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An Assessment of the Potential Oil Production (POP) in *Glycine max* L. under No-Tillage (NT), Minimum-Tillage (MT), Full-Tillage (FT) and Conventional-Tillage (CT) in Semi-arid Conditions

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ABSTRACT

In order to tillage system management (TSM) for achieved to the sustainable agriculture in field of soybean (*Glycine max* L.) in Iran, This experiment was carried out using by a factorial design with four replications during 2009-2010. The factors were till-systems including no tillage (NT), minimum tillage (MT), full tillage (FT) and conventional tillage (CT). The results showed that oil yield was increased under tillage system management and seed yield was improved by tillage control. Our data indicated that MT system was better than NT, FT and CT systems and highest oil yield was obtained under MT system. Therefore, the findings of this study showed that tillage system management is very important in Iranian farming, because Iran has a arid and semi arid weather and water resources are limited, so MT system is a good system for farming in this conditions at filed of soybean for achieved to the sustainable agriculture.

Key words: Potential Oil Production (POP), No-Tillage (NT), Minimum-Tillage (MT), Full-Tillage (FT) and Conventional-Tillage (CT), *Glycine max*.

Introduction

The soybean (U.S.) or soya bean (UK) (*Glycine max*) is a species of legume native to East Asia, widely grown for its edible bean which has numerous uses. The plant is classed as an oilseed rather than a pulse. Fat-free (defatted) soybean meal is a primary, low-cost, source of protein for animal feeds and most prepackaged meals ; soy vegetable oil is another valuable product of processing the soybean crop. For example, soybean products such as textured vegetable protein (TVP) are important ingredients in many meat and dairy analogues.[2] Soybeans produce significantly more protein per acre than most other uses of land. Traditional nonfermented food uses of soybeans include soy milk, and from the latter tofu and tofu skin. Fermented foods include soy sauce, fermented bean paste, natto, and tempeh, among others. The oil is used in many industrial applications. The main producers of soy are the United States (35%), Brazil (27%), Argentina (19%), China (6%) and India (4%). The beans contain significant amounts of phytic acid, alpha-Linolenic acid, and the isoflavones genistein and daidzein. Tillage is the agricultural preparation of the soil by mechanical agitation of various types, such as digging, stirring, and overturning. Examples of human-powered tilling methods using hand tools include shoveling, picking, mattock work, hoeing, and raking. Examples of draft-animal-powered or mechanized work include ploughing (overturning with moldboards or chiseling with chisel shanks), rototilling, rolling with cult packers or other rollers, harrowing, and cultivating with cultivator shanks (teeth). Small-scale gardening and farming, for household food production or small business production, tends to use the smaller-scale methods above, whereas medium- to large-scale farming tends to use the larger-scale methods. There is a fluid continuum, however. Any type of gardening or farming, but especially larger-scale commercial types, may also use low-till or no-till methods as well. Tillage is often classified into two types, primary and secondary. There is no strict boundary between them as much as a loose distinction between tillage that is deeper and thorough (primary) and tillage that is shallower and sometimes more selective of location (secondary). Primary tillage such as ploughing tends to produce a rough surface finish, whereas secondary tillage tends

