when applied directly to weeds with a rope wick and should be seriously considered for adoption as a weed management practice in Herat Province. It is clear from this research that the use of glyphosate is a relatively inexpensive method to effectively control all weeds encountered during this study. Metribuzin provided excellent control of broadleaf weeds, but, as expected, was not effective against grasses or nutsedge. Therefore, metribuzin should only be used in combination with another herbicide or other practices that control those weeds. Considering the constraints on Afghan agriculture resulting from lack of water, the use of either plastic mulch or organic mulch in combination with trickle irrigation will reduce the amount of water used in irrigation as well as conserve the water in the soil. Yields in the organic mulch plots were somewhat suppressed but the losses would need to be weighed against the increased costs of the plastic mulch. Neither mulch effectively controlled nutsedge, so adoption of either of these strategies would require use of some other technique for nutsedge control. Improved weed management is an important income management strategy for Afghan tomato growers. In rural areas where production is more for home use and households have excess labor, hand weeding is an appropriate strategy. In more urban areas and on farms focusing on commercial production, proper utilization of glyphosate can be an effective strategy for managing weeds in tomatoes.

Development of Extension training materials on effect weed control for home and commercial tomato production using hand weeding and chemical application strategies would be appropriate methods to share these research results and to teach growers how to allocate time and other resources to maximize production and income.

REFERENCES


Altai, 2014. The 2014 ADCUS Horticulture Survey conducted by the Ministry of Agriculture, Irrigation and Livestock


Robinson, Darren E., Soltani, Nader., Hamill, Allan S., Sikkemna, Peter H. 2006. Weed control in processing tomato (Lycopersicon esculentum) with Rimsulfuron and Thifensulfuron on applied alone or with Chlorothalonil or copper pesticides, HortScience 41(5): 1295-1297.
