YYÜ TAR BİL DERG
(YYU J AGR SCI)
2015, 25(1): 41- 47

Geliş Tarihi (Received): 25.06.2014
Kabul Tarihi (Accepted): 23.12.2014

Araştırma Makalesi/*Research Article (Original Paper)*

Weed Control and Crop Production Practices in Cotton Production in Diyarbakır Province of Turkey

Cumali ÖZASLAN[1] Songül AKIN[2] Songül GÜRSOY[3*]

[1] : Dicle University, Agricultural Faculty, Plant Protection Department, Diyarbakır
[2] :Dicle University, Agricultural Faculty, Agricultural Economy Department, Diyarbakır
[3] :Dicle University, Agricultural Faculty, Agricultural Machinery Department, Diyarbakır
*e-posta: songulgursoy@hotmail.com; Tel: +90 412 2488509; Fax: +90 412 2488153

Abstract: Cotton agriculture is very important in South Eastern Anatolia Region of Turkey. Weeds are a major problem in cotton farming systems. In this study, a survey was conducted in Diyarbakır Province of Turkey to evaluate weed management practices being opted, crop production methods in use, most important weed species and major production problems in the region. Moreover, effect of agricultural extension activities on weed control was investigated. For this purpose, over 75 cotton growers were surveyed by a questionnaire. The questionnaire included 15 questions about crop rotation, tillage systems, irrigation and weed management methods being applied by these growers in cotton production. Moreover, growers were surveyed about the most common weeds that they faced in cotton fields. The survey results showed that the most common weeds in cotton production fields were *Xanthium strumarium* L. (common coclebur), *Sorghum halepense* (L.) Pers. (johnsongrass), *Amaranthus retroflexus* L. (common amaranth), *Cynodon dactylon* (bermudagrass), *Physalis* spp. (ground cherry) [*Physalis philadelphica* Lam. (mexican groundcherry) and *Physalis angulata* L. (cutleaf groundcherry)] , *Solanum nigrum* L. (black nightshade), *Portulaca oleracea* L. (purslane), *Cyperus rotundus* L. (nutgrass). Most growers used pre-emergence and post emergence herbicides before planting and in the season. The preceding crops of cotton were cotton (63.4%), wheat (18.3%) and maize (16.9%). The tillage system used was commonly conventional tillage method including moldboard plough in the autumn and two times cultivator and planking before planting. Over 70% of growers stated that tillage system significantly influenced the weed population. This study suggests that it is very important to research and choose the suitable crop production and weed management practices for region conditions.

Key words: Cotton, survey, weed, tillage, crop rotation, Diyarbakır

Diyarbakır İli (Türkiye) Pamuk Üretim Uygulamaları ve Yabancı Ot Kontrolü

Özet: Pamuk tarımı, Türkiye'nin Güneydoğu Anadolu bölgesinde çok önemlidir. Yabancı otlar, pamuk tarımında karşılaşılan en önemli sorunlardan birisidir. Bu çalışmada, bölgedeki yabancı otlarla mücadele yöntemleri, uygulanan bitki yetiştirme teknikleri, en önemli yabancı ot türleri ve karşılaşılan sorunları değerlendirmek amacıyla Diyarbakır ilinde bir anket çalışması yürütülmüştür. Ayrıca, tarımsal yayım uygulamalarının yabancı ot kontrolüne etkisi de araştırılmıştır. Bu amaçla, 75 pamuk üreticisine anket uygulanmıştır. Ankette pamuk üreticilerine uyguladıkları ekim nöbeti, toprak işleme, sulama ve yabancı ot kontrol yöntemlerini içeren 15 soru sorulmuştur. Ayrıca, pamuk tarlalarında en fazla karşılaştıkları yabancı otlar da belirlenmiştir. Araştırma sonucunda pamuk taralalarında en yaygın görülen yabancı otların *Xanthium strumarium* L. (domuz pıtrağı), *Sorghum halepense* (L.) Pers. (kanyaş), *Amaranthus retroflexus* L. (horozibiği), *Cynodon dactylon* (köpekdişi ayrığı), *Physalis* spp. [*Physalis philadelphica* Lam. (fener otu) and *Physalis angulata* L. (fener otu), *Solanum nigrum* L. (kopek üzümü), *Portulaca oleracea* L. (semiz otu) ve *Cyperus rotundus* L. (topalak) olduğu saptanmıştır. Üreticilerin coğunun çıkış öncesi ve sonrası yabancı ot ilaçlarını, ekim öncesi ve bitki gelişimi döneminde kullandıkları görülmüştür. Ankete katılanların % 63.4'ü pamuğun ön bitkisinin pamuk, %18.3'ü buğday ve %16.9'ü ise mısır olduğunu ifade etmişlerdir. Bölgede yaygın olarak sonbaharda kulaklı pulluk, ekimden önce kültüvatör ve tapan uygulamalarını içeren geleneksel toprak işleme yönteminin kullanıldığı tespit edilmiştir. Üreticilerin %70'inden daha fazlası yabancı ot kontrolünde toprak işleme sisteminin önemli oranda etkili olduğunu belirtmişlerdir. Bu çalışmanın sonucunda, bölge koşullarına uygun bitki yetiştirme ve yabancı