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to produce a smoother surface finish, such as that required to make a good seedbed for many crops. Harrowing and rototilling often combine primary and secondary tillage into one operation. "Tillage" can also mean the land that is tilled. The word "cultivation" has several senses that overlap substantially with those of "tillage". In a general context, both can refer to agriculture generally. Within agriculture, both can refer to any of the kinds of soil agitation described above. Additionally, "cultivation" or "cultivating" may refer to an even narrower sense of shallow, selective secondary tillage of row crop fields that kills weeds while sparing the crop plants. Intensive tillage systems leave less than 15% crop residue cover less than 500 pounds per acre (560 kg/ha) of small grain residue. These types of tillage systems are often referred to as conventional tillage systems but as reduced and conservation tillage systems have been more widely adopted, it is often not appropriate to refer to this type of system as conventional. These systems involve often multiple operations with implements such as a mold board, disk, and/or chisel plow. Then a finisher with a harrow, rolling basket, and cutter can be used to prepare the seed bed. There are many variations. Reduced tillage systems leave between 15 and 30% residue cover on the soil or 500 to 1000 pounds per acre (560 to 1100 kg/ha) of small grain residue during the critical erosion period. This may involve the use of a chisel plow, field cultivators, or other implements. See the general comments below to see how they can affect the amount of residue. Conservation tillage systems are methods of soil tillage which leave a minimum of 30% of crop residue on the soil surface or at least 1,000 lb/ac (1,100 kg/ha) of small grain residue on the surface during the critical soil erosion period. This slows water movement, which reduces the amount of soil erosion. Conservation tillage systems also benefit farmers by reducing fuel consumption and soil compaction. By reducing the number of times the farmer travels over the field, farmers realize significant savings in fuel and labor. Conservation tillage was used on about 38%, 109,000,000 acres (440,000 km^2), of all US cropland, 293,000,000 acres (1,190,000 km^2) planted as of 2004 according to the USDA. However, conservation tillage systems delay warming of the soil due to the reduction of dark earth exposure to the warmth of the spring sun, thus delaying the planting of the next year's spring crop. Modern agricultural science has greatly reduced the use of tillage. Crops can be grown for several years without any tillage through the use of herbicides to control weeds, crop varieties that tolerate packed soil and equipment that can plant seeds or fumigate the soil without really digging it up. This practice, called no-till farming, reduces costs and environmental change by reducing soil erosion and diesel fuel usage (although it does require the use of herbicides). Most organic farming tends to require extensive tilling, as did most farming throughout history, although researchers are investigating farming in polyculture that would eliminate the need for both tillage and pesticides, such as no-dig gardening. Apart from reducing costs, minimum tillage systems will give the added extremely important benefit of improving soils. Some soils in the UK contain less than 1% organic matter, which is not a healthy situation, by reducing tillage this can be improved relatively quickly. Under good management this can be increased to 2.5% which activates the micro organisms and increases the earthworm population dramatically. You now have a positively active soil working for you ie. unlocking some of the nutrients and making them feely available to the crop in a more balanced form. When you consider that these benefits are freely available to you and at the same time you are saving money and time on tillage, you cannot afford to ignore the benefits. Ploughing costs between £28 - £35 / hectare and takes nearly 1 man hour per hectare, add to this power harrowing which costs £23 / hectare and over 1.1 man hours per hectare (without considering wear and tear on top). Then take into account the damage done to soil structures and, couple this to time lost and the costs, consider the limited time you have available due to the weather constraints, and you have a very compelling argument to reduce tillage. The sooner you can work the soil behind the combine the easier it will be, there is generally some moisture about and the crop roots and earthworms etc. have left the soil friable and perhaps at its easiest to work. Time is always at a premium at this time of year, so the faster you can complete the task the better. Working the surface with skill rather than deep cultivating for appearances or for traditional reasons will not only improve soils but also speed things up. Where possible shallow disking is preferable to heavy disking, and the same applies to tine cultivators - in their case more tines rather than deep. Firm pressing soon after the cultivation will leave the soil more weather proof and easier to drill, especially important in adverse weather conditions. You now have created a "stale seed bed" which is ideal to drill into, certainly for the Moore Unidrill which can handle the high volumes of residue produced on 10 tone/hectare plus crops. The 16.6 cm spacing between staggered disc/coulters allows the trash to flow though and avoids build up and bulldozing. The firm pressing after cultivation has left a seed bed which the disc can cut against and reduce - if not prevent - hair pinning. This technique gives many benefits: drilling is fast, shallow cultivation will have activated weed germination and chatting which can be sprayed off and the Moore Drill only works a narrow seedling strip which does not create a subsequent flush of weeds across the whole soil profile. Stale seedbeds, due to less cultivation, will retain moisture in a dry period, while at the same time the surface will "haze off" quicker after rain and the Moore Drilling System will run smoother than other drills requiring combined cultivation. Reduced cultivation allows the 4 meter Moore to drill at 3.3ha/hour, where as a combination of the same size will battle to achieve 1.2 ha/hour (in heavy soils) and substantially more tillage would be required. Some points to consider are: residue management with or behind the combine must be efficient and effective, if the straw can not be baled then stubble length can be left longer to enable the combine to cope with the reduced straw volume which in turn means better chopping and spreading. Effective mixing of the residue with the topsoil pays dividends. "Stale seedbeds" improve weed and volunteer chatting which dramatically improves spraying efficacy and ensures cleaner crops. Firm pressing leaves the soil weather proof and easier, and more readily drilled after a wet period. When this firm seed bed is coupled with the Moore heavy press wheel the seed is placed into a firmed furrow this is the most slug proof any mechanical system can produce, with the best seed/soil contact resulting in quick, disease free germination in dry trashy conditions. In conservation tillage, crops are grown with minimal cultivation of the soil. When the amount of tillage is reduced, the stubble or plant residues are not completely incorporated, and most or all remain on top of the soil rather than being plowed or disked into the soil. The new crop is planted into this stubble or small strips of tilled soil. Weeds are controlled with cover crops or herbicides rather than by cultivation. Fertilizer and lime are either incorporated earlier in the production cycle or placed on top of the soil at planting. Because of this increased dependence on herbicides for weed control and to kill the previous crop, the inclusion of conservation tillage as a "sustainable" practice could be questioned. It is included in this book for two reasons. First, on highly erodible soils, protecting the soil may be an overriding consideration. Second, growers and researchers are working on less herbicide-dependent modifications of conservation tillage practices, some of which are deSRCibed here. Methods deSRCibed as no-till, minimum till, incomplete tillage, reduced tillage, or conservation tillage differ from each other mainly in the degree to which the soil is disturbed prior to planting. Even in no-till systems, the soil is opened by coulters, row cleaners, disc openers, in-row chisels or rototillers prior to planting the seed. By definition, conservation tillage leaves at least 30 percent of the soil covered by crop residues. In another variation of reduced tillage, narrow strips are tilled and then planted with standard equipment. Where soils are compacted but subject to erosion, strip tillage is a good compromise because crops can be planted efficiently and grow well in the loosened soil of the tilled strips while the untilled portions of the field conserve soil and water and control weeds.

