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EMERGENCE OF WHEAT SEEDLINGS AS AFFECTED BY SOIL COMPACTION

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ABSTRACT

Effect of soil compaction on the emergence of wheat seedlings was studied during two cropping seasons. A compaction pressure of 1.55×10^4 N/m^2 was managed through the transport wheel of a grain drill used in planting operations. The emergence was found faster and greater in the compacted soil. The desirable response of compaction may be associated with a better soil-seed contact coupled with greater soil moisture availability.

INTRODUCTION

There are a number of factors that influence the germination of seeds. Some of them which are of interest in analyzing the grain drill performance and developing improved designs, are opening the seed furrow to a proper depth, metering, depositing, covering and compacting the seed to a proper degree. The grain drills currently used in Pakistan are not equipped to cover and compact the seeds, whereas Smith (1962), Kepner *et al.* (1972) and Sheikh (1979) indicated that both compacting and covering operations affect the emergence of seedlings. The present study was undertaken to investigate the effects of tillage and compaction on the emergence of seedlings.

MATERIAL AND METHODS

This experiment was conducted in silty loam soil at the University of Agriculture, Faisalabad, Pakistan. A carefully calibrated tractor drawn grain drill was used for planting wheat seeds. All the seed rows made by the grain drill were left uncovered and uncompacted except the one preceded by the transport wheel which served as a compaction device. The pressure exerted by the transport wheel as calculated from field measurements was 1.55×10^4 N/m^2. The wheel being wider than the seed furrow reasonably covered the seeds before compacting them.

With a view to study interaction of compacted seed and tillage operations, five tillage treatments each having three replications resulting in 15 plots were completely randomized during the first year. Each implement was used twice in a plot of 58 x 46 square meters. Soil density and cone index measurements were made from each plot. Five rows, each 1.5 m long, were selected in each of the plots for seedling counts on completion of germination. With two compaction pressures (0.0 and 1.55 x 10^4 N/m^2) and five tillage treatments, a factorial design was considered appropriate for analyzing the data.

During the second year, the above experiment was repeated under a single tillage treatment. Germination rates were statistically analyzed using paired t-test.

RESULTS AND DISCUSSION

The effect of covering wheat seeds with soil and then compacting the soil with a pressure of 1.55 x 10^4 N/m^2 on germination rates in the plots prepared with different tillage implements was investigated during the first year of study. The analysis of variance (Table 2) indicated that the compaction pressure had a highly significant effect on the seedling emergence. The average emergence of seedlings was 6 to 22 per cent higher in compacted rows compared to the uncompacted ones. A noticeable response of compaction pressure on seedling emergence may be attributed to a number of factors, namely increased availability of soil moisture, appropriate soil temperature and a desirable soil-seed contact. The results of the present study, however, contradicted Harrison (1975) who indicated suppression in emergence rate by compacting soil after seeding, since the compaction pressure in those studies was beyond the optimum level.

The main effect of tillage treatment was found statistically significant indicating that the soil compaction above the seed affected the germination rates differently under varying tilth conditions, which may be related to the variation of soil moisture available to seed due to varied ploughing depth, soil density and penetration resistance encountered under various tillage operations (Table 1). Obviously a different package of physical soil conditions is available by using different types of tillage implements with the result that various implements responded differently. Figure 1 indicates the following points :

Table 1. *Germination rates and other soil properties in different tillage operations*

	Treatments*	Seedling count 1.5 meter/row		Ploughing depth (cm)	Wet soil density g/cm³	Penetration resistance (kg/cm²)
		Without compaction	With compaction			
1.	'Muna' plough with bullocks	40,41,34	43,42,36	12.2,12.7,11.4	2.76,2.83,2.94	3.0,2.0,1.4
2.	Double plow of Chinese power tiller	31,32,41	38,37,46	12.7,13.2,14.0	2.71,2.82,3.07	3.2,2.1,2.0
3.	Rotavator of Chinese power tiller	27,37,30	40,41,34	6.8, 6.1, 8.1	2.86,2.14,3.07	6.8,7.2,3.6
4.	Rotavator of garden tractor	37,44,41	43,43,47	8.4, 8.1, 6.8	2.90,2.75,2.96	1.2,1.1,1.4
5.	Disk harrow of Massey Ferguson	38,43,42	50,46,43	12.2,11.4,13.2	2.86,2.87,2.88	1.3,1.2,1.0

