

THE EFFECT OF TILLAGE AND PLANT DENSITY ON YIELD AND YIELD COMPONENTS OF SOYBEAN [*Glycine max* (L.) Merrill] GROWN UNDER MAIN AND DOUBLE-CROPPING SOYBEAN (*Glycine max* L. Merr.)

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Abstract

The aim of this study was to compare tillage methods and plant density on yield and yield components of soybean [*Glycine max* (L.) Merrill] grown under main and double cropping systems. The field experiments were carried out at the experimental area of Agricultural Faculty, Dicle University during 2013 and 2014. The experiments were conducted as split-split plot design based on randomized complete blocks with two sowing dates (normal and late) as the main plot, three tillage methods (no-tillage, reduced and conventional) as sub-plot, and three between row spacing (35, 55 and 70 cm) sub-sub plot factor. The experiments were performed in three replications and soybean cultivar Nova (MG III) was used. The combined analysis of the data showed that yield means of reduced tillage (2015.4 kg/ha) and conventional tillage (2036.1 kg ha⁻¹) were significantly different ($P>0.01$) compared with no-tillage (1881.1 kg/ha). Significant interaction was observed among experimental factors. The highest value was obtained at early sowing x conventional tillage x 70x5 cm as of 2206.1 kg ha⁻¹

KEYWORDS: SOYBEAN, SOWING TIME, TILLAGE, PLANT DENSITY, YIELD

1. Introduction

Due to the limited agricultural land in the world, the increasing food gap emerging as a result of increasing population should be closed with increased yield per unit area in the current agricultural fields. For this purpose, highly efficient and high-quality varieties are developed by improvements and agronomic practices such as irrigation, fertilization, sowing time, tillage and sowing time still continue intensively.

Considering that the ideal soil temperature for rapid germination and growth of soybean is 25-30 °C, the best sowing time in Southeastern Anatolia Region part of Turkey is mid-May when soil conditions and potential plant diseases are considered, and it is known that it can be grown as a double crop after harvest of cereals and legume grains (mid-June/late of June). In the double-crop agriculture, seeds are planted without wasting any time due to the short growing season after harvest of wheat (Sanford et al., 1986).

In the agricultural production, conservation tillage, including reduced tillage and no-tillage are applied as an alternative to conventional tillage system within the context of sustainable agriculture systems based on protecting and improving soil fertility. There are changes about tillage system in Turkey due to increasing environmental awareness and necessity of economic production and saving energy. Conservation tillage and especially direct sowing methods are spreading as an alternative to conventional tillage methods in worldwide and Turkey (Sessiz, 2010).

Previous crop residue of crop are important components of reduced tillage methods and they affect the crop yields, positively by adding nutrients to the soil (Erenstein 2003), balancing the soil temperature (Greb, 1966: Wilhelm et al., 1989) and reducing soil water evaporation (Biamah 2005). For most soils, crop residue can increase the water infiltration in the root of the plants (Bruce et al., 1987; Dick et al., 1987), which provide suitable conditions for agricultural activities by reducing soil erosion and runoff water and improve crop yield. Conservation tillage or reduced tillage practices allow crop residues left on the soil and these remains suppresses the weeds out (Crutchfield et al., 1985; Putnam et al., 1983). Reduced or tillage methods can provide expansion of the under double crop since sowing season is advanced.

In the agricultural ecosystem, plant growth and development is influenced by cultural practices such as row spacing and number of plants. In the narrow row spacing, larger number of plants are planted, earlier canopy formation is provided and first pods are formed at higher levels and water in the soil is less evaporated, and a better root development is provided and less soil erosion occurs (Palmer and Privette, 1992).

In recent years, increased use of soybeans as a source of renewable energy in the biodiesel sector led to a rise in commodity prices and it is expected to rise further in the coming years. Therefore, producers need alternative agricultural practices with lower production costs and highest yield potential. In these alternative agricultural practices, determination of the lowest optimal number of plants and the most appropriate tillage methods that can provide fuel savings have become the priority research topics in recent years (Peterson and Higley, 2001).

Although the Mediterranean, Aegean and Southeastern Anatolia Regions of Turkey have favorable ecological conditions for soybean production; unfortunately, the cultivation area and production amounts at very low levels. In this study, in which the proper tillage and plant density will be investigated for soybean that has a growth potential as both main and double crop; it was aimed to determine effects of different tillage methods on growth and development, yield and quality of the plant by using appropriate row spacing if soybeans are grown under main and double-crop production conditions.

