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REVIEW PAPER

Conservation tillage and nitrogen fertilizer: a review of corn growth, yield and weed management

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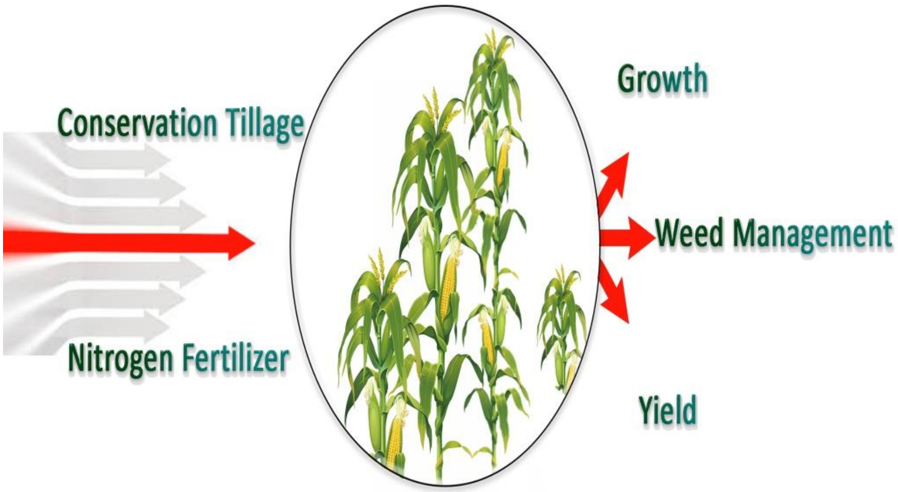
Highlights

- Corn (*Zea mays*) is one of the most critical crops with a vital role in industry, human and poultry nutrition, and animal feed.
- Nitrogen fertilizer and conservation tillage (CT) can be adopted as practical approaches in increasing corn yield and being more economic.
- The growth and development of corn are considerably affected by nitrogen; so, optimal application of nitrogen fertilizers is of high importance.
- Weed flora is affected by tillage and nitrogen fertilizer in terms of density and species diversity of weeds in fields.

Graphical Abstract



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Abstract

Corn is cultivated as a strategic crop in most parts of the world to meet animal and human feed needs. In this study, there is an attitude that nitrogen fertilizer and conservation tillage (CT) can be useful in increasing and improving the desired yield of corn and reducing economic costs. On the other hand, the development of tillage systems and farmers' acceptance of them requires a serious study of these factors on the growth and yield indicators of corn and weed management. This study showed that the growth and development of corn are very much affected by nitrogen; therefore, nitrogen fertilizer's optimal use is essential. The quantitative and qualitative yield of corn is affected by the type of tillage system. CT has shown more promising results over several consecutive years. Weed flora is affected by tillage and nitrogen fertilizer in terms of density and species diversity of weeds in fields. Therefore, proper management is necessary to maintain all aspects of environmental agriculture to use the type of tillage systems and the optimal use of nitrogen fertilizer to control weeds. Therefore, this study was intended to guide further studies in the future for further investigation. However, little information was available on the effects of CT and nitrogen on corn weeds. However, an attempt has been made to examine some of the critical factors more prominently that significantly affect maize's agro-ecophysiological properties.

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1. Introduction

Corn (*Zea mays*) is one of the most critical crops after wheat and rice, which is essential in industry, human nutrition, animal feed and poultry nutrition. Corn is widely cultivated in different parts of Iran. In most parts of Iran, corn is grown as a second crop after autumn grains. Farmers in these areas usually burn crop residues to prepare the soil bed faster. Today, tillage is an integral part of industrial agriculture. The purpose of tillage is to create a suitable environment for improving seed germination, root system development, weed control, soil improvement and soil stabilization for complete seed contact with the soil, burying crop residues, mixing fertilizers and pesticides with soil and disrupting pipes. Capillaries in the soil reduce evaporation, especially in arid and semi-arid environments. One of the essential strategies for optimal soil management in agriculture is Conservation tillage. CT operations, which are accompanied by the preservation or addition of crop residues, have an influential role in increasing soil fertility (Boomsma et al., 2009; Cardina et al., 1991; Hajabbasi and Hemmat, 2000).

The primary purpose of implementing CT is to maintain appropriate amounts of crop residues in the soil surface to control water and soil erosion of fields, reduce energy consumption and protect water and soil resources. Reduced tillage (RT), no-tillage (NT) and mulch tillage, which is used to enhance yield stability, are other CT methods (Hobbs et al., 2008). CT includes the three basic principles of reducing soil disturbance, crop rotation, and continuous land cover with crop residues. In CT, at least 30% of the crop residue must remain on the soil surface. Increasing plant water availability is often the first significant effect of NT cultivation, which reduces evaporation and at least soil turbidity, reduces evaporation and increases permeability (Baker and Saxton, 2007). Plowing operations affect the soil's physical properties, the storage capacity of water and aggregates (Mathew et al., 2012). Due to crop residues, CT reduces erosion, controls runoff and surface loam, permeability and improves soil moisture content. CT has been reported to increase moisture content and increase soil biological activity (Carlson and Hill, 1985; Habtegebrial et al., 2007; Hall et al., 1992).

There are other reports regarding CT's impact in different conditions, including positive impact, negative impact, and ineffectiveness (Halvorson et al., 2006; Archer and Reicosky, 2009). However, this tillage method's effectiveness depends on the type of crop, climatic conditions, Type of CT implements and soil type. Many studies indicate that conventional tillage increases the population of weed species, while the results of other studies show a higher population of weed species in CT and RT methods (Smith, 2006). Nitrogen is one of the most consumed elements that play an essential role in the growth and physiology of crops, especially corn. Thus, a significant amount of nitrogen fertilizers are used to produce the crop. Balanced use of chemical fertilizers, especially nitrogen fertilizers, is necessary to achieve the optimal yield and, at the same time, reduce environmental risks (Karami et al., 2018). The high need for nutrients in corn has led to increased production costs and environmental hazards, and excessive chemical inputs consumption. Therefore, nutrition management, especially nitrogen fertilizer, is one of the most critical factors for corn growth and corn production. Nitrogen in the soil is wasted for various reasons, such as weed competition with crops and leaching (Lindquist et al., 2010; Cussans, 1975).

On the other hand, tillage practices significantly affect nitrogen transport and access (Silgram and Shepherd, 1999). The use of nitrogen fertilizer, although it increases crop production, may have harmful environmental effects. Therefore, the mechanism of nitrogen uptake and uptake in competing plants can be considered as one of the weed management strategies and reduction of resource wastage. Researchers have reported that some weeds absorb chemical fertilizers, especially nitrogen, more rapidly and relatively more than crops, which reduces the amount of fertilizer absorbed by the crop (Barker et al., 2006; Di Tomaso, 1995). Therefore, to increase the efficiency and productivity of fertilizer consumption and reduce crop production costs, it is necessary to control and manage weeds in the field.

On the other hand, Di Tomaso (1995) reported that weeds absorb higher concentrations of high-consumption elements, including nitrogen than crops, which are called luxury consumers. Therefore, it reduces the level of nutrients in the soil more rapidly and thus reduces the yield of crops. In recent decades, increasing population growth and increasing human expectations have led to more severe and unfavorable use of arable land.

Therefore, this paper aims to highlight CT and nitrogen fertilizer's role on agroecophysiological properties of maize and weed management (Di Tomaso, 1995).

2. The effect of Conservation tillage on corn growth and yield

The impact of tillage on corn yield is very variable. As reported in some studies, no difference in corn yield was observed between CT and conventional tillage (Shirani et al., 2002; Singer et al., 2004). A decrease in maize yield in CT has been reported compared to conventional tillage (Afzalinia and Zabihi, 2014). However, many reports have been presented on the positive impact and improvement of soil properties and the yield of CT on maize (Lamptey et al., 2018; Issaka et al., 2019). In this section, we briefly examine the possible reasons for the increase in the yield of maize under CT compared to conventional tillage. Crop residue management is one of the most important issues in CT for corn production. Mixing 25 to 50% of wheat residues with soil in CT has been reported to improve corn yield (Bahrani et al., 2007). Conventional tillage systems reduce soil organic matter, enzymatic activity and ultimately reduce soil quality (Bayer et al., 2001; Mrabet, 2002). The use of CT system, especially no plowing, preserves straw on the soil, stabilizes soil temperature, moisture, improves soil granulation stability, increases soil organic matter and reduces soil erosion (Dabney et al., 2004).

Plant debris on the soil surface reduces the runoff rate and its destructive effects on the soil. Proper residue management in arid and semi-arid regions where water and soil resources are protected is essential and plays a major role in increasing crop production (Kumar and Goh, 1999). In CT, part of the previous crop plant remains on the soil surface. In this case, it reduces soil erosion, increases soil permeability, and improves physical properties and soil biology (Celik et al., 2011). The results of a 10-year study of CT on wheat and corn showed a 10% increase in crop yield and a 20% reduction in operating costs. Also, conservation plowing compared to conventional plowing improved water use efficiency by up to 11%. And reduce soil water erosion by 52% (Jin et al., 2007). In the study of the effect of conservation and conventional tillage systems on corn and soybean yield, it was stated that higher grain yield in conventional tillage was due to better seed contact with soil and better germination in the first year.

However, in the following years, there was an improvement in grain yield in CT due to less soil compaction and density and its effect on optimal seed germination (Hussain et al., 1999). In an experiment of different tillage treatments, the usual tillage system without tillage for three years was performed on corn yield. This study showed that crop yield in the first year in the system NT decreased by 30%, but in the second and third years, there was no difference between conventional and RT systems (Edwards et al., 1988).

The amount of nutrients that return to the soil through the storage of residues is significant. For example, the amount of nitrogen added to agricultural soils annually through crop residues is estimated at 25-100 million tons (Kumar and Goh, 1999). Storing residues at the soil surface often increases crop yield. However, in some cases, due to various reasons such as lack of appropriate tools and insufficient knowledge of farmers about residue management, reduced soil aeration and cold and wet due to leaving large amounts of residues and problems caused by the spread of pests and diseases and control of pests Also, reducing the availability of nutrients for the next crop reduces the yield of the crop. So indicates that waste management systems are not suitable for all environmental conditions. Therefore, efforts to establish a link between residue management systems' effects on crop yield and factors limiting production continue (Kumar and Goh, 1999).

In many countries, crop residues are often returned to the soil after harvest to improve the soil's physical, chemical, and biological properties. In most corn production areas in the south and west of Iran, corn is considered the second crop after wheat harvest. Farmers in these areas remove wheat crops from the ground after harvest to sell. So causes significant amounts of nutrients in the form of plant debris removed from the soil after each growing season. On the other hand, reports indicate that with the release of large volumes of plant materials, energy sources and nutrients, especially organic matter in the soil, are gradually depleted (Sadeghi and Bahrani, 2009). Plant residues can maintain soil fertility, maintain soil water, and increase soil organic matter. Also, stimulate microbial activity, reduce evaporation, reduce temperature fluctuations, increase soil granulation, and improve physical properties by providing or replacing nutrients in the soil. In the other study, was show that subsoiling crop residues of wheat over time increased corn yield in wheat rotation. This researcher reported that the increase in corn yield in this rotation is due to increased soil nutrients and soil organic matter and the improvement of the root development environment. Researchers have reported that mixing residues in corn and wheat rotations after 6 years increases crop yield and increases soil organic carbon content.

