Effects Of Different Tillage and Press Wheel Weight on Dryland Wheat Grain Production

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ABSTRACT

Combined effects of tillage and press wheel weight with the impact upon soil compaction were shown an important role on seedling emergence, crop establishment and plant growth. Using the proper combination of tillage implements and determining suitable weight of press wheels were recommended for greater growth and grain yield. In this paper, the effect of different tillage methods and press wheel weights on seedling emergence and wheat yield under dryland conditions in Izeh, Khuzestan province, Iran were investigated. Also, Soil cone index and yield components were recorded. Tillage treatments including conventional tillage (Moldboard plow and disk), reduced tillage (double disks, chisel and disk) and no tillage were applied. Seeding treatments including grain drills using different press wheels and weights (4, 5 and 8 kg/cm). The Experiment was conducted as a split factorial in complete randomized block design using three replications. Results showed that reduced tillage system increased seedling emergence and grain yield. Independent press wheel drills with the decreased of cone index and increased emergence rate (54%) was significantly the greatest treatment in wheat yield production compared to other treatments. The highest grain yield, (2202.9 kg/ha) was produced where 5 kg/cm width of press wheel was used. In order to increase seedling emergence rate and grain yield under dryland condition using an independent 5 kg/cm press wheel width followed reduced tillage was recommended.

Key words: Tillage, seeding machines, cone index, press wheel, dryland wheat, Iran

1. INTRODUCTION

Tillage can provide appropriate seed bed for plant by changing soil structure and decreasing cone index which has direct effect on seedling and rate of emergence (Aiken, et al, 1997; McMaster, et al, 2000; McMaster, et al, 2002; Lapen, et al, 2004). Suitable selection of tillage method and providing proper effect on soil physical properties to improve seed bed for plant emergence, growing and its development, finally higher grain yield (Barzegar, et al, 2004; Licht and Al-Kaisi, 2005). Reduced tillage provides better physical conditions for seedling emergence, root growth and by decreasing cone index, compared to conventional tillage (Helm, 2005). Proper use

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of tillage provides enough soil moisture at seeding, hence enhances its ability to germination, and the early establishment of roots. Press wheels as ports of seeding machines can create the condition for uniform plant growth and increased yield (Karayel, et al, 2004). Planter's performance related to many factors such as seed vitality, soil temperature at the time of germination (McMaster, et al, 2002). The presence of soil moisture and the amount of air in the soil around seed (Eskandari, 1997; Eskandari and Mahmoodi, 2000), and sowing depth (Ozmerzi et al, 2002) would affect yield. Press wheels by creating appropriate conditions on top of the seed, leave a good effect on the germination and seed emerging rate as well (Asoodar, et al, 2006; Vamerali, et al, 2006). Press wheels allow faster seed germination and increased emergence rate (Rainbow and Dare, 1997; Naser and selles, 1995; Asoodar, et al, 2006) by reducing sowing depth (Karayel, et al, 2004) thus improved performance via emerging and faster establishment (Radford, 1996). Design and the right combination of seed planter tools for instance, furrow openers and press wheels have quantifiability effect on furrow preparation, moisture absorbing (Tessier, et al, 2003). The weight of press wheels should be corrected at the time of seeding (Asoodar, et al, 2006). Unfortunately press wheels in most drills have implemented on one or two axels in groups and independent regulation of wheels weight is not proportionate to the possible condition, so its necessary to study the on press wheels weight variations and their effect on crop yield. Also determining seed bed affected by tillage system to provide dryland soil conditions in any region.

2. MATERIAL AND METHODS

The experiment was carried out in 2005 in Khuzestan province which is located in 31° 51´ N and 49° 52´ E. with annual rainfall within a 10-year period was 757.52 mm. According to a 10-year statistics January and February received the greatest amount of rainfall. Four tillage methods consist no-tillage, reduced tillage (disk and chisel), reduced tillage (twice disks) and conventional tillage (moldboard plow followed by a disk). Tillage depth of plow, disk and chisel was 15, 10-15 and 25 respectively. Sowing practices were performed using a drill equipped two axles press wheels and independent press wheels. Press wheel weight was 4, 5 and 8 kg/cm of press wheel width. The experiment was conducted using a factorial split complete randomized block design with three replicates.