2. Materials And Methods

The study was carried out at University of Dicle, Faculty of Agriculture, Field Crops Department, Diyarbakir located in South East Anatolian Region of Turkey in 2013 and 2014. The region has a warm climate in summer, and the mean annual rainfall is around 450 mm, most of which fall in a major cropping season which extends from November to June. Experimental soil has a heavy built (fine textured), it is poor in terms of organic matter and phosphorus with medium lime and moderate alkaline reaction and high cation exchange capacity no salt (Anonymous 1995). The

experimental area is located at 37⁰ north latitude and 40⁰ east meridian at 670m height in city center of Diyarbakır, Turkey. The treatments were replicated three times in split-split plot based on randomized complete block design with sowing time (early and late) in the main plots, tillage methods (no-tillage, reduced tillage and conservation tillage.) in the sub-plots and plant density of 35x5 cm, 55x5 cm and 70x5 cm with 571 400, 363 600 and 285 700 plants ha⁻¹ in the sub-sub plots. The conventional tillage treatment (plow + disc harrow + harrow) and reduced tillage (cultivator + harrow) were involved before sowing. All plots were fertilized with 20-20-0 pure compound fertilizer 100 kg ha⁻¹; 10 kg of pure nitrogen prior to sowing then all plots were fertilized with 33% ammonium nitrate 100 kg ha⁻¹ at R1 growth stage. Soybean cultivar NOVA (MG III) was sown as early sowing on MAY and late sowing on June. The irrigation was performed within 9-10 days depending on need of the plants with sprinkler system. All plots were harvested from two central rows at early sowing (mid-September), late sowing (mid-October).

Data was subjected to an analysis of variance (ANOVA) using a statistical software package (JMP version 5.0.1a). Least significant difference (Tukey's HSD test) was used to compare treatment means at P=0.05.

3. Results and Discussion

According to the results of the experiment, the two-year average values showing the effects of tillage methods and plant density on the yield and agronomic characteristics of soybean grown as the main and double-crop soybean are given in Table 1. Considering the two-year average plant height values; they reached 63.84 cm in normal sowing and reached up to 61.04 cm in late sowing. Since soybean is a short day plant, vegetative growth drops down after June due to the effect of short-day conditions in the planting and eventually plant height becomes shorter in the late sowing method. Cinsoy et al. (2005) conducted a study under the main and second product conditions and stated that the height of the plant gets shorter as the sowing time is delayed. The results of this study are supported by Ansari et al. (1997), Söğüt et al. (2005) and Arıoğlu (2007). The effect of tillage on plant height was found to be significant based on a two-year average. According to two-year average values; the highest plant height was obtained from conventional tillage practices (67.11 cm), and it was followed by reduced tillage practices (62.54 cm) and the lowest values were obtained from zero-tillage practices (57.68 cm). Although our data on plant height are consistent with results of Arslan and Arıoğlu (2001), they are inconsistent with findings of some researchers such as Temperly and Borges (2006). Temperly and Borges (2006) state that taller plants (88.7 cm) can be grown by no-tillage method and there is a significant difference compared to conventional tillage method (82.5 cm). Considering two-year average values indicating that height of the plant increases as plant density is increased; no