Some researchers have reported that plant yield increases under conditions of CT due to maintaining soil moisture during the growing season and reducing evaporation from the soil surface (Ram et al., 2012). Tillage directly affects the crushing and distribution of crop residues in the soil and indirectly affects environmental conditions which can affect the decomposition of crop residues, seed germination and grain removal from the soil surface. There is still a debate between the use of NT methods, RT and conventional tillage because there is no solution for all methods (Guérif et al., 2001). Various studies have shown the effect of CT on the growth characteristics and yield of maize (Table 1).

Table 1. Effect of CT on agroecophysiological characteristics of maize.

Tillage treatments	Effects	References
Disk, chisel packer and CT	The results showed that conservation systems significantly affect growth, yield, yield components, soil phosphorus, and potassium. Grain yield was higher in the Chisel Packer method than in the CT method.	Gorouh et al., (2019)
Conventional tillage, RT and CT	RT with 60% of crop residues had the most significant effect on grain nitrogen uptake, nitrogen uptake in biomass and nitrogen harvest index.	Akbari et al., (2019)
Conventional tillage, RT, CT	Tillage had a significant effect on carotenoids, leaf area index and grain phosphorus. But it had no significant effect on chlorophyll and soluble sugars.	Sestili et al., (2019)
Conventional tillage, CT and direct	The use of CT and direct sowing in pea-corn rotation can replace conventional tillage. Direct cultivation increased soil bioactivity. Stem dry and wet weight, cob dry weight and forage fresh weight were not significantly different between conventional and CT treatments.	Mousavi Boogar, (2018)
Cultivator and CT	Tillage between planting lines reduced weed density and dry weight. Tillage between planting rows increased corn yield by 17% compared to NT.	Vakali et al., (2011)

3. Effect of nitrogen on agro-physiological properties of corn

Nitrogen is one of the essential elements for the growth and yield of plants (Fathi and Kardoni, 2020), including corn. Nitrogen is considered a limiting factor for crop production in arid and semi-arid regions. However, the lack of nitrogen required by the plant impairs the growth and yield of corn. Nitrogen is one of the primary constituents of organic compounds such as amino acids, proteins and nucleic acids. Its deficiency delays phenological development in both vegetative and reproductive stages. Also reduces the rate of leaf expansion and leaf area durability in plants (El-Sayed et al., 2000). Nitrogen and being present as a protein in the plant is the main constituent of chlorophyll in the plant. Chlorophyll content plays an important role in determining the rate of photosynthesis and dry matter production. Nitrogen deficiency stimulates competition for the transfer of this element in corn. Nitrogen deficiency, through a decrease in crop growth rate, impairs the timely and complete formation of reproductive organs, delays plant phenology (lower durability, LAI), lower harvest index, and ultimately lower grain yield in maize (O'Neill et al., 2004; Ding et al., 2005).

Nitrogen deficiency slows down the rate of pure assimilation (Echarte et al., 2008) and accelerates leaf ageing (Ding et al., 2005). The researchers reported that with increasing nitrogen fertilizer from 50 to 200 kg N/ha, the plant's growth rate increased, and the lowest plant growth rate was obtained in the absence of nitrogen fertilizer (Kogbe and Adediran, 2003). The response of maize to nitrogen consumption is complex due to its associated morphophysiological and phenological mechanisms. Corn is a dual-purpose plant (seeds, forage) that requires higher nitrogen consumption than other crops to produce. Therefore, nitrogen deficiency affects corn. Numerous experiments have clearly shown the major effect of nitrogen stress on reducing corn grain yield (Raja, 2001; Khaliq et al., 2009).

Other studies have shown that along with a decrease in nitrogen, the weight of leaves, stems and reproductive parts such as cob and seed are reduced, which reduces the dry matter yield of the whole plant. Nitrogen seems to maintain leaf surface survival, with increasing leaf surface durability, the duration and rate of leaf photosynthesis also increase, and as a result, the plant can produce more dry matter (Zebarth and Sheard, 1992). The researchers reported that by consuming 25 and 50% more nitrogen than recommended, Ecophysiological properties such as leaf area index, photosynthetically active radiation absorbed, and corn radiation efficiency increased significantly (Kaur et al., 2012). Other researchers stated that the leaf area index of corn increased sharply with increasing nitrogen so that the maximum and minimum leaf area index were observed with the use of 150 kg of nitrogen and no nitrogen fertilizer application (Nadeem et al., 2009). An increase in leaf area index of maize has also been reported with the increasing application of nitrogen fertilizer. Nitrogen perpetuates leaf area, which increases the duration and rate of leaf photosynthesis, and the plant can produce more dry matter (Zebarth and Sheard, 1992).

The plant properties of corn can be strongly influenced by the amount of nitrogen available. Many researchers have reported increased grain yield with sufficient nitrogen (Sangoi et al., 2007). However, the proper response of maize to the application of nitrogen, which leads to higher yields by affecting the phenological and physiological characteristics, is one of the reasons for the excessive use of nitrogen fertilizers by farmers. Although nitrogen plays an essential role in achieving high quantitative and qualitative yields in crops, it is easily leached from the soil and causes groundwater pollution. About 40 to 60% of the added nitrogen fertilizer is removed from the soil and this amount increases with increasing fertilizer application, which results in increased fertilizer residues in the soil and intensifies water pollution (Timsina et al., 2001).

Therefore, it is important to develop cropping systems that use nitrogen effectively to minimize nitrate pollution, nitrogen losses, reduce consumption costs, and ultimately increase nitrogen efficiency. Nitrogen, as the most important element required for plant growth and development, plays an important role in photosynthetic activities and ultimately plant function (Kaur al., 2012; Antonietta et al., 2016). Which is now intensively used in modern agricultural systems to increase crop yield. Optimal use of nitrogen plays an important role in increasing the productivity and usefulness of crop ecosystems as well as reducing the risks of nitrogen pollution effects on the environment. Direct fertilizer loss occurs when this mobile element exceeds the required Crops are used inappropriately at the wrong time (Dawson et al., 2008). Optimal application of nitrogen fertilizer and non-application of excess fertilizer, which does not change the increase in plant yield, can not only reduce the incidence of environmental pollution but also improve plant growth conditions and increase yield (Ozer, 2003; Gastal and Lemaire, 2002).

According to the results of these studies, it seems that the optimal application of nitrogen fertilizer has a positive effect on the growth and yield indices of maize. On the other hand, the results of researchers' studies have shown that despite the excessive increase in input consumption in the agricultural sector, especially the increase in the use of nitrogen fertilizers, crop yields have not increased in the same proportion. Various studies have shown the effect of fertilizer and nitrogen content on different characteristics of corn (Table 2).

Table 2. Effect of different amounts of nitrogen fertilizer on various characteristics of corn.

Different levels of nitrogen	Nitrogen source	Effects	Reference
0, 75, 150, 225, and 300 Kg/ha	Urea	Increased nitrogen consumption increased the quantitative and qualitative characteristics of corn. Also, at a 225 and 300 kg N/ha rate, it showed the best optimal growth and improvement of maize characteristics.	Agrama et al., (1999)
50, 100, 200, and 300 Kg of nitrogen per hectare	Urea	To improve the characteristics, corn cultivated during the summer requires a higher application rate of 300 kg N / ha to achieve the highest yield. In comparison, corn grown during the fall requires 50 kg/ha/ha.	Altarugio et al., (2019)
0, 60, and 80 kg nitrogen (N / fed.)	Ammonium nitrate (33.5% nitrogen)	The results showed that the amount of nitrogen fertilizer significantly affected ear length, number of grains per ear, 100-grain weight and grain yield. Nitrogen consumption of 80 kg for all studied traits had the most significant effect on the studied traits.	Hassanein et al., (2019)
0, 30, 90, 150, and 180 kg N / ha in 2010 and zero, 100, 150, and 200 kg N / ha in 2011	Ammonium calcium nitrate (27% nitrogen) (ammonium nitrogen 34%) Ammonium sulfate (24% sulfur, 21% nitrogen and 46% urea)	Maize showed the highest optimal growth compared to other surfaces with 210 kg N / ha. In 2010, both biological and grain yields increased to 150 kg/ha/ha, but further increases in nitrogen did not significantly increase biomass and yield. The highest harvest index of both experiments was 150 and 180 kg N / ha, and the lowest was obtained at 30 kg N / ha.	Biswas and Ma (2016)
0, 23, 46, and 92 kg of nitrogen per hectare	Urea	Corn showed optimal growth at 92 kg N / ha compared to other levels. The results showed that the amount of nitrogen fertilizer significantly affects growth and yield.	Wang et al., (2018)
75, 150, and 225 kg N / ha	Urea	Improved maize's morphological growth was achieved at 225 kg N/ha because nitrogen level increased from 75 to 225 kg/ha, grain yield also increased by 38.2%. The use of 225 kg N / ha caused an increase in LAI, which was 16.3% compared to the application of 75 kg N / ha.	Moosavi (2012)
45, 90, 135, and 180 kg N / ha	Urea	Application of 135 kg/ha nitrogen fertilizer had the most significant effect on grain yield, chlorophyll a, b and protein percentage and protein yield. The highest crop yield and nitrogen consumption were 45 kg. In general, nitrogen fertilizer had a significant effect on physiological traits.	Hocking and Stapper, (2001)
80, 160 and 240 kg of pure nitrogen	Urea	The results showed that consumption of 240 kg of pure nitrogen had the most significant effect on the number of seeds per row, number of rows per ear, 1000-seed weight, number of seeds per ear, biological yield, grain yield, harvest index and protein yield.	Etzold et al., (2020)

4. Weed management

Understanding the underlying mechanisms and timing of nutrient uptake into weeds and crops can lead to fertilization strategies that reduce crop weed and increase crop competitiveness (Di Tomaso, 1995). Weeds are one of the most critical constraints on optimal crop production, and the most successful of them play the most significant role in reducing crop production. This success may occur by rapidly establishing weed colonies (which are somewhat challenging to remove) in plowed areas and reducing crop yields. Weeds compete with other crops for the nutrients they need to grow. Chenopodium album competition significantly reduced corn grain yield; and the effect of emergence time on corn yield was more than its density (Anderson et al., 1998). Lack of weed weeding also significantly reduced grain yield compared to weed weeding. Weed interference affected maize leaf area by affecting leaf development, the number of leaves developed, and older leaves (Hernández et al., 2002).