To determine soil cone index in the depth of 30 cm a Penetrologer machine was used. This machine was equipped with an 80 cm axle to the end of which there was a small cone with 30° vertex angle and 2 cm^2 base area. This sampling was performed at the emergence and blooming times (Nidal and Hamdeh, 2003). The number of emerged seeds of two lines, at one meter length in each plot was counted daily, To calculate seedling emergence percentage (Hemat, 1995), using formula (2-1).

Formula (2-1): $$M = \frac{ppsm}{(spsm \times P \times G)} \times 100$$

Where: M is the percent of seedling emergence, ppsm is the number of emerged bushes in m^2, spsm is the number of sowing seed in m^2, P is pure seed percentage and G is the vitality (germination percentage) of seed.

Also, formula (2-2): was used to determine the emergence rate index (Chen, et al, 2004; Tessier, et al, 1991).

Formula (2-2): $$SE = \frac{\sum\left(\frac{Ni}{di}\right)}{L}$$

Where: SE is the rate of emergence (daily in one meter), Ni is the number of seeds emerged every day, and finally L is the length of line (m).
This practice continued as long as the number of emerged seeds was not increased. At harvesting, grain yield, biomass, and spike number, the number of thousand grains and harvest index were calculated. After harvesting the crop (3 m^2 in each plot) stalk and spikes were weighted. Then the spikes numbers in each m^2 and seed yield were calculated.

3. RESULTS AND DISCUSSION

3.1. Soil Cone Index

Tillage and sowing machines showed significant effect on soil cone index table 3-1. Independent and two axle press wheel drills included rubber and metal press wheels were shown their own different effects on soil compaction.

Table (3-1). analysis of variance for cone index in different depth (KPa)

Source of variation	df	0-5 cm depth		5-10 cm depth		10-20 cm depth	
		F	Ms	F	Ms	F	Ms
Replicate	2	0.12	146.3	1.33	1495.3	15.47	5659.1
Tillage	3	$3.84^{n.s}$	4742.1	9.45^{*}	10627	28.01^{**}	10247.9
E_a	6	3.11	1233.6	1.81	1124.5	0.48	365.8
Planter	1	5.22^{*}	2027.2	7.52^{**}	4664.5	$1.96^{n.s}$	1498.5
Weight	2	4.4^{*}	1745.1	$1.17^{n.s}$	727.5	$1.95^{n.s}$	1490.6
T×P	3	3.79^{*}	1506	3.28^{*}	2036.2	$0.73^{n.s}$	558.3
T×W	6	$0.3^{n.s}$	117.7	$0.85^{n.s}$	528.7	$0.93^{n.s}$	711.4
P×W	2	$0.37^{n.s}$	147.4	$1.69^{n.s}$	1046.8	$0.34^{n.s}$	258.3
T×P×W	6	$0.7^{n.s}$	279.1	$1.69^{n.s}$	1050.9	$0.98^{n.s}$	744.9
E_b	40	-	396.9	-	620.4	-	762.8
CV		20.32		18.38		17.34	

* and ** shown significant at level of 5 and 1 percentage and n.s shown no difference in each column

There was a significant difference in cone index between the two drills at 0-5 and 5-10 cm depths. Two-axle press wheel drill caused greater resistance (103.4 KPa) in 0-5 cm depth, figure (3-1). This 11.57% difference was due to press wheel profile. The independent press wheel drill was made of rubber whereas the press wheels in two-axle drill was made of metal and shown no flexibility at soil unevenness and caused more pressure on soil.