difference was found between plant height values with 35x5 cm and 70x5 cm row spacing, they were found to be higher compared to 55x5 cm row spacing. These data were also supported by Board (2000) and Green-Tracewicz et al. (2011), stated that there is an increase in the height of soybean due to the light competition in parallel with increased number of plants per unit area. The number of lateral branches per plant obtained That normal sowing founded higher than late sowing (2.12 unit plant⁻¹). These findings in regard with the effect of sowing time on the number of lateral branches are found to be consistent with results of Söğüt et al. (2005) and Cox et al. (2008). According to the two-year average values, no difference was found between effects of tillage methods on the number of lateral branches. The number of lateral branches varied between 1.63-1.98 unit plant⁻¹. These findings in regard with the effect of tillage methods on the number of lateral branches seem similar to the findings of Sessiz et al. (2009). Considering the effects of plant density on the number of lateral branches per plant; the number of branches varied between 1.64-1.91 unit plant⁻¹, the number of lateral branches were reduced as the plant density increased. These result are similar to those obtained by other authors Öz (2002) and Cox et al. (2008). The number of fruits per plant is found to be 43.75 units/plant in normal sowing and 42.32 units/plant in late sowing, respectively. According to these data, there is a decrease in the number of fruits as the sowing time delays. This finding is consistent with results of Cox et al. (2008). The effects of tillage on the number of fruits were found to be significant and the number of fruits obtained from conventional tillage practices was found to be higher compared to the number of fruits obtained from reduced tillage and no-tillage practices (46.17 units plant⁻¹, 42.03 units plant⁻¹ and 40.90 units plant⁻¹, respectively). These results are consistent with results of Sessiz et al. (2009). Considering the effects of plant density on the number fruits per plant; according to the two-year average values, although no significant difference was seen, it varied between 41.80–44.76 units plant⁻¹ and a slight downward trend was seen in the number of fruits as the plant density increases. This is thought to be caused by smaller number of branches in plants grown with narrow row spacing. Our findings are consistent with results of Cox et al. (2008) and Daneshmand et al. (2013). According to the effect of sowing time on the weight of seed is considered to be important. Weight of seed is found to be 11.37 gr in normal sowing and 12.60 in late sowing, respectively. In this regard, it can be suggested that the weight of 100 seeds is increased as the sowing time delayed. These results are in line with findings of Pedersen and Lauer (2004a), Bastidas et al. (2008) and Daneshmand et al. (2013). The effect of tillage practices on the weight of 100 seeds is considered to be important. According to the two-year average values, the difference between tillage practices is considered to be important and the seed weight ranged between 11.37–12.56 g. The highest seed weight was obtained from conventional tillage practices (12.56 g).

However, Pedersen and Lauer (2003) and Singer et al. (2008) found different results. According to the results of their studies, the effect of plant density on the weight of 100 seeds is found to be insignificant and the seed weight ranged between 11.87-12.06 g (35x5: 12.06 g, 70x5:11.87 g). Although similar results were obtained by De Bruin and Pedersen (2008), Daneshmand et al. found different results. Considering the seed yield; according to the two-year average values, the effect of sowing time on the yield is not found to be significant the seed yield was found to be 1932.05 kg ha⁻¹ in normal sowing and 2021.06 kg ha⁻¹ in late sowing. Although Daneshmand et al. (2013) determined that the seed yield obtained from late sowing is 14.5% higher than the seed yield obtained from early sowing, Sarmah and Chaudhry (1984), Bruin and Pederson (2008b) state that late sowing has negative effects on the seed yield. The effect of tillage practices on the seed yield is found to be significant. The seed yield varied between 1881.11-2036.15 kg ha⁻¹ and no significant difference was found between reduced tillage and conventional tillage methods and the highest yield was obtained from no-tillage practices. Similar to our results, Sabo et al. (2007), Sessiz et al. (2009) and Mazzoncini et al. (2008) determined the highest yield from conventional tillage practices. However, Ozpinar and Cay (2005) and Six et al. (2002) obtained different results. The effect of plant density on the seed yield was is not found to be significant according to the two-year average values. The seed yield varied between 1951.26 - 2023.19 kg ha⁻¹. According to many studies conducted on the yield of soybean, 27% higher yield is obtained from plants with 25 cm row spacing compared to those with 76 cm row spacing (Costa et al. 1980). In addition, Board and Harville (1992); Bullock et al. (1998) reported that soybean plants with narrow row spacing use the light more efficiently compared to those with wider row spacing and therefore the yield of plants with narrow row spacing is found to be higher. Similar to our results, Lee et al. (2008) stated that the yield of soybean is reduced as plant density increased. Considering the harvest index; according to the two-year average values, the effect of harvest index is not found to be significant and it was found as 37% in normal sowing and 39% in late sowing. Although these findings about sowing time seem similar to the findings of Söğüt et al. (2005), the results of Pedersen and Lauer (2004) seem different. The harvest index results varied between 37-39% in tillage practices were found similar to results of Pedersen and Lauer (2004). Plant density has no significant effect on the harvest index, and varied between 36-39%. According to these findings, there is an inverse relationship between harvest index and plant density. Although these findings seem similar to the findings of Öz (2002), Edwards and Purcell (2005) and Rahman et al. (2013), Board (2000)