Among the problems facing the cultivation and production of corn is the presence of weeds in this valuable crop. The most critical broadleaf weeds in Iranian cornfields are *Amaranthus retroflexus*, *Sorghum halepense, Echinochloa crus-galli, Chenopodium album* and *Convolvulus arvensis*. Narrow-leaved weeds include *Echinochloa crus-galli, Cyperus rotundus and Sorghum halepense*. Weed damage in Iranian grain fields is 25% per year (Shirani et al., 2002). The growth and yield of the corn plant are significantly reduced due to competition with weeds. As weeds can reduce corn yield by 25 to 72%, weed control in cornfields, especially in the early stages of growth, is significant to compete with water, food and light (Johnson and Harvestad, 2002). Weed control should, in principle, have the lowest cost, in other words, by using the principles of crop management to reduce the use of herbicides to protect the environment. The essential crop management methods to weeds can be diversity in crop rotation, increasing density, using narrower cultivation rows, the competitiveness of crop cultivars, application of strip fertilizer, cover crops and use of green manure. It can be mentioned that increasing the ability of crops to overcome weeds (Lemerle et al., 2001). One of the limiting factors of production in agricultural fields is weed interference, which leads to reduced yields. Increased plant population density due to weeds next to crops causes water, light, and nutrients, leading to reduced products. Decreased crop yield due to weed interference varies considerably depending on the weed, the type of crop and the growing conditions. If the field is severely infested with weeds throughout the growing season, it may lead to the corn field's destruction (Azeem et al., 2015). Therefore, due to weeds' reduction of yield, their control is an essential and integral part of agricultural operations.

4. 1. Weed Interference and Competition

The primary goal of weed management in production systems is to reduce the negative effects of weeds on crops. One quick way to control weeds is to use herbicides. Still, increased weed resistance to herbicides, biological health, and environmental damage to herbicides such as surface water pollution and damage to other living organisms are some of the concerns. On the increasing use of herbicides in production systems (D'Emden and Liewellyn, 2006). In the early stages of growth, which causes the natural superiority of weeds over corn plants, weed control in corn is of particular importance (Lorzadeh, 2011). Competitive balance between weeds and crops is affected by crop density, and increasing crop density reduces weed growth on the farm and significantly reduces competitive yield loss (Van Acker et al., 1993). Despite global weed control, weed interference leads to a 12.8% reduction in yield, while in the absence of weed control, corn yield decreases by 29.2% (Ghanizadeh et al., 2010). According to research, when the corn plant reaches a height of 50 cm, weeds will no longer affect this plant, but in the early stages of growth is very sensitive to weed competition (Larbi et al., 2013). With the germination of corn, a critical period of weed control begins. Researchers have reported that herbicides should be applied two weeks after corn sowing to keep the field free of weeds for 4 or 5 weeks until the critical period of maize has passed (Uremis et al., 2009). Determining the appropriate period of weed control is essential to reduce the cost of widespread use of weed control methods. Past studies have shown that the onset and end of the critical period of weed control in maize are strongly dependent on the period of weed emergence, density and competitive power (Ghanizadeh et al., 2010). To determine the critical period of weed control, one must first identify the stage at which crop growth, crop cover area, and rooting depth are low. Therefore, limiting weeds at this stage can improve plant growth. Awareness and recognition of the critical period of weed control promote the use of weed management methods, including farming methods, which reduce the number of times the use of herbicides. The critical period of weed control for each region should be determined depending on the climatic conditions and the type of weeds. Some researchers have stated that the composition of weeds in the region, the extent of weed infestation and the environmental conditions of the critical period of weed competition with the crop differ according to the condition of the crop (Mahmoudi and Rahimi, 2009). The critical period of weed control is the time interval during the crop growth period that must be maintained free of weeds in order to prevent yield loss. The critical period of competition in corn is the first two to three weeks of growth. The researchers reported the six-leaf stage and the end of the 9- to 13-leaf stage as the beginning of a critical period of maize weed control. Weeds compete with crops for growing space, absorbing light, water and nutrients. Therefore, sustainable and proper weed management seeks an easy and effective solution to control weeds and reduce the use of herbicides. The combined use of different methods of weed control is emphasized in the integrated management of weeds. One of the first steps in the effective and successful design of integrated weed management is to identify the critical period of weed control (Wu et al., 2011).

4.2. The relationship between weeds and nitrogen application

One of the important strategies in sustainable agriculture is weed management. Corn needs more than ten nutrients for its growth and development, among which nitrogen is of special importance, and its deficiency is a limiting factor for growth. Therefore, to reduce this limitation and improve the growth and development conditions, the need to use it as a chemical fertilizer seems necessary. Weed management is critical in corn fields because if weeds are not controlled, reports have shown that corn yield is reduced by more than 80% (Baghestani et al., 2007). Competition over food sources, especially nitrogen, is one of the problems associated with reduced corn yield in the presence of weeds. Maize competes with weeds for nitrogen uptake and affects the growth and yield of maize. As a result, optimal management and use of nitrogen fertilizer may contribute to maize plants' competition against weeds (Lemerle et al., 2001). Weeds are among the consumers of soil nutrients, that the use of chemical fertilizers may increase their growth and development more than crops. However, more application of nitrogen fertilizer can change crops and weeds' competitiveness, which better response of weeds to nitrogen fertilizer leads to increased interference and weed competitiveness against crops (Barker et al., 2006; Harbur and Owen, 2006).

The researchers reported that increasing nitrogen fertilizer increases the leaf area index (LAI) of corn in the absence of weeds. Still, in the weed Pennisetum glaucum, the leaf area index and thus corn yield decrease at all nitrogen fertilizer levels. Yield loss was greater in higher amounts of nitrogen fertilizer in the presence of weeds (Cathcart and Swanton, 2003). It has also been reported that as a result of the effect of *Amaranthus retroflexus* interference in the cornfield, by doubling and tripling the density of this weed, corn grain yield was 23 and 39% lower than the control treatment, respectively (Fisk et al., 2001). However, corn is not a weak competitor against weeds, but it needs to control weeds to improve yield, and if weeds are not controlled in the cornfield, yield may decrease depending on the density and type of weeds (Wilhelm and Wortmann, 2004). Of all the nutrients, nitrogen is the most common concern for weed competition. Knowing the amount of soil nitrogen and the competitive relationship between the crop and weeds can greatly help the proper application of nitrogen fertilizers and ultimately improve the crop's competitive characteristics compared to weeds. Almost all weeds have a luxury consumption to use more nutrients than needed and use more fertilizers from crops. The presence of weeds can affect the yield components of corn (Williams, 2006). The researchers reported that the number of grains per ear was the most sensitive corn yield to weed and nitrogen fertilizer interference.

Increasing weed interference time reduced the number of seeds per ear (Evans et al., 2003). Among the traits associated with corn cob, the number of seeds per cob row has been reported to decrease significantly under the influence of Ambrosia trifida weed interference (Williams, 2006). In a 2-year study on the effect of nitrogen levels on the competitiveness of corn and Abutilon theophrasti, the results showed that in both corn and Abutilon theophrasti, nitrogen allocation to dry matter production increased when nitrogen levels decreased. However, it was noteworthy that in this case, the weed Abutilon theophrasti absorbed 45.1% more nitrogen than corn. Still, when the amount of nitrogen was not limiting, corn was always better nitrogen uptake (Bonifas et al., 2005). Barker et al., (2006) stated in a report that the effect of adding different levels of nitrogen on corn plants and Abutilon theophrasti made the weed superior, so that Abutilon theophrasti in terms of height, leaf area and biomass, was able to add different levels of nitrogen, respectively (Barker et al., 2006). 68, 90 and 89% increase and maize with the same amount of nitrogen, only 15, 51, and 68% increase in the above cases.

According to a report, nitrogen deficiency causes a decrease in the quantitative and qualitative traits of corn. In their study, nitrogen deficiency reduced grain yield by 23% compared to full nitrogen fertilizer application. One study showed that increasing Chenopodium album weed interfered with corn growth and reduced grain yield and biomass (Sarabi et al., 2011). However, studies show that a large portion of nitrogen fertilizer is absorbed by weeds and waste is increased. In a field experiment, the effect of nitrogen fertilizer application on corn yield in weeds' presence was investigated and reported that in the absence of weeds and the highest amount of nitrogen, leaf and grain nitrogen content, leaf area index, height and dry matter of maize were significant. Increased but in the presence of the weed, Setaria viridis reduced growth, plant height, leaf nitrogen content, leaf area index and maize dry matter at different levels of nitrogen (Cathcart and Swanton, 2004). The researchers stated that the use of nitrogen in farms with four-carbon weeds is most effective, so in this case, C4 weeds are competitively ahead of C3 weeds. In other words, the higher the amount of nitrogen fertilizer application, the higher the germination rate for weeds. For this reason, control methods must be applied more quickly to control such weeds.

4.3. The relationship of CT with weeds

Weed control is one of the most important problems for accepting CT systems. Changes in weed population dynamics occur when one CT method is used (Derksen et al., 1993). Since the tillage method interacts with variables such as environmental conditions, management factors and weed biology, the dynamics of weed population under the influence of tillage methods is one of the most important challenging factors (Derksen et al., 1993; Légère et al., 2011). Tillage affects weed germination and emergence by changing soil properties, degradation of weed seedlings, redistribution of weed seeds vertically in the soil profile, and affects the weed life cycle (Pawlikowski et al., 2008). Alteration of weed flora in different tillage methods is caused by the effect of crop residues on seed germination environment in the soil, changes in soil temperature and moisture, and changes in the distribution of weed seeds in the soil (Derksen et al., 1993; Liebman et al., 1996). The researchers stated that weeds' diversity and density in CT methods is higher than the moldboard tillage method (Dorado et al., 1999). Weed diversity and density can change with changes in the type of tillage operations (Demjanová et al., 2009). Researchers have reported rapid infestation of some annual or perennial weeds and increased weed seed banks in RT (Moyer et al., 1994).

Streit et al., (2002) stated that the effect of tillage systems (RT, conventional tillage and direct cultivation) to control weeds for corn production was different (Streit et al., 2002). They stated that about perennial weeds, the density of this type of weed in the direct cultivation system was higher compared to the other two tillage systems. In a direct sowing system, annual weed control was more successful than conventional and RT systems. Nakamoto et al., stated that reduced plowing for moldboard production compared to the moldboard method increases weed biomass (Nakamoto et al., 2006). The researchers stressed that tillage operations provide optimal conditions for the growth and development of corn. RT has many advantages over conventional tillage in terms of improving soil structure and moisture retention. However, when preparing the planting medium, reducing soil disruption in different CT methods can create favourable conditions for the growth of various weeds (Weaich et al., 1996). Donald (2007) concluded in an experiment that tillage could control summer weeds well (Donald, 2007). The researcher also said that for optimal weed control, pre-emergence herbicides such as atrazine were used before tillage, which can be reduced by up to 50% using tillage. Based on the researchers' results, it was shown that weed control over weed control could increase the yield and yield components of maize (Nurse et al., 2006; Johnson and Hoverstad, 2002). In deep tillage, seeds seem to be transferred to the soil's depth, which reduces weeds and a variety of CT methods increase weed density by transferring seeds to the soil surface. Tillage greatly impacts the weed community by transferring seeds and transferring weeds to different soil profiles, returning crop residues to the soil, and ultimately changing the nutrient cycle (Vencill and Banks, 1994). Tillage operations reduce soil resistance to root infiltration and weed establishment (Nichols et al., 2015), which may increase the percentage of germination, emergence and weed growth (Grundy et al., 2003). Tillage also allows weed seeds to germinate from deeper soils (Franke et al., 2007).