ot kontrol yöntemlerinin araştırılmasının ve seçilmesinin çok önemli olduğu görülmüştür.

Anahtar kelimeler: Pamuk, Anket, Yabancı ot, Toprak işleme, Ürün rotasyonu, Diyarbakır

Introduction

Cotton is one of the most important crops in Turkey. Turkey is ranks 6th and 7th in global production and area under cultivation respectively. According to statistical data in 2014, domestic cotton production and area under cultivation was 877.500 tonnes and 450.900 hectares, respectively (Coban, 2014). The cotton is mainly grown in the Southeastern Anatolia (GAP), Aegean and Çukurova. Also, small amounts of cotton are produced around Antalya. The Southeastern Anatolia region (GAP) contributes over 50% of Turkey's total cotton production. It was estimated that cotton planting area would significantly increase with the expansion of irrigation area to 1.04 million hectares by 2014 in the Southeast Anatolia region of Turkey (Basal and Sezener, 2012). But, high production costs and low cotton prices are adversely affecting the cotton production in region as well as country. Yücer and Sarsu (2005) stated that cotton planting area has seriously decreased in Turkey since 2005 and this decrease trend is still continuing due to number of reasons such as; contraction in world textile industry, increase in production cost, decrease of cotton prices and drought stress. They defined the costs of cotton production as land rents, fuel, fertilizer, herbicides, seeds, and labour costs. In Southeastern Anatolia Region as well as the in the Aegean and Çukurova regions, pests, including budworm and bollworm, have become a serious problem for cotton producers. Başrag et al. (2010) suggested that the studies should be carried out for recognition and training, integrated product management of cotton and diseases and weeds threatening the sustainable production of cotton in Diyarbakır and Şanlıurfa regions. Also, they suggested that the infrastructure studies related to the establishment of early warning systems should be started.

Among different agents threatening the sustainability of cotton production, weeds and insects are most troublesome. Weeds reduce cotton yield directly by competing for light, nutrients and water, and reduce cotton quality by lint contamination. Also, weeds may reduce irrigation efficiency and harbor insect pests and pathogens (Charles, 1991). Cotton is a slow-growing plant and it is a very poor competitor of weeds (Kendig et al., 1994). Effective, economical and sustainable weed control in cotton requires an integrated approach that includes cultural, mechanical, biological, and chemical methods. Many researchers studied the effect of weed competition on cotton yield and quality. Uludağ et al. (2007) stated that Johnson grass is one of the worst weeds in cotton fields worldwide. They carried out the field experiments in 1992, 1997 and 2002 to show the effect of Johnson grass densities on cotton yield. They found that one Johnson grass plant in 8 m of cotton row decreased cotton yield 4.82 and 9.42% in 1997 and 2002, respectively. Bükün and Uygur (2001) reported that *Physalis* spp. densities and distribution increased every year in the period of 1998 and 2000 in Şanlıurfa. They found that the yield loss of cotton was 8.88%, 29.98%, 51.55%, 65.76% and 75.04%, respectively, when plant number per square meter was 1, 2, 3, 4 and 5, and the economic threshold level varied between 0.317 and 0.380 plant/m^2 according to different herbicides applied. Snipes et al. (1987) found that *Xanthium strumarium* emerging with cotton and was removed after only two weeks still reduced cotton yield. Also, Buchanan and Burns (1970) reported up to 90% yield reductions when weeds were not controlled in first two weeks after cotton emergence.