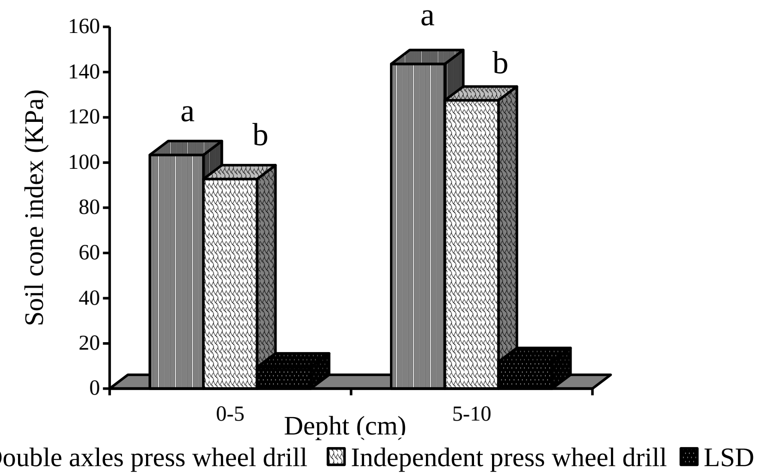

Figure (3-1). The effect of sowing machine on soil cone index

There was a significant difference in soil cone index, at 0-5 cm depth for 8 kg/cm and the weights of 4 and 5 kg/cm press wheel width, table (3-2). The 8 kg/cm press wheel weight showed 18% and 23% greater cone index where compared to 4 and 5 kg/cm press wheel weight respectively.

Table (3-2). mean of soil cone index using press wheels different weight

Depth / weight	8 kg/cm	5 kg/cm	4 kg/cm
0-5 (cm)	107.44[a]	90.81[b]	85.68[b]
5-10 (cm)	139.76[a]	137.63[a]	129.34[a]

Common letter shown not significant in each row

The interaction effect of tillage and sowing machine on soil cone index for no tillage and two axle press wheel drill was the highest (138.92 KPa) compared to conventional tillage as shown in figure (3-2).

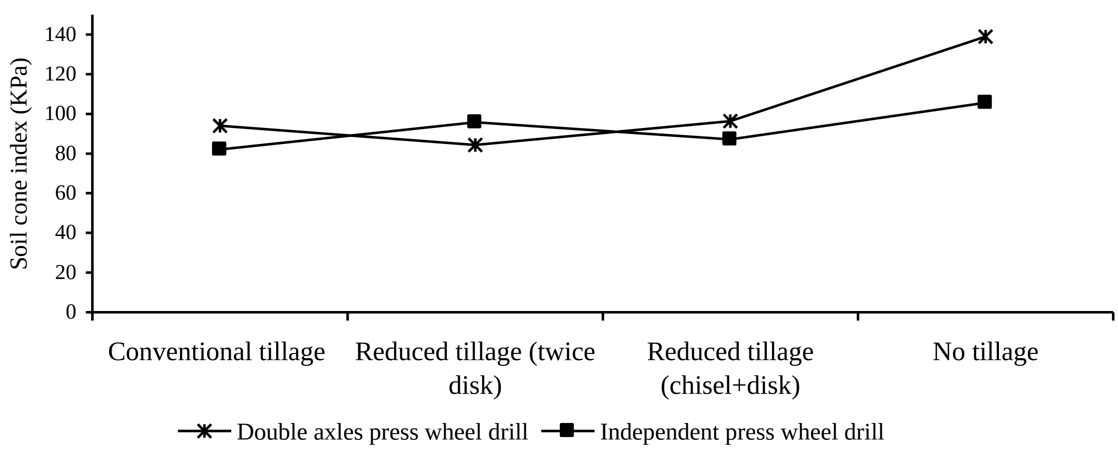

Figure (3-2). Interaction effect of tillage and sowing machine on soil cone index

3.2. Seedling and Rate of Emergence

Tillage and sowing machine were shown significant ($p \leq 0.05$) effect on emergence rate table (3-3). Tillage, sowing machine and press wheel weights all affected the emergence rate at 1% level of probability. Interaction effect of sowing machines was significant where seedling emergence was compared.

Table (3-3). Analysis of mean variance for seedling and rate of emergence

Source of variation	df	Emergence rate		seedling emergence	
		F	Ms	F	Ms
Repeat	2	1.1	0.337	1.31	23.55
Tillage	3	6.67*	2.043	24.03**	432.14
E_a	6	1.18	0.306	0.39	17.98
Planter	1	63.18**	16.45	104.69**	4798.73
Weight	2	7.69**	2.003	28.6**	1310.77
T×P	3	1.56n.s	0.41	0.31n.s	14.14
T×W	6	1.9n.s	0.495	0.47n.s	21.48
P×W	2	6.22**	1.62	7.14**	327.16
T×P×W	6	2.31*	0.6003	0.49n.s	22.32
E_b	40	-	0.26	-	45.83
CV		22.52		10.21	

* and ** shown significant at the level of 5 and 1 percentage and n.s shown no difference

The interaction effect of sowing machine and press wheel weights on seedling emergence was significant where press wheel with 5 kg/cm weight was applied. The independent press wheel drill, 5 kg/cm weight with the lower cone index would lead to improve emergence rate, figure (3-3).

