Effects of Three Acaricides on the Germination Rate and Head Weight of Taşköprü Garlic in Turkey

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Received 31 December 2015; accepted 16 January 2016; published 20 January 2016

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Abstract

Three acaricides (azadirachtin, abamectin, and hexythiazox) were used, the effects on development parameters of Taşköprü garlic, *Allium sativum* L. (Asparagales: Amaryllidaceae) as seed treatment. This research was done in 2013-2014 on one hectare of garlic at Alatarla, Kastamonu, Turkey. Each acaricide and the untreated control were designated as four replicates on 16 plots. The effects of these acaricides on the germination rate and head weight of Taşköprü garlic were evaluated through regular sampling. Azadirachtin positively affected germination rate of Taşköprü garlic, while the other two acaricides had no effects on germination rate. None of the acaricides affected garlic head weights or head development. This is the first field study to evaluate acaricides that may also affect plant development.

Keywords

Allium sativum L., Neemazal, Abamectin, Hexythiazox, Germination Rate, Seed

Subject Areas: Agricultural Engineering, Agricultural Science

1. Introduction

Pesticides are chemical agents used to reduce the destructive effects of insects, rodents, weeds, fungi, and other pests that lower the value of a commodity during production, storage, or consumption. However, pesticides also have negative effects on environment. Intensive use of insecticides can cause environmental pollution, deteri-

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How to cite this paper: Çobanoğlu, S., Cilbircioğlu, C. and Hepkorucu, A. (2016) Effects of Three Acaricides on the Germination Rate and Head Weight of Taşköprü Garlic in Turkey. *Open Access Library Journal*, 3: e2276.

<http://dx.doi.org/10.4236/oalib.1102276>

oration of untargeted species, and foster resistance problems [1]. Pesticides and their residues can accumulate on plants, enter the food chain, or cause chronic toxicities [2]. Pesticides may induce phytotoxic effects on leaves, lead to morphological, anatomical or physiological changes in plants, or inhibit pollen germination and pollen tube formation [3]. Pesticide can also cause acute or chronic poisoning in bees with serious economic losses [4].

Therefore, use of chemicals has been limited in recent years, and biological or cultural methods have been advocated [5]. Natural plant extracts with biological activities against diseases and insects are being investigated, and herbal insecticides have been found to be effective against several pests [6]. Other natural products such as plant extracts can help control weeds, plant diseases, and insects [7] [8].

Early research on herbal pesticides included evaluations of extracts of neem tree seeds, *Azadirachta indica* A. Juss (Meliaceae), which includes the active substance azadirachtin that is effective against insects. Neem products affect feeding, growth, and development stages of insects and mites. Pesticides (active ingredients) with slow modes of action are more important in integrated pest management systems than the rapid destructive effects of synthetic insecticides [9]-[12]. Neem pesticide products are registered in more than 40 countries, and they are used against key pests of fruits, vegetables, and flowers [10] [13].

Product from actinomycete bacteria (Actinobacteria), *Streptomyces avermitilis* (ex Burg) Kim & Goodfellow (Actinomycetales: Streptomycetaceae), is found naturally in the soil. It is accepted by United States Environment Protection Agency (EPA) as second class toxic pesticide [14]. Hexythiazox is a mixture of four stereoisomers chemical compounds from the group of thiazolidines and carboxamides. Hexythiazox is an effective acaricide on mite eggs and nymphs, like juvenile stages but not adults. The precise mode of action of this acaricide is not known (1986 unpublished report by R. B. Chapman: Toxicity of nissorun to two-spotted spider mite. Entomol. Dept., Lincoln College, Canterbury, UK, 22 p.).

One of the most commonly produced vegetable crops in the world is garlic, *Allium sativum* L. (Asparagales: Amaryllidaceae). Garlic is used as a spice mash, a canned product, a dried powder, garlic oil, and garlic pellets. Because garlic has a wide range of uses and it has positive effects on human health, research on this plant has increased. Also, it can be grown in different environmental conditions and is economically important where it grows. According to United Nations Food and Agricultural Organization, 24.3 million metric tons of garlic was grown worldwide in 2013 [15]. Nearly 80% of this global production was from China, while India, South Korea, Egypt, and Russia follow China as the top five countries in production of garlic [15]. Garlic is used in medicine for a wide range of symptoms such as asthma, hypertension, bronchitis, cancer, circulatory weaknesses, colds, colitis, and coughing [16].