In the direct sowing system, the probability of seedling death increases due to the root growth of newly germinated seeds that penetrate the soil surface with difficulty (Liebman et al., 1996). The tillage methods' effectiveness on weeds depends on the tillage method, carbon to nitrogen ratio in C / N residues, environmental conditions and soil type (Liebman et al., 1996). In a seven-year experiment with two types of RT and conventional tillage systems on corn, weed density and biomass rate in the RT system were higher than conventional tillage (Demjanová et al., 2009). The use of tillage between planting rows to manage corn weeds has increased maize yield (control to weed ratio) (Donald et al., 2001). A report found that less weed biomass was observed in the cornfield in the NT method, but more weed biomass was observed in the conventional and CT methods (Modak et al., 2019). In a study (Chovancova et al., 2020), the highest weed infestation in the maize field, mainly composed of perennial species, was recorded in CT treatment, while the rich range of annual weed species was higher in Minimal tillage treatment was observed. The researchers said that specific soil treatments created different conditions for weed emergence and soil properties. Therefore, by studying CT's effect on weed maize field contamination, it may be possible to predict further weed contamination. It is also followed by a targeted weed management program that reduces farmers' costs and preserves the environment.

5. Relationship between tillage and soil moisture

Nowadays, farm management does not end with planting and harvesting, but requires a more comprehensive view of the farmer who is compatible with environmental protection. This environmental-friendly perspective can be achieved through taking proper and efficient management approaches in maintaining the farm as an ecosystem to earn income. This management method can also prevent soil degradation and water wastage; ultimately, causing to achieve maximum performance. One of the most important limiting factors of agriculture in arid and semi-arid regions in Iran is water shortage. However, in most parts of Iran, corn can be cultivated under the least rainfall. However, the role of CT in keeping and absorbing moisture is very important. Irrigation in CT due to the presence of more than 30% of plant debris in the soil surface reduces the evaporation process and increases soil moisture permeability and water storage in the soil. The relationship between the type of tillage and soil moisture requires proper management. Lack of proper management in the agricultural machinery application (improper use of machines), burning of crop residues, lack of proper crop rotation have exposed the soils of arid and semi-arid regions to water and wind erosion. It should be noted that in these areas, maintaining more debris on the soil surface is an important factor in maintaining more soil moisture. CT reduces the number of field operations compared to conventional tillage, which has many benefits, including moisture maintenance and reduced degradation of soil structure, being more economic, increased water efficiency (Okumura et al., 2014).

Crop residues act as mulch and shade on the soil surface , protecting the top layer of soil from raindrops and preventing water from being flowed on the soil surface; thus, increasing soil moisture (Tian et al., 1993). Researchers have reported 34-50% reduction in water evaporation from residue-preserved soils (Monneveux et al., 2005). Also, the results of other researchers showed that the interaction effect of CT and mulch was significant on soil moisture, growth and yield of corn and the highest rate for CT was obtained with 7 tons per hectare of mulch (Booth and Swanton, 2002). However, the amount of moisture in the soil regulates root growth, which ultimately affects plant yield. Corn has three types of roots, including seminal roots, coronal roots, and brace roots. The root system of corn is responsible for maintaining the plant in the soil, absorbing water and minerals. However, the presence of sufficient and available moisture in the plant increases the growth of roots in the soil and enhances the plant's ability to absorb water and minerals. It has been reported that soil conditions affect soil moisture and have a direct effect on root growth and nutrient uptake (Krauss et al., 2010). However, there are limited reports on CT and soil moisture in arid and semi-arid regions of Iran. Therefore, in future studies, it is recommended to do more research on CT aspects and soil moisture in these areas (Ogola et al., 2002).

5.1. The relationship between tillage, nitrogen and other soil elements

Knowledge of the long-term impacts of crop management practices on soil fertility is essential for development of nutrient management strategies (Hirel et al., 2007). A 50-year long-term study to investigate changes in soil surface chemistry under the influence of tillage and nitrogen fertilizer in the United States provided interesting results (Knezevic et al., 2002). The researchers reported that in the NT system of soil organic matter, the concentrations of manganese and iron were higher than the RT system and conventional tillage. The researchers found that the NT system increased phosphorus accumulation at a depth of 7.5 cm in the soil, and the lowest rates obtained in conventional tillage (21 mg/kg) and RT (26 mg/kg). The researchers stated that the interaction between tillage and nitrogen fertilizer showed that with increasing nitrogen application, soil pH decreased at the surface (0-7.5 cm). They further stated that in RT treatments, the concentration of manganese and iron increased with increasing nitrogen fertilizer application (Fathi et al., 2020). The effect of tillage on the distribution of elements in soil profiles that are less mobile in the soil, such as calcium, potassium and phosphorus, has been reported by many researchers (Den Hollander et al., 2007; Javeed and Zamir, 2013; Modhej et al., 2014). The researchers illustrated that the NT system leads to more accumulation of potassium and phosphorus concentrations at a depth of 5 cm compared to conventional tillage (Dobermann and Cassman, 2002).

Some of the adverse effects of conventional crops cultivation in recent decades, in the form of reduced soil fertility and increased consumption of nutrients and chemical fertilizers, decreased organic matter and increased soil compaction, the emergence of weeds competing with emerging plants. Continuation of this trend in the future can have adverse consequences on crop production systems. The use of appropriate farming systems as an effective solution to increase the sustainability and improve crop production and food security worldwide has been considered by experts. Proper farming systems provide optimal conditions for pest management, nutrient rotation, resource utilization, and increased yields, while increase production diversity, and reduce system risk and losses. At the same time, conventional systems cannot be abandoned at once, but using crop rotation, can increase diversity in these systems. In the other study, reported that cereals residues provide 40, 10, and 80% of the nutrients nitrogen, phosphorus, and potassium needed for the corn plant.

6. Interaction of tillage and nitrogen on growth and yield characteristics and maize weed management

6. 1. Interaction of tillage and nitrogen on growth characteristics and yield of corn

Tillage and nitrogen fertilizer have a significant role in improving soil fertility and increasing corn productivity. Because nitrogen is often the most limiting nutrient in agricultural systems, nitrogen availability is necessary to improve and produce maximum corn yield. The stability of corn production depends on a sufficient amount of nitrogen for adsorption in addition to a suitable tillage system. However, various studies have shown that CT improves the physical properties, growth, and maize (Olojugba and Ibiloye, 2019; Wasaya et al., 2018; Iqbal et al., 2006). One of the most important points in CT due to the preservation of plant debris on the soil surface is preserving moisture. It has been reported that crop response to nitrogen depends significantly on the availability of moisture. Since tillage affects soil moisture, it is expected to affect crop response to nitrogen (Blevins and Frye, 1993). Crop residues that have been reported in the soil surface along with the implementation of CT system in hot and dry growing season due to reduced water evaporation, improved soil temperature, increased soil moisture and more root growth and increased soil nitrogen mineralization Compared to the removal of plant residues, it increases the yield of corn. However, various reports have been presented on the rejection or acceptance of CT and nitrogen fertilizer (Table 3). In a statement, tillage and nitrogen fertilizer interaction has shown that conventional tillage or deep plowing has a greater impact on the growth and yield parameters of corn (Shahid et al., 2016). However, some researchers have reported an interaction between tillage than conventional tillage with increasing nitrogen levels to cause a significant effect on grain yield has (Pareja-Sánchez et al., 2019; Olojugba and Ibiloye, 2019).

Table 3. Interaction of tillage and nitrogen fertilizer on growth characteristics and yield of maize.

Tillage treatments	**Nitrogen fertilizer levels**	**Effects**	**References**
Deep tillage, CT, NT	Zero, 200, 250 and 300 N kg/h	The interaction of CT and nitrogen fertilizer had a significant effect on the growth characteristics and yield of maize.	Iqbal et al., (2006)
CT, moldboard tillage, chisel tillage	100, 150 and 200 N kg/h	The interaction effect of CT and nitrogen fertilizer on oil percentage was significant. The researcher reported that it is better to use chisels to increase nitrogen uptake by roots and increase porosity.	Wasaya et al., (2018)
CT, Conventional tillage, Intensive tillage	100, 200 and 300 N kg/h	The highest corn grain yield was obtained in intensive tillage using 200 kg/ha nitrogen. Minimal tillage had no significant effect on height, yield and yield components.	Shahid et al., (2016)
Conventional tillage, RT, NT	Zero, 200 and 400 N kg/h	The interaction of tillage and nitrogen and their interaction with the year had a significant effect on corn grain yield. The use of 200 kg N / ha showed a higher grain yield in non-tillage than conventional tillage with the same amount in tillage. The use of 400 kg N / ha in reduced and non-tillage tillage resulted in higher grain yield compared to conventional tillage.	Pareja-Sánchez et al., (2019)
Conventional tillage, RT, NT	Zero, 50 and 120 N kg/h	By reducing tillage operations from conventional tillage to reduction and non-tillage tillage and increasing the application of nitrogen fertilizer, it improved yield and yield components as well as growth indices in maize.	Olojugba and Ibiloye, 2019

The results of a five-year study of tillage effect and nitrogen application showed that corn grain yield in moldboard tillage (conventional) is higher than NT treatment. The researchers also reported that increasing nitrogen fertilizer application in both tillage systems had a significant effect on maize dry matter yield (Halvorson et al., 2006). Other studies have shown that due to less residue mixing with the soil, residue decomposition and nitrogen release are slow in the CT method (Halford et al., 2001). Therefore, to achieve equal yield with the conventional tillage method, it is necessary to increase the amount of nitrogen fertilizer in the first years of the NT method (Sims et al., 1998). Studies by Kihara et al., (2011) reported that the CT system performed better than conventional tillage, which is achieved over several seasons (Kihara et al., 2011). The researchers also suggested that combining one of the CT methods, including reduced or NT with nitrogen fertilizer and previous crop residues could be the best way to advise farmers. The above studies show a wide range of CT methods that vary in the type of machinery used, herbicide application, chemical fertilizers and residue management practices. Besides, differences in climatic conditions and soil types in different study areas have made it impossible to prescribe the impact of management practices resulting from one region's studies as a single prescription for other regions (Chhokar et al., 2007; Endale et al., 2008; Li et al., 2005)

6. 2. Interaction of CT and nitrogen on corn weeds

Weed competition with reduced plant growth, which results in a decrease in the number of leaves in corn as a result of the reduced number of leaves and accelerated ageing processes (Amini et al., 2017), as reported, the rate of leaf ageing in corn is highly dependent With the presence of nitrogen in the soil (Bosnic and Swanton, 1997). Weeds can accelerate the ageing of corn leaves by reducing soil nitrogen. Despite the plant residues on the soil surface, it is possible to prevent further growth for the corn plant, probably due to the prevention of germination and weed growth. Also, shading by straw reduces evaporation and retains soil moisture, which increases the growth of corn (Amini et al., 2017). Researchers have concluded that factors such as tillage, crop type, crop rotation, and management are influential on weed populations (Menalled et al., 2001; Kruidhof et al., 2008). Some experiments also indicate that the use of tillage at least led to the reduction of annual and perennial grasses (Chen et al., 2012; Guerif et al., 2001; Tørresen et al., 1999).