Van der Meulen (2006) reported that in recent years, weed management practices that provide long-term solutions to weed problems have been developed, but adoption of these practices has not been widespread. Further, proper weed control is achieved by relatively small proportion of farmers. He stated that many factors such as crop production practices, weeds present, irrigation water, soil types and fertility, vegetation cover, topography, climate, size of enterprise, propensity to adopt new ideas affected the success of weed control.

This paper reports the results of a survey related to crop production practices, weed problems, herbicide use and weed control patterns and extension activities to identify the major shortcomings of the weed control system in Diyarbakır province of Turkey.

Materials and Methods

This study was conducted in Diyarbakır province in the South Eastern Anatolia region of Turkey. The province of Diyarbakır extends over an area of 15.355 km^2. In this region, the field crops cover an area of

6.53 thousand ha among these; area under cotton production is 7.5%. Cotton is mainly grown in the irrigated areas of province. The most cotton growing districts are Bismil, Çınar, Eğil, Ergani, Kayapınar, Silvan, Sur, and Yenişehir. A survey was conducted at the most intense areas of cotton production in the province in April and May 2013. Sampling size and the settlements of the interviews were determined purposively according to the experience and knowledge of the researchers. In this regard, 75 farm enterprises were determined and interviewed to represent the study area. A questionnaire containing questions regarding a) agronomic practices including tillage, irrigation, crop rotation, fertilization, harvesting b) weed management practices, c) problematic weed rankings, d) knowledge of weed management and e) efficiency of extension services; was prepared and each grower was interviewed for answering the questionnaire.

The data collected during the survey were analyzed by using frequencies and simple percentages with SPSS statistical software (SPSS, 2012).

Results and Discussion

The majority of participants of survey were between 30-50 years of age and had education up to primary school (45.33%) and secondary school (44%). This shows the education level was low and very small portion of respondents had higher graduate degrees. The farmers were asked; since how long you have been grown cotton (years). Response was 1-10, 10-20, 20-30 and >30 years which ranged 45.33%, 37.33%, 10.66%, and 6.68%, respectively. The area of cotton production was <5, 5-10, 10-20, 20-50, >50 ha with percentages of 5.33, 22.66, 22.66, 37.33, and 9.33 of respondents, respectively. Cotton production area per farm reported from our survey was higher than Turkey's average farm size of 6.81 ha. The 69.33% of respondents stated that their cotton yield was 4000-5000 kg ha^{-1}. This value was close to the national average of Turkey, 4990 kg ha^{-1} (Kutlu, 2014).

The preceding crops of cotton are represented in Table 1. The results of survey showed that 63.4% of farmers practiced mono cropping system, in which a particular crop is planted repeatedly in the same field. Crop rotation strongly affects density and composition of weed flora because the different crops in rotation require different agricultural practices and herbicide. Due to continuously changing agricultural practices as a result of crop rotation; the adaptations success of certain species to a specific area under sole or mono cropping could be prevented (Bükün, 2005). Ferrell et al. (2011) reported that crop rotation is an important part of a good weed control program in cotton agriculture. Certain weeds, especially nutsedges, may be less difficult to control in a farming system having preceding crop such as peanut. Other benefits of crop rotation may include reduction in insects, diseases and nematode problems both in cotton and succeeding crops.

Table 1. The preceding crops of cotton grown by farmers in survey

The preceding crop	**Frequency**	**Percentage (%)**
Cotton	45	63.4
Wheat	13	18.3
Maize	12	16.9
Lentil	1	1.4
Total	**71**	**100.0**

When the respondents were asked for the tillage practices being used by them in cotton agriculture, more than 85% of respondents stated that the tillage practices included the moldboard plough in autumn, the cultivator in March and before planting and at least three times soil leveling and firming followed by planking. Pneumatic planter was the instrument used for drilling the cotton seeds. This indicated that intensive tillage system is opted by the growers in the region. The 94% of respondents stated that they use planker before planting to compact the soil, which prevents the moisture loss of soil. When asked the effect of tillage systems on weed density, 65% of respondents said "yes" and they stated that deep ploughing reduces weed density. When asked for previous crop residue, the majority of respondents answered that they chopped the stalks or collected them if previous crop was cotton, whereas, corn and wheat residue was usually burned. Previous crop residue and tillage practices can affect weed population dynamics, including weed seed distribution and abundance in the soil seed bank (Mulugeta and Stoltenberg, 1997). Hatfield et al. (1998) stated that changing the tillage system would change the distribution and density of weed seeds in agricultural soils. There are reports that weed control was