Garlic also is an important crop in Turkey, where over 87,000 tons is produced annually; which accounted for 0.36% of the total world garlic production in 2013 [15]. The greatest production area in Turkey is in Taşköprü Province, especially near the city of Kastamonu (25.2% of total production in Turkey). Taşköprü garlic is recognized as one of the best garlic varieties in Turkey and the rest of the world. In 2012, there was 18,500 ha of Taşköprü garlic with total production of 16,650 tons and yields of 900 kg/ha [17]. In Taşköprü Province, 3500 families (about 40,000 people) are employed in garlic production. In Kastamonu, mainly Taşköprü garlic is grown, but there are 216 kinds of local garlic cultivars, including some Chinese varieties that are grown.

Although garlic is now grown in almost every region of the world, it grows well under temperate climates on sandy, loamy, and argilliferous soils, especially in soils rich in germanium and selenium [18]. Some of the highest quality garlic in the world is grown on the Taşköprü Plain where 85% of the soil has a permeable, loamy-argilliferous structure that garlic needs. In addition, Taşköprü has an optimum climate for garlic production with a warm, humid spring [17]. Adequate rainfall is received in February and March when garlic germinates, and the crop can be grown without additional irrigation in Kastamonu [18]. Diseases and pests can cut garlic yields by 10% - 50%, and mites are one of the most important problems on onions, garlic, and bulbous ornamental plants [19]-[27]. In preparation for this study, garlic producers on the Taşköprü Plain were interviewed and asked to fill out questionnaires concerning the effects of diseases and pests on garlic yields. From these surveys, it was found that approximately 800 hectares of garlic in 15 villages was in risk of being lost because of pests, so these producers had to move to poorer lands at higher altitudes. Because of severe mite damage in this area, extensive spraying was done, which could lead to environmental degradation or resistance in the mite population. The purpose of this study was to determine the effects of three acaricides on garlic germination and production.

2. Materials and Methods

This study was performed in 2013-2014 on a 0.2 hectare field located in Alatarla, Turkey. A local variety, Taşkoprü garlic, was planted at 1250 kg per hectare in March into 3×10 meter plots. To prevent cross contamination for comparison acaricide effects, each plot was separated by a three meters of empty space. The experiment was set up as a randomized complete block design with four treatments (three acaricides and an untreated control) each plot has four replicates. Thus, there was a total of 16 plots covering about one hectare and plots were randomly assigned. Before planting, garlic cloves were treated by dipping them in abamectin (Avirmec EC[®], Koruma, İzmit, Turkey) at 30 ml/100 L water, azadirachtin (NeemAzal-T/S[®], Verim Grup, İstanbul, Turkey) at 30 ml/100 L water, or hexythiazox (Yoksorrun 5EC[®], Agrobrest Grup, İzmir, Turkey) at 50 ml/100 L water. Garlic cloves were immersed in one of the three acaricide-water treatments for 15 minutes before planting. The application of insecticides which is the advised and regulated by Ministry of Agriculture.

The numbers of germinating garlic plants were estimated by, in a 1 m² area of each plot were counted three times and taken consideration by the average values during the germination period in April and May. To determine yields at harvest, six garlic heads from each plot were weighed. Data were analyzed with an ANOVA test.

3. Results & Discussion

As a group, the acaricides significantly affected garlic germination ($P < 0.001$) (Table 1). However, a significant positive effect on germination was only seen for azadirachtin (Table 2). Although germination rates were numerically higher than the control for abamectin, and hexythiazox, these differences were not statistically significant (Table 2, Figure 1). As a group and individually, the three acaricides did not significantly affect garlic development or head weights ($P < 0.472$) (Table 1 & Table 2). The non significant effect on head weight is important, as growers require high average weights. However, the acaricides did contribute to greater variation in head weight than in the untreated control (Figure 2).

Figure 1. Box-Jenkins plot for germination rate with acaricides.