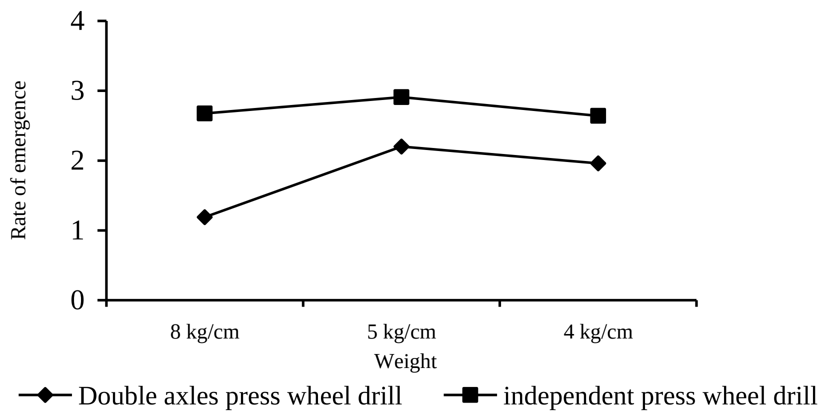

Figure (3-3). Interaction effect of machine and press wheel weight on rate of emergence

No-tillage method showed the lowest emergence rate (1.78) and was different from other treatments table (3-4). The high soil cone index in no-till treatment was lead to a decrease emergence rate. Finlay et al (2003) also reported that tillage of any form could increase the emergence rate by decreasing soil cone index. However, reduced and conventional tillage were not shown any significantly differences.

Soil temperature in reduced tillage was higher than no-tillage, and this could be due to better water drainage. Reduced tillage followed by double disk produced 71.36% seedling emergence which was higher compared to reduced tillage (chisel and disk) and no-tillage by 4% and 12% respectively.

Table (3-4). Mean of seedling and rate of emergence using different tillage systems

Tillage	Rate of emergence	Seedling emergence
Conventional tillage (moldboard plow & disk)	2.45[a]	66.61[a]
Reduced tillage (twice disk)	2.40[a]	71.36[a]
Reduced tillage (chisel disk)	2.43[a]	67.56[a]
No-tillage	1.76[b]	59.61[b]

Common letter shown not significant in each row

Two-axle press wheel drill was different from the independent press wheel drill regarding emergence percentage and rate table (3-5). Independent press wheel drill with a difference of 54% in the emergence rate and 28% in emergence percentage had shown a better rate in comparison to tow axle drill. Sowing machines created different rates and percentages of seed emergence by the diverse effects leaving on seed furrow due to different kinds of furrow openers and the soil over seeds due to the press wheel kind and weight variation.

Table (3-5). Mean compression seedling and rate of emergence in sowing machine

Sowing machine	Independent press wheel drill	Twice press wheel drill	different
Rate of emergence	2.74[a]	1.78[b]	53.93%
Seedling of emergence	74.45[a]	58.12[b]	28.09%

Common letter shown not significant in each row

8 kg/cm with 4 and 5 kg/cm of press wheel width affected the rate and percentage of plant emergence significantly table (3-6). Rainbow and Dare (1997); Chen et al, (2004) and Asoodar et al, (2006), have also obtained the same results. This effect was mostly due to the increased contact surface between seed and soil, the increased ability of moisture absorbing by seed and maintaining soil cone index on seed in a specified area as well. Reduced rate and percentage of emergence for 8 kg/cm press wheel treatment was the result of an increased soil cone index to a depth of 5 cm, compared to other weights table (3-3).

Table (3-6). Mean of seedling and rate of emergence using different press wheel weight

Press wheels weight (kg/cm of press wheel width)	8kg/cm	5kg/cm	4kg/cm
Rate of emergence	1.93b	2.44a	2.42a
Seedling of emergence	57.79b	71.25a	69.81a

Common letter shown not significant in each row

3.3. Wheat Yield and Components

Machine and press wheel weight showed great impact on yield and spikes numbers table (3-7). Effects of combination furrow opener and press wheels were shown to be useful at seeding operation.