improved by using moldboard plough for tillage (Durutan et al., 1989; Pala et al., 2000; Camara et al., 2003). Yalcin et al. (2003) observed that the amount and density of weed in cotton farming with reduced tillage were higher than the conventional tillage. They stated that conventional tillage applied in cotton farming has a considerable role in the development of weed population and deep tillage by plough prevents the germination of weed seeds. But, Hooker et al. (2000) found no effect of tillage system on weed populations and stated that weeds could be effectively managed with reduced herbicide inputs in conservation tillage systems.

When asked for irrigation source, 45% and 34% of respondents answered that they used tubewell and canal water, respectively. More of 50% of respondents stated they used the furrow irrigation system. The source of irrigation water and irrigation method significantly influenced weed density. Unnecessary applications of water and fertilizer can also allow weeds to flourish in modern agriculture (Coolong, 2013). Bükün (2005) indicated that irrigation and continuous cotton cultivation as well as weed control and crop production practices had an important role to influence on the shifting of weed flora because irrigation encourages soil salinity and so the species that prefer these conditions are well adjusted and become dominant.

The most problematic weed species in cotton field are represented in Table 2. *Xanthium strumarium*, *Sorghum halepense*, *Cynodon dactylon* were the first, second, and third most problematic weeds, respectively. Özaslan et al. (2011) reported diversity of weed spectrum for the cotton growing districts of the Diyarbakır where they found *X. strumarium, Amaranthus retroflexus, Cyperus rotundus* and *C. dactylon* as dominant weed species. Tepe (1997) stated that most problematic weeds in cotton were *S. halepense, C. dactylon, X. strumarium, Portulaca oleracea, A. retroflexus, C. rotundus, Physalis* spp. (*Physalis angulata, Physalis philadelpica*) and *Solanum nigrum.* Özaslan and Bükün (2013) found that dominant weed species in cotton growing areas of Southeast Anatolia region were *X. strumarium, Physalis* sp., *A. retroflexus, S. halepense, S. nigrum, C. rotundus and P. oleracea.* Bükün and Uygur (2003) indicated that weed species such as *Amaranthus albus, C. dactylon, Echinocloa colonum, P. angulata, P. philadelphica, P. oleracea, Setaria verticillata* and *X. strumarium* are well adapted and become more common species in cotton growing areas. This shows that the problematic weed species stated by farmers are similar to the majority of species reported in the cotton growing areas.

Table 2. The most problematic weed species in farmer's field of the surveyed region

Weed species	**Frequency**	**Perc. (%)**
Xanthium strumarium, *Sorghum halepense*, *Cynodon dactylon*	25	38.4
X. strumarium, *S. halepense*, *Solanum nigrum*	6	9.3
X. strumarium, *Amaranthus retroflexus*, *Physalis* spp.,	11	16.9
X. strumarium, *Amaranthus albus*	6	9.2
X. strumarium, *C. dactylon*	2	3.1
X. strumarium, *S. nigrum*.	2	3.1
Physalis spp., *A. retroflexus, S. halepense*,	7	10.8
Physalis spp., *A. retroflexus*, *S. nigrum*.	6	9.2
Total	**65**	**100.0**

Cotton growers are using different methods for controlling weeds. Some use mechanical method by modifying the commonly used cultivator while others rely on herbicides and many of the cotton growers combine all the methods. The 61.3% of farmers interviewed stated that that they used manual, mechanical and chemical weed control methods (Table 3).

Table 3. Methods used by farmers to control weeds in cotton fields in area surveyed

Weed control method	**Frequency**	**Perc. (%)**
Manual + Mechanical + Chemical	46	61.3
Mechanical + Chemical	13	17.8
Chemical	6	8.0
Manual + Mechanical	6	8.0
Mechanical	4	5.3
Total	**75**	**100.0**

The herbicides used in cotton fields by farmers participated in survey are seen in Table 4. Glyphosate amin salt, haloxyfop-R-methyl ester, trifluralin were commonly used herbicides to control weeds. More than 70% of farmers stated that they used trifluralin. Kendig et al. (2007) stated that fewer herbicides are available for use in cotton and weed control in cotton was improved significantly by the registration of transgenic, glyphosate-resistant cotton cultivars.