Figure 2. Box-Jenkins plot for head weights with acaricides.

Table 1. Analysis of variance (ANOVA) of the effects of acaricides on germination rates and head weights of Taşköprü garlic.

Factor	Source of variation	Sums of squares	Degrees of freedom	Mean square	F	P
Germination	Acaricide treatment	8857.19	3	2952.34	77.57	>0.001
	Error	456.75	12	38.06		
	Total	9313.94	15			
Head weight	Acaricide treatment	14.4219	3	4.81	0.90	0.472
	Error	64.47	12	5.37		
	Total	78.89	15			

Table 2. Effects of acaricides on germination rates and head weights of Taşköprü garlic in Alatarla.

		Mean	Std. error	95% confidence interval for mean	
				Lower bound	Upper bound
Germination (plants/m ²)	Abamectin	76.25	2.14	69.45	83.05
	Azadirachtin	129.00	2.74	120.28	137.72
	Hexythiazox	78.50	4.03	65.67	91.33
	Untreated control	70.50	3.12	60.56	80.44
Head weight (g)	Abamectin	15.17	0.93	12.22	18.11
	Azadirachtin	13.21	1.00	10.02	16.39
	Hexythiazox	14.66	1.87	8.72	20.60
	Untreated control	12.92	0.17	12.36	13.47

This study showed that azadirachtin had the greatest effect on garlic germination. Neither abamectin or hexthiazox had any effects on garlic germination, and none of the acaracides had an impact on the head weights of Taşköprü garlic. This is the first study on the effects of acaricides on garlic germination. In future research, correlations between acaricide type and germination rate should be examined.

The results from garlic produced area proved that the pest management in production of organic vegetables can be successfully performed with the allowed preparations such as *Melia azedarach* L. on some pests [28]-[30]. There was no significant differences were found between natural (Neem Azal T/S), and conventional pesticides in respect to yield and fruit properties [31]. [32] were found as slightly harmful for the side effects of neem oil and NeemAzal on the predatory mite *Phytoseiulus persimilis*. These datas proofed our neem oil result, due to Neem Azal has not any side effects of the beneficials and successfully effective on the mites and germination rate will be higher.

Although, *P. persimilis* shows oversensitivity for *T. urticae* against bifenthrin and dimethoate. Toxicity of bifenthrin and dimethoate were harmful effect. Hexythiazox was less toxic than the other pesticides and evaluated as harmless [33], we found almost the same germination rate because of the negatif effects of the beneficial mites. The contact toxicity of Abamectin to beneficials such as, predatory mites *Amblyseius fallacis* (Garman), *Phytoseiulus persimilis* and nymphs of *Orius insidiosus* (Say) (Hemiptera: Anthocoridae) was very toxic all the beneficials [34].

Dimethoate was estimated harmful for the predatory mites *P. persimilis* and *Neoseiulus californicus*, the toxicity on immature Two spotted spider mite was weak [33]. Neem oil residues has been evaluated no mortality on *P. persimilis* [35]. [36] reported that, soil application with neem (Neem Azal) has strong systemic effects however were recorded in the larval stages of *Liriomyza sativae* (Diptera: Agromyzidae) attaining mortalities up to 100%. Activity of Neem Azal-U was persistent since application of even seven days before infestation resulted in mortalities extending between 40% to 70%. This is also effect the health plants growing. NeemAzal insecticides that have demonstrated high potential control of different harmful pests [11]. Azadirachtin is considered the most important active ingredient contained in neem seeds. This plant extracts shows variable effects on insect pests including oviposition and feeding deterrence, growth regulation, fecundity and fitness reduction [9] [37]. Neem compounds have antiviral [38] antibacterial [39] antifungal [40] antiinflammatory effect [41]. It was estimated that all metabolic parameters of exposure different concentration of Neemazal lepidopteran larvae were less than control larvae. Food intake and faeces output had been decreased due to strong action of Neemazal. The approximated digestibility values decrease during 4th larval [42].

4. Conclusion

All of these have positive effect for the soil fauna and the plant health. Further studies may be required on this subject.

Support

This study was supported by TÜBİTAK TOVAG 114O 416.

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