and Green-Tracewicz (2011) obtained different results. According to the two-year average values, the fat content is found to be 22.88% in late sowing, and 20.23% in normal sowing. According to these results, there is an increase in the fat content as sowing time delays. According to the earlier studies in regard with fat content, there are different results in the literature. Hu (2013) reported that sowing time has no effect on the fat content and the fat content is reduced with a delay in the sowing time (Kumar et al., 2006; Tremblay et al., 2006); Daneshmand et al. (2013) determined that the highest fat content was obtained from late sowing. The effect of tillage method on the fat content is considered to be significant. No significant difference was found between conventional tillage (22.10%) and reduced tillage (22.00%) practices and higher fat content was obtained from these practices compared to no-tillage method (20.57%). Similar results were obtained by Singer et al. (2008) and Sabo et al. (2007). The effect of plant density on the fat content is considered to be significant; the lowest fat content was obtained from 35x5 cm plant density (21.27%), while the highest fat content was obtained from 70x5 cm plant density. Although there are inconsistencies, the fat content seems to be decreased as the plant density increases. According to sowing time has no significantly effect on the protein content. The seed protein content were found as 37.68% (early sowing) and 37.27% (late sowing), Although there are no significant differences between practices in terms of protein content, there is a slight downward trend with a delay in the sowing time. Although Hu (2013) and Pedersen and Lauer (2003) indicated that the effect of sowing time on the protein content is not significant, Helms et al. (1996) reported that a delay in the sowing time reduces the protein content in the soybean, which seems to be different from our results. The effect of tillage practices on the protein content is not found to be significant according to the two-year average values. According to the two-year average values 39% protein content was obtained. Higher protein content was obtained by strip tillage (Hu, 2013) and conventional tillage (Osborne and Riedell 2006) methods compared to no-tillage method. The effect of plant density on the protein content is not found to be significant. The two-year average values were found to be very close to each other. In the studies conducted on effect of plant density on fat and protein contents, it was reported that both fat and protein contents increase with increased plant density (Weber et al. 1966). Similar results were obtained by Cober et al. (2005) and they determined that the protein content is often affected by the plant density.

Table 1. In the soybean grown as the main and second product, the effect of tillage methods and plant densities on the Plant height (cm) Lateral Branch, Fruit and Seed Numbers, 100 Seed Weight, Seed Yield, Harvest Index, Fat Content, Protein Content and Biological Yield of the product.

Practices	Plant height (cm)	Lateral Branch Number (no plant-1)	Fruit Number (no plant-1)	100 seed mass (g)	Seed yield (kg ha-1)	Harvest Index (%)	Oil content (%)	Seed Protein content (%)
Sowing Time								
Normal	63.84	2.12 A	43.75	11.37 B	1932.05	0.37	20.23 B	37.68
Late	61.04	1.51 B	42.32	12.60 A	2021.06	0.39	22.88 A	37.27
LSD (% 5)	-	0.41	-	1.04	-	-	0.73	-
Tillage								
No-Tillage	57.68 C	1.83	40.90 B	11.37 C	1881.11 B	0.38	20.57 B	37.45
Reduced Tillage	62.54 B	1.63	42.03 B	12.04 B	2015.40 A	0.39	22.00 A	37.26
Conventional Tillage	67.11 A	1.98	46.17 A	12.56 A	2036.15 A	0.37	22.10 A	37.69
LSD (% 5)	1.66	-	2.73	0.38	56.85	-	1.08	-
Plant Density								
35x5 cm	64.26 A	1.64	42.54	12.06	1951.26	0.36	21.27 B	37.55
55x5 cm	59.65 B	1.88	41.8	12.03	1958.23	0.39	21.36 B	37.54
70x5 cm	63.41 A	1.91	44.76	11.87	2023.19	0.38	22.04 A	37.33
LSD (% 5)	2.73	0.55	-	-	-	-	0.69	-
General Average	62.44	1.81	43.03	11.98	1977.29	0.37	21.55	37.47

4. Conclusions

In this study, which was conducted during years 2013 and 2014; considering the two-year average values, the sowing time has significant effects on the number of branches, 100 seed weight, seed yield, oil content. Early sowing time has significant effects on the number of branches. Late sowing time has significant effects on harvest index and fat content. On the other hand, late sowing time has significant effects on 100 seed weight and fat content.