Material and Methods

In order to tillage system management (TSM) for achieved to the sustainable agriculture in field of soybean (*Glycine max* L.) in Iran at shahr-e Qods region. Shahr-e Qods, is a city located on the south-west of the provincial capital Tehran, in Iran. According to 2006 census, it has 189,120 inhabitants. This experiment was carried out using by a factorial design with four replications during 2009-2010. The factors were till-systems including no tillage (NT), minimum tillage (MT), full tillage (FT) and conventional tillage (CT). The observed data were subjected to analysis of variance (ANOVA) using Statistical Analysis System and followed by Duncan's multiple range tests. Terms were considered significant at $P < 0.05$.

Results And Discussion

The results showed that oil yield was increased under tillage system management and oil yield was improved by tillage control. Our data indicated that MT system was better than NT, FT and CT systems and highest oil yield was obtained under MT system. Reduced tillage practices in agronomic crops such as corn, soybeans, cotton, sorghum and cereal grains were introduced over 50 years ago to conserve soil and water. Crops grown without tillage use water more efficiently, the water-holding capacity of the soil increases, and water losses from runoff and evaporation are reduced. For crops grown without irrigation in drought-prone soils, this more efficient water use can translate into higher yields. In addition, soil organic matter and populations of beneficial insects are maintained, soil and nutrients are less likely to be lost from the field and less time and labor is required to prepare the field for planting. In general, the greatest advantages of reduced tillage are realized on soils prone to erosion and drought, but significant advantages were seen in a 12-year study of Wisconsin silt-loams which were excellent agricultural soil. This study found improvements of many soil quality factors compa red to chisel or plow treatments. These included greater water-stability of surface soil aggregates, higher microbial activity and earthworm populations and higher total carbon. Soil loss was less from sprinkler irrigation than in the plow treatment. There are also disadvantages of conservation tillage. Potential problems are compaction, flooding or poor drainage, delays in planting because fields are too wet or too cold, and carryover of diseases or pests in crop residue. Additional problems from r esidues may be caused by allelopathy and high C:N ratios. Allelopathic effects are most often seen when small-seeded