Table (3-7): Analysis of variance for grain yield, spikes number in m^2, press wheel weights and 1000 seeds

Source of variation	df	Grain yield					
		yield		spikes number in m^2		1000 grain seed weight	
		F	Ms	F	Ms	F	Ms
Repeat	2	3.07	1537197.8	1.17	4322.24	0.84	15.33
Tillage	3	$0.71^{n.s}$	3527757	10.33n.s	4898.5	1.18n.s	21.48
E_a	6	4.17	499931	3	3683.48	1.89n.s	18.15
Planter	1	92.87^{**}	11138704	54.71**	67203.27	52.03**	498.75
Weight	2	1.36^{*}	42753.2	2.09*	109.6	1.45n.s	13.89
T×P	3	$2.25^{n.s}$	269899	0.99n.s	1215.18	0.51n.s	4.86
T×W	6	$0.59^{n.s}$	71064	0.36n.s	447.95	0.44n.s	4.24
P×W	2	$0.17^{n.s}$	20137	0.2n.s	250.99	0.03n.s	0.253
T×P×W	6	$1.29^{n.s}$	155293	1.22n.s	1503.81	1.54n.s	14.75
E_b	40	-	119935	-	1226.4	-	9.58
CV		19.13		17.43		8.73	

* and ** shown significant at the level of 5 and 1 percentage and n.s shown no difference

Independent press wheel drill produced higher grain yield (2202.9 kg/ha) which shown 55.5% greater compared to two axle press wheel drill figure (3-4). Decreased soil cone index, increased seedling emergence and enhanced spike number in m^2 were all lead to an increased yield for independent press wheel drill treatment.

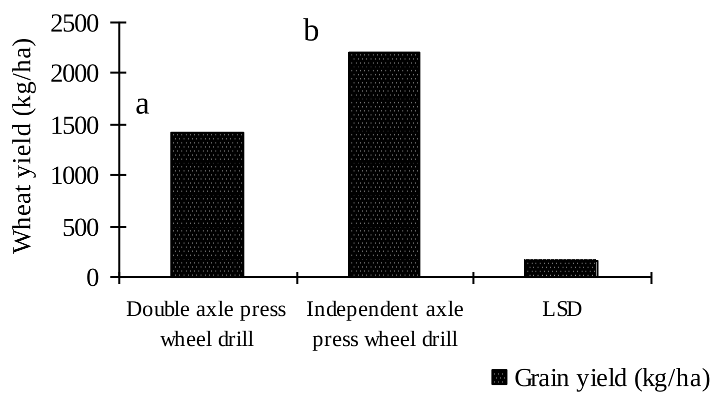

Figure (3-4). Effect of sowing machines on grain yield

Decreased cone index and also improved emergence rate (Table 3-4) in reduced tillage method (double disks), could increase the spike number in m^2 led to increase yield. The results were similar with findings of Ciha (1982), Kreuz (1990) and Finlay et al (2003).