Table 4. Herbicides being used by farmers to control weeds in cotton fields in surveyed region

Herbicide	**Frequency**	**Perc. (%)**
Trifluralin	17	40.5
Trifluralin, haloxyfop-R-methyl ester	12	28.6
Haloxyfop-R-methyl ester, glyphosate amin salt	8	19.1
Glyphosate amin salt	3	7.2
Haloxyfop-R-methyl ester	2	4.8
Total	**42**	**100.0**

The results of survey showed that 13.1% of farmers participated in survey had rotary inter-row cultivator, 20.6% had sweep inter row cultivator. The 47.1 % of farmers had the sweep inter row cultivator and fertilizer applicator mounted on lister cultivator (Table 5). Mechanical cultivators are major proven units for inter row cultivation in corn, cotton and soybean. During inter row cultivation, cultivator moves between the rows of the crop for soil loosening, weeding, fertilizing, and ridge forming. There are very different cultivators being used for inter-row cultivation. The inter row cultivator are used for mechanical control of weeds between the rows and to improve aeration and infiltration of soil. Fertilizer applicator mounted on lister cultivator is used to form furrow after inter-row cultivator.

Table 5. Cultivation equipment being used by farmers to control weeds in surveyed region

Equipment	**Frequency**	**Perc. (%)**
Inter-row cultivator and fertilizer applicator on lister cultivator	32	47.1
Inter-row cultivator	14	20.6
Fertilizer applicator mounted on lister cultivator	13	19.1
Rotary inter-row cultivator	9	13.2
Total	**68**	**100.0**

A number of extension activities are being done by Agricultural Faculty of Dicle University, Plant Protection Research Institutes and Diyarbakır Directorate of Provincial Food Agriculture and Livestock. Therefore, the efficiency of these extension activities was also evaluated. When asked “do you know the institutes serving the subjects on plant protection”, 85% of respondent stated they know and when asked the names of these institutes, 37.33% of respondent stated they know Diyarbakır Directorate of Provincial Food Agriculture and Livestock. While the 57.33 % of respondent stated that they participated in the extension activities such as field day, seminar, training, the 36% said that they did not. Agricultural extension according to Leeuwis (2006) is a series of embedded communicative interventions that are meant, among other things, to develop and/or induce innovations, which supposedly help to resolve (usually multi-actor) problematic situations.

This survey highlights the need to define the effects of weeds on cotton production and to understand the effects of management on weed populations. The results of the study showed that intensive tillage and monoculture cropping practices are used in cotton production areas of Diyarbakır. Many crop production practices such as tillage, rotation, irrigation, fertilization as well as weed management systems significantly affects the weed population and the success of weed control. Therefore, it is very important to research and choose crop production and weed management practices by considering the region conditions for weed control.

Acknowledgements

The Authors would like to express their gratitude and appreciation to Abdurrahman Kara and Shahid Farooq who looked closely at our article for English style and grammar, correcting both and offering suggestions for improvement.

References

Basal H, Sezener V (2012). Turkey Cotton Report. https://www.icac.org/wp-content/uploads/2012/11/03-HBASAL_TURKEY-COTTON-REPORT2.pdf.

Başrag S, Ekinci R, Akıncı C, Akın S, Öcal-Kara F, Tonçer Ö (2010). Diyarbakır ve Şanlıurfa İllerinde Pamuk Sektörü Envanterinin Hazırlanması Projesi Sonuç Raporu. Karacadağ Kalkınma Ajansı.

Buchanan GA, Bums ER (1970). Influence of weed competition on cotton. Weed Sci. 18: 149-54.

Bükün B (2005). Weed flora changes in cotton growing areas during the last decade after irrigation of Harran Plain in Şanlıurfa, Turkey. Pak. J. Bot., 37(3): 667-672.

Bükün B, Uygur FN (2001). Determination of economic and injury threshold levels of troublesome weed, Groundcherry (*Physalis* spp.) in cotton cultivated area of Harran Plain. The Journal of Turkish Weed Science, 4 (1): 48-58.

Bükün B, Uygur FN (2003). The impact of irrigation on weed species composition and density in cotton plantations of Harran Plain (Turkey). Proc. *7th EWRS Mediteranean Symp*. *Adana,Turkey*, 143-144.

Camara KM, Payne WA, Rasmussen PE (2003). Long-term effect of tillage, nitrogen and rainfall on winter wheat yields in the Pacific Northwest. Agron J. 95:828-835.