Today, various tillage methods are considered as a way to control weeds. Although most researchers agree on increasing the number of weeds in RT systems or the complete removal of tillage due to the dispersal of asexual organs (Koskinen and McWhorter, 1986), in the case of annual weeds, some believe Increasing the number of weeds and some belief in reducing the number of weeds in RT systems (Below et al., 2000; Mohler and Callaway, 1992). Weed flora is affected by agricultural methods such as tillage and fertilizer management in terms of the density and diversity of weed species in the fields (Fracchiolla et al., 2018). In a report from Pakistan, the decrease in corn yield compared to other developed countries was due to incorrect management practices such as tillage and nitrogen fertilizer (Wasaya et al., 2012). Changes in weed species are often due to tillage practices, and long-term studies have shown that weeds move to broadleaf weeds (Hellwig et al., 2002). Weed seed distribution in the soil is improved by tillage, severely affecting germination and emergence (Morris et al., 2010). Studies by several researchers have shown that with decreasing tillage, one-year weed density increases (Ball, 1992; Buhler and Mester 1991). Researchers have reported that acceptance of CT provides different environments by changing competition in soil's physical and chemical properties for rejuvenation, greening, and weed growth (Feldman et al., 1997). On the other hand, chemical fertilizers, especially nitrogen fertilizers, interact with different tillage systems in the germination, emergence, growth and development of weeds (Fracchiolla et al., 2018; Chaab et al., 2009; Gruber and Claupein, 2009).

7. Conclusion

Corn is one of the most important crops that is used in various industries. It is used in animal feed to produce meat and milk, and other corn products can directly meet part of the human nutritional needs. However, the management of such things as tillage and nitrogen application causes a significant and influential increase in corn growth and development. This study concludes that CT, such as NT or RT, is effective in increasing maize production and improving soil structure and soil water retention. CT follows three main components: soil loosening reduction, crop rotation, and continuous land cover with crop residues. The primary purpose of implementing CT is to maintain crop residues on the soil surface to control water and soil erosion on farms, reduce energy consumption and protect water and soil resources. The application of high amounts of nitrogen required by the plant leads to reduced growth or corn yield. Therefore, the optimal amount of nitrogen is significant for corn production. Corn is a dual-purpose plant (seeds, forage) that requires higher nitrogen consumption than other crops to produce. Therefore, nitrogen deficiency can affect the quantitative and qualitative yield of corn. Weed crop management is also one of the essential strategies in sustainable agricultural development. One of the aspects of crop management is the proper management of nitrogen consumption. Nitrogen can increase or decrease the effect of weed competition with corn. Another part of crop management is CT. Two types of CT, including RT or NT, can cause changes in weed diversity and density compared to conventional tillage. Weed flora is affected by tillage and nitrogen fertilizer in terms of density and species diversity of weeds in the fields. Therefore, proper management is necessary to maintain all aspects of environmental agriculture to use the type of tillage systems and the optimal use of nitrogen fertilizer to control weeds.

References

Afzalinia, S., Zabihi, J., 2014. Soil compaction variation during corn growing season under conservation tillage. *Soil Till. Res.*, **137**, 1-6. https://doi.org/10.1016/j.still.2013.11.003

Agrama, H.A.S., Zakaria, A.G., Said, F.B., Tuinstra, M., 1999. Identification of quantitative trait loci for nitrogen use efficiency in maize. *Mol. Breed.*, **5**(2), 187-195. https://doi.org/10.1023/A:1009669507144

Akbari, F., Dahmardeh, M., Morshdi, A., Ghanbari, A., Khoramdel, S., 2019. Effects of Tillage System and Plant Residue on Nitrogen Uptake and Use Efficiency in Corn and Bean Intercropping Systems. *J. Crops Improv.*, **20**(4), 785-799. [In Persian] https://doi.org/10.22059/jci.2018.259464.2043

Altarugio, L.M., Savieto, J., Machado, B.D.A., Migliavacca, R.A., Almeida, R.F., Zavaschi, E., Carneiro, L.D.M.E.S., Vitti, G.C., Otto, R., 2019. Optimal Management Practices for Nitrogen Application in Corn Cultivated During Summer and Fall in the Tropics. *Commun. Soil Sci. Plant Anal.*, **50**(6), 662-672. https://doi.org/10.1080/00103624.2019.1589478

Amini, R., Abdi, H., Dabbagh Mohammadi Nassab, A., 2017. Effect of Integrated Weed Management Methods on Yield and Yield Components of Corn (Zea mays L.) in Kermanshah Province, Iran. *J. Plant Prot.*, **31**(1), 92-104. [In Persian] https://doi.org/10.22067/jpp.v31i1.52186

Anderson, R.L., Tanaka, D.L., Black, A.L., Schweizer, E.E., 1998. Weed community and species response to crop rotation, tillage, and nitrogen fertility. *Weed Technol.*, **12**(3), 531-536. https://doi.org/10.1017/s0890037x00044262

Antonietta, M., Acciaresi, H.A., Guiamet, J.J., 2016. Responses to N deficiency in stay green and non-stay green argentinean hybrids of maize. *J. Agron. Crop Sci.*, **202**(3), 231-242. https://doi.org/10.1111/jac.12136

Archer, D.W., Reicosky, D.C., 2009. Economic performance of alternative tillage systems in the northern Corn Belt. *Agron. J.*, **101**(2), 296-304. https://doi.org/10.2134/agronj2008.0090x

Azeem, K., Shah, S., Ahmad, N., Shah, S.T., Khan, F., Arafat, Y., Naz, F., Azeem, I., Ilyas, M., 2015. Physiological indices, biomass and economic yield of maize influenced by humic acid and nitrogen levels. *Russ. Agric. Sci.*, **41**(2), 115-119. https://doi.org/10.3103/S1068367415020020

Baghestani, M.A., Zand, E., Soufizadeh, S., Eskandari, A., PourAzar, R., Veysi, M., Nassirzadeh, N., 2007. Efficacy evaluation of some dual purpose herbicides to control weeds in maize (Zea mays L.). *Crop Prot.*, **26**(7), 936-942. https://doi.org/10.1016/j.cropro.2006.08.013

Bahrani, M.J., Raufat, M.H., Ghadiri, H., 2007. Influence of wheat residue management on irrigated corn grain production in a reduced tillage system. *Soil Till. Res.*, **94**(2), 305-309. https://doi.org/10.1016/j.still.2006.08.004

Baker, C.J., Saxton, K.E., 2007. No-tillage seeding in conservation agriculture. Cabi.

Ball, D.A., 1992. Weed seed bank responses to tillage, herbicide and crop rotation sequence. *Weed Sci.*, **40**(4), 654-659. https://doi.org/10.1017/s0043174500058264

Barker, D.C., Knezevic, S.Z., Martin, A.R., Walters, D.T., Lindquist, J.L., 2006. Effect of nitrogen addition on the comparative productivity of corn and velvetleaf (Abutilon theophrasti). *Weed Sci.,* **54**(2), 354-363. https://doi.org/10.1043/0043-1745(2006)54[354:EONAOT]2.0.CO;2

Bayer, C., Martin-Neto, L., Mielniczuk, J., Pillon, C.N., Sangoi, L., 2001. Changes in soil organic matter fractions under subtropical no-till cropping systems. *Soil Sci. Soc. Am. J.,* **65**(5), 1473-1478. https://doi.org/10.2136/sssaj2001.6551473x

Below, F.E., Cazetta, J.O., Seebauer, J.R., 2000. Carbon/nitrogen interactions during ear and kernel development of maize. *Physiol. Model. Kernel Set Maize,* **29**, 15-24. https://doi.org/10.2135/cssaspecpub29.c2

Biswas, D.K., Ma, B.L., 2016. Effect of nitrogen rate and fertilizer nitrogen source on physiology, yield, grain quality, and nitrogen use efficiency in corn. *Can. J. Plant Sci.,* **96**(3), 392-403. https://doi.org/10.1139/cjps-2015-0186

Blevins, R.L., Frye, W.W., 1993. Conservation tillage: an ecological approach to soil management. *Adv. Agron.,* **51**, 33-78. https://doi.org/10.1016/S0065-2113(08)60590-8

Bonifas K.D., Walters D.T., Cassman, K.G., Lindquist J.L., 2005. The effects of nitrogen supply on root: shoot ratio in corn and velvetleaf. *Weed Sci.,* **53**, 670–675. https://doi.org/10.1614/ws-05-002r.1

Boomsma, C.R., Santini, J.B., Tollenaar, M., Vyn, T.J., 2009. Maize morphophysiological responses to intense crowding and low nitrogen availability: An analysis and review. *Agron. J.,* **101**(6), 1426-1452. https://doi.org/10.2134/agronj2009.0082

Booth B.D., Swanton C.J., 2002. Assembly theory applied to weed communities. *Weed Sci.,* **50**, 2-13. https://doi.org/10.1614/0043-1745(2002)050[0002:AIATAT]2.0.CO;2

Bosnic A.C., Swanton C.J., 1997. Influence of barnyard grass (Echinocholoa crus- galli) time of emergence and soybean (*Glycin max*). *Weed Sci.,* **41**, 34-37. https://doi.org/10.1017/S0043174500092833

Buhler, D.D., Mester, T.C., 1991. Effect of tillage systems on the emergence depth of giant (Setaria faberi) and green foxtail (Setaria viridis). *Weed Sci.,* 200-203. https://doi.org/10.1017/S0043174500071472

Cardina, J., Regnier, E., Harrison, K., 1991. Long-term tillage effects on seed banks in three Ohio soils. *Weed Sci.,* **39**(20), 186-194. https://doi.org/10.1017/S0043174500071459

Carlson, H.L., Hill, J.E., 1985. Wild oat (Avena fatua) competition with spring wheat: plant density effects. *Weed Sci.,* **33**(2), 176-181. https://doi.org/10.1017/S0043174500082059

Cathcart, R.J., Swanton, C.J., 2003. Nitrogen management will influence threshold values of green foxtail (Setaria viridis) in corn. *Weed Sci.,* **51**(6), 975-986. https://doi.org/10.1614/P2002-145

Cathcart, R.J., Swanton, C.J., 2004. Nitrogen and green foxtail (Setaria viridis) competition effects on corn growth and development. *Weed Sci.,* **52**(6), 1039-1049. https://doi.org/10.1614/WS-03-071R1

Celik, I., Barut, Z.B., Ortas, I., Gok, M., Demirbas, A.H.M.E.T., Tulun, Y., Akpinar, C., 2011. Impacts of different tillage practices on some soil microbiological properties and crop yield under semi-arid Mediterranean conditions. *Int. J. Plant Prod.,* **5**, 237-254. https://doi.org/10.22069/ijpp.2012.736

Chaab, A., Fathi, G. Siadat, A., Zand, E., Anafjeh, Z., 2009. The interference effects of natural weed population on growth indices of corn (Zea mays L.) at different plant densities. *Iran. J. Field Crop Res.,* **7**(2), 391-400. [In Persian]

Chen, Y.Q., Peng, S.U.I., Chen, L.U.A.N., Shi, X.P., 2012. Xanthium suppression under maize|| sunflower intercropping system. *J. Integr. Agric.,* **11**(6), 1026-1037. https://doi.org/10.1016/S2095-3119(12)60095-1

Chhokar, R., Sharma, R., Jat, G., Pundir, A., Gathala, M., 2007. Effect of tillage and herbicides on weeds and productivity of wheat under rice–wheat growing system. *Crop Prot.,* **26**(11), 1689–1696. https://doi.org/10.1016/j.cropro.2007.01.010

Chovancova, S.V.E.T.L.A.N.A., Illek, F., Winkler, J., 2020. The effect of three tillage treatments on weed infestation in maize monoculture. *Pak. J. Bot.,* **52**(2), 697-701. https://doi.org/10.30848/PJB2020-2(11)

Cussans, G.W., 1975. Weed control in reduced cultivation and direct drilling systems. Outlook Agric., **8**(1_suppl), 240-242. https://doi.org/10.1177/003072707500801s08

Dabney, S.M., Wilson, G.V., McGregor, K.C., Foster, G.R., 2004. History, residue, and tillage effects on erosion of loessial soil. *Trans. ASAE,* **47**(3), 767.