*1. Bullocks with an indigenous plough i.e., 'Muna'

2. Chinese two wheel power tiller, Model Dong-Feng 12, 12 HP type 195 (diesel) with double plough

3. The above Chinese tiller with rotavator.

4. German Four wheel garden tractor model AM-18 with rotavator.

5. Massey Ferguson four wheel general purpose tractor model MF-135 with disk harrow.

Table 2. *Analysis of variance for effect of compaction pressure and tillage operation on germination rates*

Source of variation	DF	MS	F. ratio
Compaction pressure	1	168.4	10.44**
Tillage operation	4	78.22	4.86*
Pressure x tillage	4	5.62	0.35
Error	20	16.10	

*Significant at 0.05 probability level.

**Significant at 0.005 probability level.

Table 3. *Germination rates per 1.2 meter per row in a single treatment (tractor drawn cultivator*

Plot No.	Without compaction	With compaction
1.	25	34
2.	24	30
3.	34	35
4.	31	34
5.	33	31
6.	34	36
7.	27	30
8.	25	33
9.	30	35
10.	26	34

T. calculated = 4.22 and T. table = 3.69 at 0.005 probability level : hence variation of the effect is highly significant.

— Emergence was greater in the compacted rows under all the tillage operation.

— Tilth achieved with bullock's plow and rotavator of garden tractor is comparable to double plow of powertiller and Massey Ferguson's

disk harrow respectively.

— Germination rates significantly decreased in the plots prepared with rotavator of power tiller. The decrease is due to greater soil strength/mechanical impedence as evidenced by the values of penetration resistance (Table 1) in the said treatment plots.

Again, the effect of compaction on emergence was found statistically significant from the observations (Table 3) made during the second year. This confirmed the results obtained earlier.

Conclusions : The compaction of soil at a pressure of 1.55×10^4 N/m² improved the seedling emergence under the given soil and crop conditions. Nevertheless, the amount of optimum compaction pressure still remains to be investigated. The optimum pressure will change with the texture of soil and type of crop.

It was observed during the course of this experiment that the germination is expedited when seed is covered and compacted. Consequently, such operations may be helpful particularly at the time of late sowing.

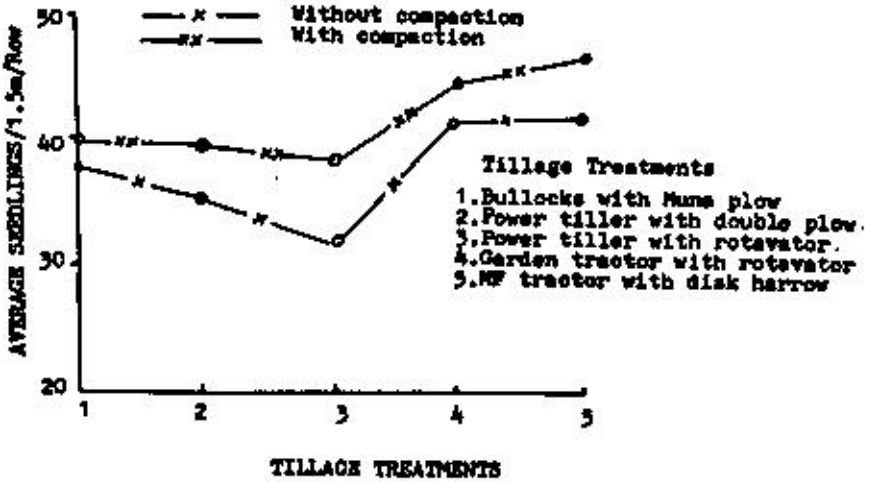

Figure I. Effect of compaction pressure on seedling emergence under different tillage treatments

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