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vegetables, such as lettuce, are planted directly into rye residues. When the residues are incorporated, as in strip tillage, allelopathic substances break down relatively quickly and are usually not a problem. In vegetable crops, the difficulty of controlling weeds and the need for custom-built equipment have slowed the acceptance of reduced tillage practices. Commercial seeders which plant well into stubble have been developed for most agronomic crops, but are only now becoming available for vegetable crops. A subsurface tiller transplanter has recently been developed at Virginia Polytechnic Institute and State University that should, when it becomes commercially available, greatly increase the ability of vegetable growers to transplant their crops into stubble. Other relative disadvantages of reduced tillage in vegetables relate to the intensive nature of vegetable production. Since inputs are high in terms of seeds or transplants, fertilizers, pesticides and harvest expenses compared to agronomic crops such as corn and soybeans, the economic return must also be high. For example, one no-till tomato grower in Pennsylvania estimated he saved $70/acre by skipping moldboard plowing, three diskings, and two cultivations. For most growers, this represents a small percentage of total costs. In general, vegetable growers want to harvest as soon as possible in the spring in order to get a high price and recover production costs. Without spring tillage, some no-till fields are too compacted and poorly drained for the crop to get a good start. Soil temperatures under the stubble are cooler in the spring, potentially delaying maturity of warm-season vegetables such as sweet corn, snap beans and squash. In addition, if the transplanter does not work well in stubble, the crop may be delayed and mature less uniformly. Variable maturity is a costly problem in commercially grown vegetables especially those like cabbage where each plant is harvested once. It may not be cost-effective to bring crews in to harvest more than once or twice so late or early-maturing plants may not be harvested at all. Another consideration in no-till production is an increased possibility of soil compaction in no-till compared to conventionally tilled soil. During one year of a four-year study, severe compaction and crusting prevented the transplanter shoe from penetrating the soil, resulting in cabbage yields 65 percent lower than conventional tillage. Planting also had to be delayed a month because the site was too wet to plant. A further consideration is that as no-till is generally practiced in agronomic crops, the field is prepared for planting by killing the previous crop with herbicidal desiccants such as glyphosate (e.g. Roundup) or gramoxylin (e.g. Paraquat). The no-till seeders available for agronomic crops were designed to plant into these dried residues. Recently, agronomists have been developing no-till systems where cover crops are planted for weed control then killed with flail or other types of mechanical cutters instead of herbicides. No-till seeders must be modified to work on these tougher residues, but residues control weeds legumes contribute extra nitrogen. Similar systems are under development for vegetable growers who want to reduce tillage operations without using herbicides. With experience, and with the increasing sophistication and availability of no-till equipment for planting vegetables, no-till growers should be able to reach yields at least as high as with conventional tillage practices. If soil water-holding capacity improves, no-till systems may even produce higher yields. Assuming weeds can be controlled and appropriate planters found, most vegetable crops could probably be grown with reduced tillage. Asparagus, snap beans, lima beans, beets, cabbage, carrots, dry bulb onions, peas, potatoes, spinach, popcorn, sweet corn, sweet-potatoes, and tomatoes have been successfully produced in conservation tillage systems. The feasibility of using these systems without herbicides has also been demonstrated, but, as with any new technology, growers will need to experiment to develop a cover crop/vegetable crop system that works well for them. Therefore, the findings of this study showed that tillage system management is very important in Iranian farming, because Iran has a arid and semi arid weather and water resources are limited, so MT system is a good system for farming in this conditions at filed of soybean for achieved to the sustainable agriculture.

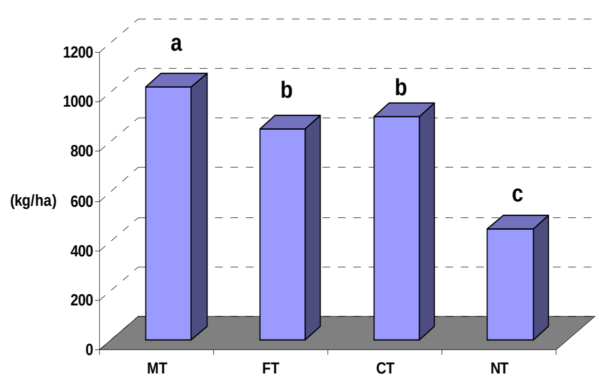

Fig. 1: Potential Oil Production (POP) in *Glycine max* L. under till-systems management

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