According to the average values of two years; tillage methods have significant effects on plant height, number of fruits, 100 seed weight, seed yield and fat content. The conventional tillage method has significant effect on plant height, number of fruits, seed yield, harvest index and fat content of the plant.

Considering the effects of plant density, according to the two-year average values, the plant density has significant effects on plant height and fat content. 35x5 cm plant density has significant effects on plant height while 70x5 cm plant density has significant effects on the fat content of the plant.

According to the results of the study, which was conducted under early and double crop conditions, the seed yield was not negatively affected by late sowing time. There are significant differences between tillage methods in terms of yield. There was more yield determined in conventional tillage method according to no-tillage practices. The best plant density found as 70 x 5 cm (23.0 plant m⁻²) in terms of yield potential, and the expected decrease in the yield due to the lower number of plants can be compensated through the formation of more side branches.

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6. Literature

1- Ansari, A., Jarvar, A.D., Majeedano, H. 1997. Genetic Analysis Of Glycine Max (L) Merrill In Selected Sowing Time. Fca 1999, 52: 3

2. Anonymous 1990. GAP Proje Sahasının Meteorolojik Etüdü. Devlet Meteoroloji İşleri Genel Müdürlüğü, Ankara.

3. Anonymous 1995. Köy Hizmetleri 8. Bölge Müdürlüğü, Diyarbakır.
4. Arıoğlu, H.H. 2007. Yağ Bitkileri Yetiştirme Ve Islahı. Ders Kitapları Yayın No:A-70, Ç.Ü.Ziraat Fakültesi Ofset Atölyesi 204s., Adana.
5. Arslan, M. ve Arıoğlu, H. 2001. Çukurova Bölgesi İkinci Ürün Koşullarında Farklı Toprak İşleme Yöntemlerinin Bazı Soya (Glycine max(L) Merr.) Çeşitlerinin Büyüme ve Gelişmelerine Etkilerinin Belirlenmesi. Türkiye 4. Tarla Bitkileri Kongresi, 17-21 Eylül 2001, Tekirdağ. Cilt: II. S,73.
6. Bastidas, A.M., T.D. Setiyono, A. Dobermann, K.G. Cassman, R.W. Elmore, G.L. Graef and J.E. Specht, 2008. Soybean sowing date: The vegetative, reproductive and agronomic impacts. Crop Science. 48: 727-740.
7. Biamah E.K. 2005. Coping with drought: options for soil and water management in semi-arid Kenya. Wageningen University, 137.
8. Board JE, Harville BG (1992) Explanations for greater light interception in narrow-row vs wide row soybean. Crop Sci 32: 198–202.
9. Board, J.E. 2000. Light Interception Efficiency And Light Quality Effect Yield Compensation Of Soybean At Low Plant Populations. Crop Sci. 40:1285- 1294.
10. Bruce, R.R., S.R. Wilkinson, and G.W. Langdale. 1987. Legume effects on soil erosion and productivity, 127-138. In J.F. Power(ed.) Role of legumes in conservation tillage systems. Soil Conserv. Soc. Am., Ankeny, IA.
11. Bruin, J., Pederson, P. 2008 B. Effect Of Row Spacing And Seeding Rate On Soybean Yield. Agronomy Journal 100:704-710.
12. Bruin, J., Pederson, P. 2008. Soybean Seed Yield Response To Planting Date And Seeding Rate In The Upper Midwest. Agronomy Journal 100:696- 703
13. Bullock, D, Khan, S., Rayburn, A. 1998. Soybean Yield Responce To Narrow Rows Is Largely Due To Enhanced Early Growth. Crop Science, 38 (4): 1011-1016.
14. Cinsoy, A. S., Tuğay, E., Atikyılmaz, N. ve Eşme, S. 2005. Ana Ve İkinci Ürün Soya Tarımında Verim Ve Bazı Özellikler Üzerine Bir Araştırma. Türkiye Vı. Tarla Bitkileri Kongresi, Cilt 1, 5-9 Eylül Antalya, 392-402.
15. Cober, E.R., Morrison, M.J., Ma, B., Butler, G. 2005. Genetic improvement rates of short season soybean increase with plant population. Crop Science. 45: 1029-1034.
16. Costa, J.A., Oplinger, E.S., Pendleton, J.W. 1980. Response Of Soybean Cultivars To Planting Patterns. Agronomy Journal., 72: 1.