Dawson, J.C., Huggins, D.R., Jones, S.S., 2008. Characterizing nitrogen use efficiency in natural and agricultural ecosystems to improve the performance of cereal crops in low-input and organic agricultural systems. *Field Crops Res.*, **107**(2), 89-101. https://doi.org/10.1016/j.fcr.2008.01.001

D'Emden, F.H., Llewellyn, R.S., 2006. No-tillage adoption decisions in southern Australian cropping and the role of weed management. *Aust. J. Exp. Agric.*, **46**(4), 563-569. https://doi.org/10.1071/EA05025

Demjanová, E., Macák, M., Dalovic, I., Majernik, F., Tyr, S., Smatana, S., 2009. Effects of tillage systems and crop rotation on weed density, weed species composition and weed biomass in maize. *Agron. Res.*, **7**(2), 785-792.

Derksen, D.A., Lafond, G.P., Thomas, A.G., Loeppky, H.A., Swanton, C.J., 1993. Impact of agronomic practices on weed communities: tillage systems. *Weed Sci.*, **41**(30), 409-417. https://doi.org/10.1017/S0043174500052127

Di Tomaso, J.M., 1995. Approaches for improving crop competitiveness through the manipulation of fertilization strategies. *Weed Sci.*, **43**(3), 491-497. https://doi.org/10.1017/S0043174500081522

Ding, L., Wang, K.J., Jiang, G.M., Biswas, D.K., Xu, H., Li, L.F., Li, Y.H., 2005. Effects of nitrogen deficiency on photosynthetic traits of maize hybrids released in different years. *Ann. Bot.*, **96**(5), 925-930.

Dobermann, A., Cassman, K.G., 2002. Plant nutrient management for enhanced productivity in intensive grain production systems of the United States and Asia. *Plant soil,* **247**(1), 153-175. https://doi.org/10.1023/A:1021197525875

Donald, W.W., 2007. Control of both winter annual and summer annual weeds in no-till corn with between-row mowing systems. *Weed Technol.*, **21**(3), 591-601. https://doi.org/10.1614/WT-05-141.1

Donald, W.W., Kitchen, N.R., Sudduth, K.A., 2001. Between-row mowing+ banded herbicide to control annual weeds and reduce herbicide use in no-till soybean (Glycine max) and corn (Zea mays). *Weed Technol.*, **15**(3), 576-584. https://doi.org/10.1614/0890-037X(2001)015[0576:BRMBHT]2.0.CO;2

Dorado, J., Del Monte, J.P., López-Fando, C., 1999. Weed seedbank response to crop rotation and tillage in semiarid agroecosystems. *Weed Sci.*, **47**(1), 67-73. https://doi.org/10.1017/S0043174500090676

Echarte, L., Rothstein, S., Tollenaar, M., 2008. The response of leaf photosynthesis and dry matter accumulation to nitrogen supply in an older and a newer maize hybrid. *Crop Sci.*, **48**(2), 656-665. https://doi.org/10.2135/cropsci2007.06.0366

Edwards, J.H., Thurlow, D.L., Eason, J.T., 1988. Influence of tillage and crop rotation on yields of corn, soybean, and wheat. *Agron. J.*, **80**(1), 76-80. https://doi.org/10.2134/agronj1988.00021962008000010018x

El-Sayed, K.A., Ross, S.A., El-Sohly, M.A., Khalafall, M.M., Abdel Halim, O.B., Ikegami, F., 2000. Effect of different fertilizers on the amino acid, fatty acid and essential oil composition of Nigella sativa seeds. *Saudi Pharm. J.*, **8**, 175-182.

Endale, D.M., Schomberg, H.H., Fisher, D.S., Jenkins, M.B., Sharpe, R.R., Cabrera, M.L., 2008. No-till corn productivity in a southeastern United States Ultisol amended with poultry litter. *Agron. J.*, 100(5), 1401-1408. https://doi.org/10.2134/agronj2007.0401

Etzold, S., Ferretti, M., Reinds, G.J., Solberg, S., Gessler, A., Waldner, P., Schaub, M., Simpson, D., Benham, S., Hansen, K., Ingerslev, M., 2020. Nitrogen deposition is the most important environmental driver of growth of pure, even-aged and managed European forests. *For. Ecol. Manag.*, **458**, 117762. https://doi.org/10.1016/j.foreco.2019.117762

Evans, S.P., Knezevic, S.Z., Lindquist, J.L., Shapiro, C.A., Blankenship, E.E., 2003. Nitrogen application influences the critical period for weed control in corn. *Weed Sci.*, **51**(3), 408-417. https://doi.org/10.1614/0043-1745(2003)051[0408:NAITCP]2.0.CO;2

Fathi, A., Barari Tari, D., Fallah Amoli, H., Niknejad, Y., 2020. Study of energy consumption and greenhouse gas (GHG) emissions in corn production systems: influence of different tillage systems and use of fertilizer. *Commun. Soil Sci. Plant Anal.*, **51**(6), 769-778. https://doi.org/10.1080/00103624.2020.1729373

Fathi, A., Kardoni, F., 2020. The importance of quinoa (Quinoa Chenopodium Willd.) cultivation in developming countries: A review. *Cercetari Agronomice Moldova,* **53**(3), 337-356. https://doi.org/10.46909/cerce-2020-030

Feldman, S.R., Torres, C.A.P.S., Lewis, P., 1997. The effect of different tillage systems on the composition of the seedbank. *Weed Res.*, **37**(2), 71-76. https://doi.org/10.1046/j.1365-3180.1996.d01-1.x

Fisk, J.W., Hesterman, O.B., Shrestha, A., Kells, J.J., Harwood, R.R., Squire, J.M., Sheaffer, C.C., 2001. Weed suppression by annual legume cover crops in no-tillage corn. *Agron. J.*, **93**(2), 319-325. https://doi.org/10.2134/agronj2001.932319x

Fracchiolla, M., Stellacci, A.M., Cazzato, E., Tedone, L., Alhajj Ali, S., De Mastro, G., 2018. Effects of conservative tillage and nitrogen management on weed seed bank after a seven-year durum wheat—Faba Bean rotation. *Plants,* **7**(4), 82. https://doi.org/10.3390/plants7040082

Franke, A.C., Singh, S., McRoberts, N., Nehra, A.S., Godara, S., Malik, R.K., Marshall, G., 2007. Phalaris minor seedbank studies: longevity, seedling emergence and seed production as affected by tillage regime. *Weed Res.*, **47**(1), 73-83. https://doi.org/10.1111/j.1365-3180.2007.00533.x

Gastal, F., Lemaire, G., 2002. N uptake and distribution in crops: an agronomical and ecophysiological perspective. *J. Exp. Bot.*, **53**(370), 789-799. https://doi.org/10.1093/jexbot/53.370.789

Ghanizadeh, H., Lorzadeh, S., Ariannia, N., 2010. Critical period for weed control in corn in the South-West of Iran. *Asian J. Agric. Res.,* **4**(2), 80-86. https://doi.org/10.3923/ajar.2010.80.86

Gorouh, H.A., Naghavii, H., Rostami, M.A., Najafinezhad, H., 2019. Effect of conservation tillage and wheat residue management in some soil properties and grain yield of corn. *Iran. J Soil Res.*, **33**(1), 1-12. [In Persian] https://doi.org/10.22092/ijsr.2019.119050

Gruber, S., Claupein, W., 2009. Effect of tillage intensity on weed infestation in organic farming. *Soil Till. Res.*, **105**(1), 104-111. https://doi.org/10.1016/j.still.2009.06.001

Grundy, A.C., Mead, A., Burston, S., 2003. Modelling the emergence response of weed seeds to burial depth: interactions with seed density, weight and shape. *J. Appl. Ecol.*, **40**(4), 757-770. https://doi.org/10.1046/j.1365-2664.2003.00836.x

Guerif, J., Richard, G., Dürr, C., Machet, J.M., Recous, S., Roger-Estrade, J., 2001. A review of tillage effects on crop residue management, seedbed conditions and seedling establishment. *Soil Till. Res.*, **61**(1-2), 13-32. https://doi.org/10.1016/S0167-1987(01)00187-8

Habtegebrial, K., Singh, B.R., Haile, M., 2007. Impact of tillage and nitrogen fertilization on yield, nitrogen use efficiency of tef (*Eragrostis tef* (Zucc.) Trotter) and soil properties. *Soil Till. Res.*, **94**(1), 55-63. https://doi.org/10.1016/j.still.2006.07.002

Hajabbasi, M.A., Hemmat, A., 2000. Tillage impacts on aggregate stability and crop productivity in a clay-loam soil in central Iran. *Soil Till. Res.*, **56**(3-4), 205-212. https://doi.org/10.1016/S0167-1987(00)00140-9

Halford, C., Hamill, A.S., Zhang, J., Doucet, C., 2001. Critical period of weed control in no-till soybean (*Glycine max*) and corn (*Zea mays*). *Weed Technol.*, **15**(4), 737-744. https://doi.org/10.1614/0890-037X(2001)015[0737:CPOWCI]2.0.CO;2

Hall, M.R., Swanton, C.J., Anderson, G.W., 1992. The critical period of weed control in grain corn (Zea mays). Weed Sci., **40**(3), 441-447. https://doi.org/10.1017/S0043174500051882

Halvorson, A.D., Mosier, A.R., Reule, C.A., Bausch, W.C., 2006. Nitrogen and tillage effects on irrigated continuous corn yields. *Agron. J.*, **98**(1), 63-71. https://doi.org/10.2134/agronj2005.0174

Harbur, M.M., Owen, M.D., 2006. Influence of relative time of emergence on nitrogen responses of corn and velvetleaf. *Weed Sci.*, **54**(5), 917-922. https://doi.org/10.1614/WS-05-167R1.1

Hassanein, A.M., Mesbah, E.A.E., Soliman, F.H., El-Aidy, T.E.T., 2019. Effect of Nitrogen Rates, Biofertilizers and Foliar Urea Application on Yield and Yield Components of Maize (*Zea mays*, L.). *J. Plant Prod.*, **10**(1), 53-58. https://doi.org/10.21608/jpp.2019.36203

Hellwig, K.B., Johnson, W.G., Scharf, P.C., 2002. Grass weed interference and nitrogen accumulation in no-tillage corn. *Weed Sci.*, **50**(6), 757-762. https://doi.org/10.1614/0043-1745(2002)050[0757:GWIANA]2.0.CO;2

Hernández, T., Moral, R., Perez-Espinosa, A., Moreno-Caselles, J., Perez-Murcia, M.D., Garcıa, C., 2002. Nitrogen mineralisation potential in calcareous soils amended with sewage sludge. *Bioresour. Technol.*, **83**(3), 213-219. https://doi.org/10.1016/S0960-8524(01)00224-3