Charles GW (1991). A grower survey of weeds and herbicide use in the New South Wales cotton industry. Aust J Exp Agric. 31:387-92.

Coban M (2014). Turkey Country Report. International Cotton Advisory Comittee-Research Associates Program. *https://www.icac.org/mtgs/Workshop/Research-Associate-Program*

Coolong T (2013). Using Irrigation to Manage Weeds: A Focus on Drip Irrigation. http://cdn.intechopen.com/pdfs-wm/42770.pdf.

Durutan N, Guler M, Karaca M, Meyveci K, Avcin A, Eyuboglu H (1989). Effect of various components of the management package on weed control in dryland agriculture. In soil and crop management of Improved Water Use Efficiency in Rainfed Areas, Proceedings of an International Workshop, Ankara, Turkey.

Ferrell JA, MacDonald GE, Leon R (2011). Weed Management in Cotton. SS-AGR-04, one of a series of the Agronomy Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Hatfield JL, Buhler DD, Steward BA (1998). Integrated weed and soil management. Ann Arbor Press, Ann Arbor, MI pp. 223-246.

Hooker DC, Vyn TJ, Swanton CJ (2000). Effectiveness of soil applied herbicides with weed control for conservation tillage systems. Agron. J. 89: 579-587.

Kendig A, Fishel F, DeFelice MS (1994) Cotton Weed Control. http://extension.missouri.edu/p/G4251.

Kendig JA, Nichols RL, Ohmes GA (2007). Tolerance of cotton (*Gossypium hirsutum* L.) seedlings to preemergence and postemergence herbicides with four modes of action. Online. Plant Health Progress doi:10.1094/PHP-2007-1108-01-RS.

Kutlu ÜB (2014) Dünya ve Türkiye Pamuk Üretimi. http://www.upk.org.tr/pdf/pamuk-zirve/Dunya_ve_Turkiye_Pamuk_Uretimi_Umit_Bayram_Kutlu.pdf.

Leeuwis C (2006). Communication for Rural Innovation: Rethinking Agricultural Extension; Third Edition. Blackwell Publishing. The Netherlands.

Mulugeta D, Stoltenberg DE (1997). Weed and seedbank management with integrated methods as influenced by tillage. Weed Sci. 45, 706–715.

Özaslan C, Bükün B (2013). Determination of the weeds in cotton fields in Southeastern Anatolia region of Turkey. Soil-Water Journal. 2 (2):1777-1788.

Özaslan C, Boyraz N, Güncan A (2011). Diyarbakır ili pamuk ekim alanlarında sorun olan yabancı otların belirlenmesi. GAP VI. Tarım Kongresi, Diyarbakır, pp:88-95.

Pala M, Harris HC, Ryan J, Makboul R, Dozom S (2000). Tillage systems and stubble management in a mediterranean-type environment in relation to crop yield and soil moisture. Expl Agric. 36: 223-242.

Snipes CE, Street JE, Walker RH (1987). Interference periods of common cocklebur (*Xanthium strumarium*) with cotton (*Gossypium hirsutum* L.). Weed Sci. 35: 529-532.

SPSS, 2012. IBM SPSS Statistics 21. SPSS Institute Inc., Chicago, IL.

Tepe I (1997). Türkiye'de tarım ve tarım dışı alanlarda sorun olan yabancı otlar ve mücadeleleri. Yüzüncü Yıl Üniversitesi Yayınları No: 32, 237 s.

Uludağ A, Gözcü D, Ruşen M, Güvercin RS, Demir A (2007). The Effect of johnsongrass densities (*Sorghum halepense* (L.) Pers) on cotton yield. Pakistan Journal of Biological Scinces, 10: 523-525.

Van der Meulen A, Reeve I, Sindel B (2006). The Sociology of Weeds -Motivating, Building Capacity and Educating Graziers Who Fail to Control Weeds. Final Report to Meat and Livestock Australia. University of New England Amidala NSW.

Yalcin I, Boz O, Ucucu R (2003). Effects of different mechanisation applications on weed control in cotton farming and its significance in terms of mechanisation management. Asian Journal of Plant Sciences, 2: 18-22.

Yücer A, Sarsu F (2005). Turkish approach to reducing cotton production cost. http://www.cottonbangladesh.com/October2011/TurkishApproach.htm.