17. Cox, J.W., Shields, E., Cherney, J. H. 2008. Planting Date And Seed Treatment Effect On Soybean In The Northeastern United States *Agronomy Journal* 100:1662-1665.
18. Crutchfield, D.A., G.A. Wicks, and O.C. Burnside. 1985. Effect of winter wheat straw mulch level on weed control. *WeedSci.* 34:110-114.
19. Daneshmand, A., Yazdanpanah, M., Koochaksaraee, H.N.K., Yasari, E. 2013. Investigation of the Effects of Plant Density and Planting Date on the Quantitative and Qualitative Yields of Two Advanced Soybean Lines. *International Journal of Biology*; Vol. 5, No. 3; 2013.
20. De Bruin, J., And Pedersen, P. 2008a. Soybean Seed Yield Response To Planting Date And Seeding Rate In The Upper Midwest. *Agron. J.* 100:696-703.
21. Dick, W.A., D.M. Van Doren, Jr., G.B. Triplett, Jr., and J.E. Henry. 1987. Influence of long-term tillage and rotation combinations on crop yields and selected soil parameters: I. Results obtained for a Mollic Ochraqual soil (Res. Bull. 1180). Ohio State Univ. Res. And Dev. Ctr., Wooster, OH.
22. Edwards, J., Purcell, L. 2005. Soybean Yield And Biomass Responses To Increasing Plant Population Among Diverse Maturity Groups. *Crop Science Society Of America* 45:1770-1777.
23. Erenstein, O. (2003). Smallholder conservation farming in the tropics and sub-tropics: a guide to the development and dissemination of mulching with crop residues and cover crops. *Agriculture, Ecosystems and Environment*, 100:17-37.
24. Greb, B.W. 1966. Effect of surface-applied wheat straw on soil water losses by solar distillation. *SoilSci. Soc. Am. Proc.* 30:786-788.
25. Green-Tracewicz, E., Page, E.R., And Swanton, C.J.. 2011. Shade Avoidance In Soybean Reduces Branching And Increases Plant-To-Plant Variability In Biomass And Yield Per Plant. *Weed Science.* 59:43-49.
26. Helms, T.C., E. Deckard, R.J. Goos, and J.W. Enz. 1996. Soil moisture, temperature, and drying influence on soybean emergence. *Agron. J.* 88:662-667.
27. Hu, M. 2013. Effects of late planting dates, maturity groups and management systems on growth, development and yield of soybean in South Carolina. All Thesis. Paper 1593.
28. Kumar, V., A. Rani, V. Pandey, P. Mande, G.S. Chauhan. 2006. Compositional traits of soybean seeds as influenced by planting date in India. *Exp. Agric.* 42:19-28.
29. Lee, C.D., Eglh, D.B., Tekrony, D.M. 2008. Soybean Response To Plant Population At Early And Late Planting Dates In The Mid-South. *Agronomy Journal.* Vol.100 Is.4. 971-976.
30. Mazzoncini, M., Di Bene, C., Coli, A., Antichi, D., Petri, M. and Bonari, E. (2008). Rainfed wheat and soybean productivity in a long-term tillage experiment in Central Italy. *Agronomy* 100: 1418-1429.
31. Osborne, S.L. and Riedell, W.E. 2006. Starter nitrogen fertilizer impact on soybean yield and quality in the Northern Great Plains. *Agron J.* 98: 1569-1574.
32. Ozpinar, S. and Cay, A. (2005). Effects of minimum and conventional tillage systems on soil properties and yield of winter wheat (*Triticum aestivum* L.) in clay-loam in the Canakkale region. *Turkish Journal of Agriculture and Forestry* 29(1): 9-18.
33. Öz, M. 2002. Bursa Mustafa Kemalpaşa Ekolojik Koşullarında Farklı Bitki Populasyonları Ve Azot Dozlarının Soyannın Verim Ve Verim Unsurlarına Etkisi. Uludağ Üniversitesi Ziraat Fakültesi Dergisi, 16: 165-177, Bursa.