Hirel, B., Le Gouis, J., Ney, B., Gallais, A., 2007. The challenge of improving nitrogen use efficiency in crop plants: towards a more central role for genetic variability and quantitative genetics within integrated approaches. *J. Exp. Bot.*, **58**(9), 2369-2387. https://doi.org/10.1093/jxb/erm097

Hobbs, P.R., Sayre, K., Gupta, R., 2008. The role of conservation agriculture in sustainable agriculture. *Philos. Trans. Royal Soc. Biol. Sci.*, **363**(1491), 543-555. https://doi.org/10.1098/rstb.2007.2169

Hocking, P.J., Stapper, M., 2001. Effects of sowing time and nitrogen fertiliser on canola and wheat, and nitrogen fertiliser on Indian mustard. I. Dry matter production, grain yield, and yield components. *Aust. J. Agric. Res.*, **52**(6), 623-634. https://doi.org/10.1071/AR00113

Den Hollander, N.G., Bastiaans, L., Kropff, M.J., 2007. Clover as a cover crop for weed suppression in an intercropping design: I. Characteristics of several clover species. *Eur. J. Agron.*, **26**(2), 92-103. https://doi.org/10.1016/j.eja.2006.08.011

Hussain, I., Olson, K.R., Ebelhar, S.A., 1999. Impacts of tillage and no-till on production of maize and soybean on an eroded Illinois silt loam soil. *Soil Till. Res.*, **52**(1-2), 37-49. https://doi.org/10.1016/S0167-1987(99)00054-9

Iqbal, A., Ayub, M., Zaman, H., Ahmad, R., 2006. Impact of nutrient management and legume association on agro-qualitative traits of maize forage. *Pak. J. Bot.*, **38**(4), 1079-1084.

Issaka, F., Zhang, Z., Zhao, Z.Q., Asenso, E., Li, J.H., Li, Y.T., Wang, J.J., 2019. Sustainable conservation tillage improves soil nutrients and reduces nitrogen and phosphorous losses in maize farmland in southern China. *Sustainability*, **11**(8), 2397. https://doi.org/10.3390/su11082397

Javeed, H.M.R., Zamir, M.S.I., 2013. Influence of tillage practices and poultry manure on grain physical properties and yield attributes of spring maize (*Zea mays* L.). *Pak. J. Agri. Sci*, **50**(1), 177-183.

Jin, H., Hongwen, L., Xiaoyan, W., McHugh, A.D., Wenying, L., Huanwen, G., Kuhn, N.J., 2007. The adoption of annual subsoiling as conservation tillage in dryland maize and wheat cultivation in northern China. *Soil Till. Res.*, **94**(2), 493-502. https://doi.org/10.1016/j.still.2006.10.005

Johnson, G.A., Hoverstad, T.R., 2002. Effect of row spacing and herbicide application timing on weed control and grain yield in corn (*Zea mays*). *Weed Technol.*, **16**(3), 548-553. https://doi.org/10.1614/0890-037X(2002)016[0548:EORSAH]2.0.CO;2

Karami, H., Maleki, A., Fathi, A., 2018. Determination effect of mycorrhiza and vermicompost on accumulation of seed nutrient elements in maize (*Zea mays* L.) affected by chemical fertilizer. *J. Crop Nutr. Sci.*, **4**(3), 15-29.

Kaur, A., Bedi, S., Gill, G., Kumar, M., 2012. Effect of nitrogen fertilizers on radiation use efficiency, Crop growth and yield in some maize (*Zea mays* L) genotypes. *Maydica*, **57**(1), 75-82.

Khaliq, T., Ahmad, A., Hussain, A., Ali, M.A., 2009. Maize hybrids response to nitrogen rates at multiple locations in semiarid environment. *Pak. J. Bot.*, **41**(1), 207-224.

Kihara, J., Bationo, A., Mugendi, D.N., Martius, C., Vlek, P.L., 2011. Conservation Tillage, Local Organic Resources, and Nitrogen Fertilizer Combinations Affect Maize Productivity, Soil Structure and Nutrient Balances in Semi-arid Kenya. *Innov. key green Revol. Afr.*, 155-167. https://doi.org/10.1007/s10705-011-9423-7

Knezevic, S.Z., Evans, S.P., Blankenship, E.E., Van Acker, R.C., Lindquist, J.L., 2002. Critical period for weed control: the concept and data analysis. *Weed Sci.*, **50**(6), 773-786. https://doi.org/10.1614/0043-1745(2002)050[0773:CPFWCT]2.0.CO;2

Kogbe, J.O.S., Adediran, J.A., 2003. Influence of nitrogen, phosphorus and potassium application on the yield of maize in the savanna zone of Nigeria. *Afr. J. Biotech.*, **2**(10), 345-349. https://doi.org/10.5897/AJB2003.000-1071

Koskinen, W.C., McWhorter, C.G., 1986. Weed control in conservation tillage. *J. Soil Water Conserv.*, **41**(6), 365-370.

Krauss, M., Berner, A., Burger, D., Wiemken, A., Niggli, U., Mäder, P., 2010. Reduced tillage in temperate organic farming: implications for crop management and forage production. *Soil Use Manag.*, **26**(1), 12-20. https://doi.org/10.1111/j.1475-2743.2009.00253.x

Kruidhof, H.M., Bastiaans, L., Kropff, M.J., 2008. Ecological weed management by cover cropping: effects on weed growth in autumn and weed establishment in spring. *Weed Res.*, **48**(6), 492-502. https://doi.org/10.1111/j.1365-3180.2008.00665.x

Kumar, K., Goh, K.M., 1999. Crop residues and management practices: effects on soil quality, soil nitrogen dynamics, crop yield, and nitrogen recovery. *Adv. Agron.*, **68**, 197-319. https://doi.org/10.1016/S0065-2113(08)60846-9

Lamptey, S., Li, L., Yeboah, S., 2018. Reduced tillage practices without crop retention improved soil aggregate stability and maize (*Zea mays* L.) yield. *Ghana J. Hort.*, **13**(1), 50-69.

Larbi, E., Ofosu-Anim, J., Norman, J.C., Anim-Okyere, S., Danso, F., 2013. Growth and yield of maize (Zea mays L.) in response to herbicide application in the coastal savannah ecozone of Ghana. *Net. J. Agric. Sci.*, **1**(3), 81-86.

Légère, A., Stevenson, F.C., Benoit, D.L., 2011. The selective memory of weed seedbanks after 18 years of conservation tillage. *Weed Sci.*, **59**(1), 98-106. https://doi.org/10.1614/WS-D-10-00092.1

Lemerle, D., Gill, G.S., Murphy, C.E., Walker, S.R., Cousens, R.D., Mokhtari, S., Peltzer, S.J., Coleman, R., Luckett, D.J., 2001. Genetic improvement and agronomy for enhanced wheat competitiveness with weeds. *Aust. J. Agric. Res.*, **52**(5), 527-548. https://doi.org/10.1071/AR00056

Li, W., Li, L., Sun, J., Guo, T., Zhang, F., Bao, X., Peng, A., Tang, C., 2005. Effects of intercropping and nitrogen application on nitrate present in the profile of an Orthic Anthrosol in Northwest China. *Agric. Ecosyst. Environ.*, **105**(3), 483-491. https://doi.org/10.1016/j.agee.2004.07.008

Liebman, M., Drummond, F.A., Corson, S., Zhang, J., 1996. Tillage and rotation crop effects on weed dynamics in potato production systems. *Agron. J.*, **88**(1), 18-26. https://doi.org/10.2134/agronj1996.00021962008800010005x

Lindquist, J.L., Evans, S.P., Shapiro, C.A., Knezevic, S.Z., 2010. Effect of nitrogen addition and weed interference on soil nitrogen and corn nitrogen nutrition. *Weed Technol.*, **24**(1), 50-58. https://doi.org/10.1614/WT-09-070.1

Lorzadeh, S.H., 2011. Weed management based on phonological stages in corn in North Khuzestan province, Iran. *Adv. Environ. Biol.*, **5**(8), 2291-2295.

Mahmoudi, S., Rahimi, A., 2009. The critical period of weed control in corn in Birjand region, Iran. *Int. J. Plant Prod.*, **3**(2), 91-96. https://doi.org/10.22069/ijpp.2012.645

Mathew, R.P., Feng, Y., Githinji, L., Ankumah, R., Balkcom, K.S., 2012. Impact of no-tillage and conventional tillage systems on soil microbial communities. *Appl. Environ. Soil Sci.*, 2012. https://doi.org/10.1155/2012/548620

Menalled, F.D., Gross, K.L., Hammond, M., 2001. Weed aboveground and seedbank community responses to agricultural management systems. *Ecol. Appl.*, **11**(6), 1586-1601. https://doi.org/10.1890/1051-0761(2001)011[1586:WAASCR]2.0.CO;2

Modak, D.P., Behera, B., Jena, S.N., Roul, P.K., Behera, S.D., 2019. Effect of tillage and weed management on weed biomass and productivity of summer maize (*Zea mays*). *Indian J. Agron.*, **64**(2), 262-265.

Modhej, A., Kaihani, A., Lack, S., 2014. Effect of nitrogen fertilizer on grain yield and nitrogen use efficiency in corn (*Zea mays* L.) hybrids under irrigated conditions. *Proc. Natl. Acad. Sci. India Section B: Biol. Sci.*, **84**(3), 531-536. https://doi.org/10.1007/s40011-013-0254-y

Mohler, C.L., Calloway, M.B., 1992. Effects of tillage and mulch on the emergence and survival of weeds in sweet corn. *J. Appl. Ecol.*, 21-34. https://doi.org/10.2307/2404343

Monneveux, P., Zaidi, P.H., Sanchez, C., 2005. Population density and low nitrogen affects yield-associated traits in tropical maize. *Crop Sci.*, **45**(2), 535-545. https://doi.org/10.2135/cropsci2005.0535

Moosavi, S.G., 2012. The effect of water deficit stress and nitrogen fertilizer levels on morphology traits, yield and leaf area index in maize. *Pak. J. Bot*, **44**(4), 1351-1355.

Morris, N.L., Miller, P.C.H., Orson, J.H., Froud-Williams, R.J., 2010. The adoption of non-inversion tillage systems in the United Kingdom and the agronomic impact on soil, crops and the environment—A review. *Soil Till. Res.*, **108**(1-2), 1-15. https://doi.org/10.1016/j.still.2010.03.004

Moyer, J.R., Roman, E.S., Lindwall, C.W., Blackshaw, R.E., 1994. Weed management in conservation tillage systems for wheat production in North and South America. *Crop Prot.*, **13**(4), 243-259. https://doi.org/10.1016/0261-2194(94)90012-4

Mrabet, R., 2002. Stratification of soil aggregation and organic matter under conservation tillage systems in Africa. *Soil Till. Res.*, **66**(2), 119-128. https://doi.org/10.1016/S0167-1987(02)00020-X

Mousavi Boogar, A.A., 2018. Soil tillage methods effects on soil chemical and biological properties and quantitative traits of silage maize (Zea mays L.) in rotation with chickpea. *Iran. J. Field Crop Sci.*, **48**(4), 1015-1026. [In Persian]

Nadeem, M.A., Iqbal, Z., Ayub, M., Mubeen, K., Ibrahim, M., 2009. Effect of nitrogen application on forage yield and quality of maize sown alone and in mixture with legumes. *Pak. J. Life Soc. Sci.*, **7**(2), 161-167.