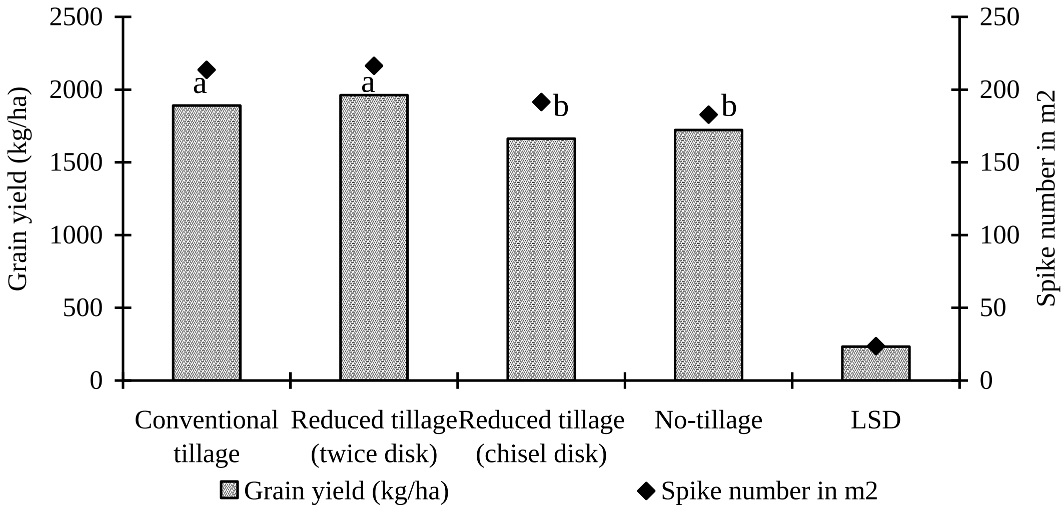

Figure (3-5). Effect of tillage system on spike of number in m^2 and grain yield

The 1000 wheat grain for reduced tillage (double disks) was more due to using disk and chisel, but was not different compared to conventional tillage table (3-8). Double disk reduced tillage with decreased of soil compaction about 75% MPa at the depth of 0-5 cm and a better clod sifting prevented the evaporation of soil moisture. No tillage method lowered the absorption of soil moisture which was actually due to its higher compaction than other tillage systems, and for this reason, this treatment had been suffering for lack of moisture with reduced 1000 grain yield.

Table (3-8). Mean of 1000 seeds using different tillage

Tillage	the weight of grain one 1000 seeds
Conventional tillage (moldboard plow and disk)	36.77[a]
Reduced tillage (twice disk)	35.72[ab]
Reduced tillage (chisel and disk)	35.13[ab]
No-tillage	34.16[b]

Common letter shown not significant in each row

Independent press wheel drills produced higher 1000 grain weight (38.08 g) compared the two axle press wheel drill figure (3-6).

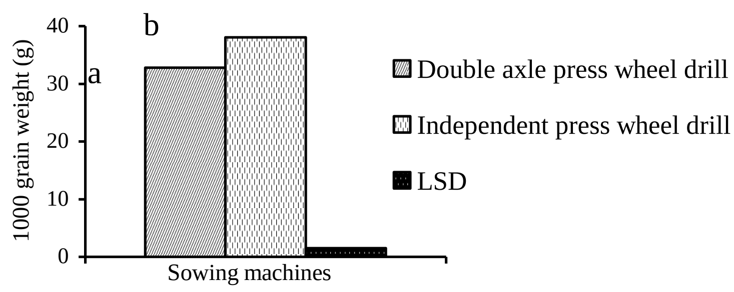

Figure (3-6). Effect of sowing machines on 1000 grain weight

4. CONCLUSION:

Tillage methods, using of press wheels on drills and the weight of press wheels regarding shown significant effects on soil cone index and also seedling emergence rate. Reduced tillage method (double disks) by the significant impact on soil cone index ($p \leq 0.05$) and of 1967.7 kg/ha was the greatest produced yield among other treatments. Independent press wheel drill with 5 kg/cm weight of press wheel width was also the greatest where produced 2202.9 kg/ha grain yield.On the basis of the results of this study, reduced tillage method (double disks) was shown to be applicable in the area and similar regions for producing dryland wheat grain yield.

5. REFERENCE:

1 Aiken, R. M., Flerchinger, G. N., Farahani. H. J. and Johnson, K. E. 1997. Energy balance simulation for surface soil and residue temperatures with incomplete cover. Agron. J. 89. 405-416.

2 Asoodar, M. A., Bakhshandeh, A. M., Afraseabi, H. and Shafeinia, A. 2006. Effects of press wheel weight and soil moisture at sowing on grain yield. Agron. J. 4.

3 Barzegar, A. R., Asoodar, M. A., Eftekhar, A. R. and Herbert, S. J. 2004. Tillage effects on soil physical properties and performance of irrigated wheat and clover in semi arid region. Agron. J. 3 (4): 237-242.

4 Barzegar, A. R., Hashemi, A. M., Herbert, S. J. and Asoodar, M. A. 2004. Interactive effects of tillage system and soil water content on aggregate size distribution for seedbed preparation in Fluvisols in southwest Iran. Soil and tillage Res. 78. 45-52.