34. Palmer, J.H. and C. Privette. 1992. Guidelines for drilling soybeans. Soybean Leaflet no.9. Clemson Univ. Coop. Ext. Serv.
35. Pedersen P, Lauer JG (2004) Soybean growth and development in various management systems and planting dates. *Crop Sci* 44: 508-515.
36. Pedersen, P., Lauer, J.G. 2003. Corn and soybean response to rotation sequence, row spacing, and tillage system. *Agron. J.* 95: 965-971.
37. Pedersen, P., Lauer, J.G. 2004a. Response Of Soybean Yield Components To Management System And Planting Date. *Argon. J.* 96:1372-1381
38. Peterson, R.K.D., Higley, L.G. 2001. Biotic stress and yield loss 2001. 83-98. CRC Press Boca Raton, FL. <https://books.google.com.tr/books?id>.
39. Putnam, A.R., J. DeFrank, and J.P. Barnes. 1983. Exploitation of allelopathy for control in annual and perennial cropping system. *J. Chem. Ecol.* 9:1001-1010.
40. Rahman, M.M., Rahman, M.M., Hossain, M.M. 2013. Effect of Row Spacing and Cultivator on The Growth and Seed Yield of Soybean (*Glycine max* [L.] Merrill) in Kharif-II Season. *The Agriculturists* 11(1):33-38
41. Sabo, M., Jug, D., Jug, I. 2007. Effect of Reduced Tillage on Quality Traits of Soybean. *Acta Agronomica*, 55(1): 83-88
42. Sanford, J.O., Eddleman, S.R. Spurlock, and J.E. Hariston. 1986. Evaluating ten cropping alternatives in the Midsouth. *Agron. J.* 78:875-880.
43. Sarmah, S.C., Chaudhry, A.K. 1984. Effect Of Varieties And Date Of Sowing On The Growth And Yield Soybean. *Soybean Genetic Newsletter.* Vol.11 S.24-26
44. Sarmah, S.C., Kalita, M.M., Kakati, N.N., 1984. Effect Of Dates Of Planting On Five Soybean Varieties. *Soybean Genetic Newsletter.* Vol.11 April 1984.S. 34-3745. Sessiz, A., Söğüt, T., Temiz, M.G., Gürsoy, S. 2009. Yield and Quality of Soybean (*Glycine max*.L.) Sown As Double Crop Under Conservation and Conventional Tillage System in Turkey. *Res.on Crops*, 10(3): 558-56546. Sessiz, A. 2010. Doğrudan Ekim Yönteminin Ekonomik ve Çevresel Etkileri ile GAP Bölgesindeki Uygulamaları. *Tarımsal Mekanizasyon 26. Ulusal Kongresi*, S:228-234, 22-23 Eylül, Hatay
47. Singh, K. P., Sinha, T.K., Rai, R.N. 1985. Effect Of Dates Of Sowing And Spacing On Grain Yield Of Soybean (*Glycine Max.*). *Seed And Farms.* Vol:11 (8) S. 32-33
48. Singer, J.W., Logsdon, S.D., Meek, D.W. 2008. Soybean growth and seed yield response to tillage and compost. *Agronomy Journal* 100: 1039-1046.
49. Six, J., Feller, C., Denef, K., Ogle, S. M., de Moraes, J. C. and Albrecht, A. (2002). Soil organic matter, biota and aggregation in temperate and tropical soils – effects of no-tillage. *Agronomie* 22: 755-775.
50. Söğüt, T., Öztürk, F., Temiz, M.G. 2005. Farklı Olgunlaşma Grubuna Giren Bazı Soya Çeşitlerinin Ana Ve İkinci Ürün Koşullarındaki Performanslarının Karşılaştırılması. *Türkiye Vı. Tarla Bitkileri Kongresi Cilt I*, 5-9 Eylül Antalya 393-398.
51. Temperly, R.J., Borges, R. 2006. Tillage and crop rotation impact on soybean grain yield and composition. *Agron. J.* 98:999-1004.
52. Tremblay, G.J., J.M. Beausoleil, P. Fillion, and M. Saulnier. 2006. Response of three soybean cultivars to seeding date. *Can. J. Plant Sci.* 86:1071-1078.
53. Weber, C.R., R.H. Shibles, and D.E. Byth. 1966. Effect of plant population on soybean development and production. *Agron. J.* 58:99-102.
54. Wilhelm, W.W., H. Bouzerzour, And J.F. Power. 1989. Soil Disturbance-Residue Management Effect On Winter Wheat Growth And Yield. *Agron. J.* 81:581-588.