Nakamoto, T., Yamagishi, J., Miura, F., 2006. Effect of reduced tillage on weeds and soil organisms in winter wheat and summer maize cropping on Humic Andosols in Central Japan. *Soil Till. Res.*, **85**(1-2), 94-106. https://doi.org/10.1016/j.still.2004.12.004

Nichols, V., Verhulst, N., Cox, R., Govaerts, B., 2015. Weed dynamics and conservation agriculture principles: A review. *Field Crop Res.*, **183**, 56-68. https://doi.org/10.1016/j.fcr.2015.07.012

Nurse, R.E., Swanton, C.J., Tardif, F., Sikkema, P.H., 2006. Weed control and yield are improved when glyphosate is preceded by a residual herbicide in glyphosate-tolerant maize (*Zea mays*). *Crop Prot.*, **25**(11), 1174-1179. https://doi.org/10.1016/j.cropro.2006.02.015

Ogola, J.B.O., Wheeler, T.R., Harris, P.M., 2002. Effects of nitrogen and irrigation on water use of maize crops. *Field Crop Res.*, **78**(2-3), 105-117. https://doi.org/10.1016/S0378-4290(02)00116-8

Okumura, R.S., Vidigal Filho, P.S., Scapim, C.A., Marques, O.J., Franco, A.A.N., Souza, R.S., Reche, D.L., 2014. Effects of nitrogen rates and timing of nitrogen topdressing applications on the nutritional and agronomic traits of sweet corn. *J. Food Agric. Environ.*, **12**(2), 391-398.

Olojugba, M.R., Ibiloye, J.O., 2019. Inter & Active Effect of Tillage and Nitrogen Fertilizer on Maize (*Zea mays* L.) Performance on a Humid Alfisol Southwestern, Nigeria. *Asian J. Soil Sci. Plant Nutr.*, 1-11. https://doi.org/10.9734/ajsspn/2019/v4i330044

O'Neill, P.M., Shanahan, J.F., Schepers, J.S., Caldwell, B., 2004. Agronomic responses of corn hybrids from different eras to deficit and adequate levels of water and nitrogen. *Agron. J.*, **96**, 1660-1667. https://doi.org/10.2134/agronj2004.1660

Ozer, H., 2003. Sowing date and nitrogen rate effects on growth, yield and yield components of two summer rapeseed cultivars. *Eur. J. Agron.*, **19**(3), 453-463. https://doi.org/10.1016/S1161-0301(02)00136-3

Pareja-Sánchez, E., Cantero-Martínez, C., Álvaro-Fuentes, J., Plaza-Bonilla, D., 2019. Tillage and nitrogen fertilization in irrigated maize: key practices to reduce soil CO2 and CH4 emissions. *Soil Till. Res.*, **191**, 29-36. https://doi.org/10.1016/j.still.2019.03.007

Pawlikowski, T., Barczak, T., Bennewicz, J., 2008. Bees (Hymenoptera: Apiformes) of the agricultural areas in the lower Vistula valley. *J. Agric. Sci.*, **52**, 67-79.

Raja, V., 2001. Effect of nitrogen and plant population on yield and quality of super sweet corn (*Zea mays*). *Indian J. Agron.*, **46**(2), 246-249.

Ram, H., Singh, Y., Saini, K.S., Kler, D.S., Timsina, J., Humphreys, E.J., 2012. Agronomic and economic evaluation of permanent raised beds, no tillage and straw mulching for an irrigated maize-wheat system in northwest India. *Exp. Agric.*, **48**(1), 21-38. https://doi.org/10.1017/S0014479711000809

Sadeghi, H., Bahrani, M.J., 2009. Effects of crop residue and nitrogen rates on yield and yield components of two dryland wheat (*Triticum aestivum* L.) cultivars. *Plant Prod. Sci.*, **12**(4), 497-502. https://doi.org/10.1626/pps.12.497

Sangoi, L., Ernani, P.R., Silva, P.R.F.D., 2007. Maize response to nitrogen fertilization timing in two tillage systems in a soil with high organic matter content. *Revista Brasileira de Ciência do Solo*, **31**, 507-517. https://doi.org/10.1590/S0100-06832007000300011

Sarabi, V., Mahallati, M.N., Nezami, A., Mohassel, M.H.R., 2011. Effects of the relative time of emergence and the density of common lambsquarters (*Chenopodium album*) on corn (*Zea mays*) yield. *Weed Biol. Manag.*, **11**(3), 127-136. https://doi.org/10.1111/j.1445-6664.2011.00414.x

Sestili, F., Garcia-Molina, M.D., Gambacorta, G., Beleggia, R., Botticella, E., De Vita, P., Savatin, D.V., Masci, S., Lafiandra, D., 2019. Provitamin A biofortification of durum wheat through a TILLING approach. *Int. J. Mol. Sci.*, **20**(22), 5703. https://doi.org/10.3390/ijms20225703

Shahid, M.N., Zamir, M.S.I., Haq, I.U., Khan, M.K., Hussain, M., Afzal, U., Asim, M., Ali, I., 2016. Evaluating the impact of different tillage regimes and nitrogen levels on yield and yield components of maize (*Zea mays* L.). *Am. J. Plant Sci.*, **7**(6), 789-797. https://doi.org/10.4236/ajps.2016.76073

Shirani, H., Hajabbasi, M.A., Afyuni, M., Hemmat, A., 2002. Effects of farmyard manure and tillage systems on soil physical properties and corn yield in central Iran. *Soil Till. Res.*, **68**(2), 101-108. https://doi.org/10.1016/S0167-1987(02)00110-1

Silgram, M., Shepherd, M.A., 1999. The effects of cultivation on soil nitrogen mineralization. *Adv. Agron.*, **65**, 267-311. https://doi.org/10.1016/S0065-2113(08)60915-3

Sims, A.L., Schepers, J.S., Olson, R.A., Power, J.F., 1998. Irrigated corn yield and nitrogen accumulation response in a comparison of no-till and conventional till: Tillage and surface-residue variables. *Agron. J.*, **90**(5), 630-637. https://doi.org/10.2134/agronj1998.00021962009000050011x

Singer, J.W., Kohler, K.A., Liebman, M., Richard, T.L., Cambardella, C.A., Buhler, D.D., 2004. Tillage and compost affect yield of corn, soybean, and wheat and soil fertility. *Agron. J.*, **96**(2), 531-537. https://doi.org/10.2134/agronj2004.5310

Smith, R.G., 2006. Timing of tillage is an important filter on the assembly of weed communities. *Weed Sci.*, **54**(4), 705-712. https://doi.org/10.1614/WS-05-177R1.1

Streit, B., Rieger, S.B., Stamp, P., Richner, W., 2002. The effect of tillage intensity and time of herbicide application on weed communities and populations in maize in central Europe. *Agric. Ecosyst. Environ.*, **92**(2-3), 211-224. https://doi.org/10.1016/S0167-8809(01)00307-3

Tian, G., Kang, B.T., Brussaard, L., 1993. Mulching effect of plant residues with chemically contrasting compositions on maize growth and nutrients accumulation. *Plant Soil*, **153**(2), 179-187. https://doi.org/10.1007/BF00012990

Timsina, J., Singh, U., Badaruddin, M., Meisner, C., Amin, M.R., 2001. Cultivar, nitrogen, and water effects on productivity, and nitrogen-use efficiency and balance for rice–wheat sequences of Bangladesh. *Field Crop Res.*, **72**(2), 143-161. https://doi.org/10.1016/S0378-4290(01)00171-X

Tørresen, K.S., Skuterud, R., Weiseth, L., Tandsæther, H.J., Jonsen, S.H., 1999. Plant protection in spring cereal production with reduced tillage. I. Grain yield and weed development. *Crop Prot.*, **18**(9), pp.595-603. https://doi.org/10.1016/S0261-2194(99)00067-8

Uremis, I., Uludag, A., Ulger, A., Cakir, B., 2009. Determination of critical period for weed control in the second crop corn under Mediterranean conditions. *Afr. J. Biotechnol.*, **8**(18), 4475-4480. https://doi.org/10.4314/ajb.v8i18.62403

Vakali, C., Zaller, J.G., Köpke, U., 2011. Reduced tillage effects on soil properties and growth of cereals and associated weeds under organic farming. *Soil Till. Res.*, **111**(2), 133-141. https://doi.org/10.1016/j.still.2010.09.003

Van Acker, R.C., Swanton, C.J., Weise, S.F., 1993. The critical period of weed control in soybean [Glycine max (L.) Merr.]. *Weed Sci.*, **41**(2), 194-200. https://doi.org/10.1017/S0043174500076050

Vencill, W.K., Banks, P.A., 1994. Effects of tillage systems and weed management on weed populations in grain sorghum (Sorghum bicolor). *Weed Sci.*, **42**(4), 541-547. https://doi.org/10.1017/S0043174500076918

Wang, D., Li, G., Mo, Y., Cai, M., Bian, X., 2018. Evaluation of optimal nitrogen rate for corn production under mulched drip fertigation and economic benefits. *Field Crop Res.*, **216**, 225-233. https://doi.org/10.1016/j.fcr.2017.10.002

Wasaya, A., Tahir, M., Tanveer, A., Yaseen, M., 2012. Response of maize to tillage and nitrogen management. *J. Animal Plant Sci.*, **22**(2), 452-456.

Wasaya, A., Tahir, M., Yasir, T.A., Akram, M., Farooq, O., Sarwar, N., 2018. Soil physical properties, nitrogen uptake and grain quality of maize (*Zea mays* L.) as affected by tillage systems and nitrogen application. *Ital. J. Agron.*, **13**(4), 324-331. https://doi.org/10.4081/ija.2018.1197

Weaich, K., Bristow, K.L., Cass, A., 1996. Simulating maize emergence using soil and climate data. *Agron. J.*, **88**(4), 667-674. https://doi.org/10.2134/agronj1996.00021962008800040028x

Wilhelm, W., Wortmann, C.S., 2004. Tillage and rotation interactions for corn and soybean grain yield as affected by precipitation and air temperature. *Agron. J.*, **96**(2), 425-432. https://doi.org/10.2134/agronj2004.4250

Williams, M.M., 2006. Planting date influences critical period of weed control in sweet corn. *Weed Sci.*, **54**(5), 928-933. https://doi.org/10.1614/WS-06-005R.1

Wu, Y., Liu, W., Li, X., Li, M., Zhang, D., Hao, Z., Weng, J., Xu, Y., Bai, L., Zhang, S., Xie, C., 2011. Low-nitrogen stress tolerance and nitrogen agronomic efficiency among maize inbreds: comparison of multiple indices and evaluation of genetic variation. *Euphytica*, **180**(2), 281. https://doi.org/10.1007/s10681-011-0409-y

Zebarth, B.J., Sheard, R.W., 1992. Influence of rate and timing of nitrogen fertilization on yield and quality of hard red winter wheat in Ontario. *Can. J. Plant Sci.*, **72**(1), 13-19. https://doi.org/10.4141/cjps92-002

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