5 Barzegar, A. R., Mosavi, M. H., Asoodar, M. A. and Herbert, S. J. 2004. Root mass distribution of winter wheat as influenced by different tillage systems in semi arid region. Agron. J. 3 (3): 223-228.

6 Chen, Y., Tessier, S. and Irvin, B. 2004. Drill and crop performances as affected by different drill configuration for no-till seeding. Soil and tillage. Res. 77. 147-155.

7 Ciha, A. G. 1982. Yield and components of four spring wheat cultivar selection. Agron. J. 78. 795-799.

8 Eskandari, A. 1997. Correct selection of drill for sowing dryland wheat. Water, soil, machine journal. Number of 42, Pp 27-33.

9 Eskandari, A. and Mahmoodi, H. 2000. Affect of fertilizer on grain yield dryland wheat. Seedling and seed journal. No. 17. Number of 2. Pp 8-10.

10 Finlay, M. J., Tisdall, J. M. and McKenzie, B. M. 2003. Affect of tillage blow the seed on emergence of wheat seedlings in a hard setting soil. Soil and tillage Res. 28 (3): 213-225.

11 Helm, V. 2005. Conservation tillage: corn, grain sorghum, and wheat in Dallas County, Texas. Soil and Tillage Res. 23 (5): 356-366.

12 Hemat, A. 1995. Effects of seed bed property and sowing method on seedling emergence watery wheat. Agricultural science Iran. No. 27. Number of 4. Pp. 55-68.

13 Karayel, D., Barut, Z. B. and Ozmerzi, A. 2004. Mathematical modeling of vacuum pressure on a precision seeder. Biosystems. Eng. 87 (4): 437-444.

14 Kreuz, E. 1990. The influence of no-plough tillage for winter wheat in a three-course rotation on yield and structure. Archive-Fur-Acker. 34 (9): 635-641.

15 Lapen, D. R., Topp, G. C., Edwards, M. E., Gregorich, E. G. and Curnoe, W. E. 2004. Combination cone penetration resistance/ water content instrumentation to evaluated cone penetration- water content relationships in tillage research. Soil and Tillage Res. 79: 51-62.

16 Licht, M. A. and Al-kaisi, M. 2005. Strip- tillage effect on seedbed soil temperature and other soil physical properties. Soil and Tillage Res. 80: 233-249.

17 McMaster, G. S., Palic, D. B. and Dunn, G. H. 2002. Soil management alters seedling emergence and subsequent autumn growth and yield in dryland winter wheat-fallow systems in the central Great Plains on a clay loam soil. Soil and Tillage Res. 65: 193-206.

18 McMaster, G. S., Aiken, R. M. and Nielsen, D. C. 2000. Optimizing wheat harvest cutting height for harvest efficiency and soil and water conservation. Agron. J. 92: 1104-1108.

19 Naser, H. M. and Selles, F. 1995. Seedling emergence as influenced by aggregate size, bulk density, and penetration resistance of the seedbed. Soil and Tillage Res. 34: 61-76.

20 Nidal, H. and Hamdeh, A. 2003. Soil compaction and root distribution for okra as affected by tillage and vehicle parameters. Soil and Tillage Res. 74: 25-35.

21 Radford, B. J. 1996. Effect of pres wheel and depth of semi dwarf and tall wheat's. Oust. J. of exp. Agric. 26 (6): 697-702.

22 Rainbow, R. W. and Dare, M. W. 1997. Summary of nitrogen and phosphorus fertilizer placement research 1993-1995 in farming systems developments in Adelaide. Cooperative research center for soil and land management. 128-129.

23 Tessier, S., Saxton, K. E. and Papendick, R. I. 2003. Furrow opener and press wheel effects on seed environment and wheat emergence. Soil and Tillage Res. 39 (7): 547-559.

24 Tessier, S., Saxton, K. E., Papendick, R. I. and Hyde, G. M. 1991. Zero-tillage furrow opener effects on seed environment and wheat emergence. Soil and Tillage Res. 21: 347- 360.

25 Vamerali, T., Bertocco, M. and Sartori, L. 2006. Effects of new wide-sweep opener for no-till planter on seed zone properties and root establishment in maize: A comparison with double-disk opener. Soil and Tillage Res. 89: 196-209.