Increasing energy efficiency by geometric modification of hoe-type furrow opener

R. Rahimzadeh¹* - Y. Ajabshichi² - S. Abdollahpour³ - A. Sharifi⁴ - N. Sartipi⁵ - A. Mohammadi⁶

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Introduction

Direct planting becomes more common in the recent years, because it conserves soil and water as well as it saves energy and time. However, this technology needs special implements such as seed planter. Given that direct planting is practiced in undisturbed lands, so it was needed to design a special furrow opener. In order to obtain a suitable furrow opener this experiment was conducted in rain-fed Agricultural Research Institute in Maragheh.

Materials and Methods

Most of seed planters that are used for cultivation in rain fed conditions are equipped by hoe-type furrow opener. Hoe-type furrow openers have good penetration in hard and dry soils. However, they do not have the ability for direct planting. Hoe-type furrow opener was chosen as a model. Then by changing the geometric form of the depth to width ratio (d/w), the two openers were designed. In the first design, which was called O₁ two wings and a narrow blade acting as a coulter were added in front of the hoe-type furrow opener. In the second design, which was called O₂, in addition to the O₁ modification, furrow opener width was decreased and a disk blade was added for seed sowing (Fig. 1).

The performance of O₁ and O₂ openers were compared with the conventional hoe-type furrow opener (check) in soil bin and in field conditions. At three different forward speeds (1, 1.5 and 2 m s⁻¹) with 3 replications, the effects of the openers designs of vertical and horizontal soil forces were evaluated in soil-bin conditions. In order to evaluate the performance of the furrow opener in field conditions, an experiment was conducted using a split plot design based on RCBD at 4 replications. Furrow openers formed the main plots and forward speeds formed the sub plots. Each plot size was 22 meters long in two rows for each treatment. After germination of wheat crop, the numbers of seedlings in two rows were counted (along a one meter). After crop maturity, all plots were harvested by hand and grain and biological yield was measured. ANOVA test, uniformity test and mean comparison were conducted by using Genstat software.

Results and Discussion

The soil bin test results showed that opener design and forward speed both have significant influences on the horizontal force (P<0.01). Horizontal force was increased with increasing of forward speeds. The same result was reported by Wheeler and Godwin, 1996 and Astafford, 1979. The lowest horizontal force (average 1.66 kN) occurred at 1 m s⁻¹ and the highest (average 1.94 kN) occurred at 2 m s⁻¹ forward speeds. Horizontal force increased in O₂ (2.8%) and decreased in O₁ (3.4%) compared with the control (average 1.77 kN). Moreover, openers had significant influence on the vertical force (P<0.01). Vertical force values were negative in O₁ (average -0.05 kN) and O₂ (average -0.07 kN) in comparison with positive value in the control (average +0.01 kN). The effect of forward speed on vertical force was not statistically significant. The field results showed that

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1- Ph.D Student of Biosystems Department, Tabriz University
2- Professor of Biosystems Department, Tabriz University
3- Associate Professor of Biosystems Department, Tabriz University
4- Member of Scientific Board of Agricultural Engineering Institute
5- Dryland Agricultural Research Institute, Agricultural Research, Education and Extension Organization (AREEO) Maragheh Iran
6- Professor of plant Breeding Department, Tabriz University

(*-Corresponding Author Email: rezarahimzadeh42@yahoo.com)
there were significant differences among the openers in the numbers of seedling, grain and biological yield (P<0.01). The O₂ opener (with the average of 48 seedlings per one meter row) had 33% and 24% more seedlings in comparison with O₁ and check furrow openers, respectively. Probably, using dick bald in O₂ design leads to increased seed germination. Increasing of seed germination by using disk furrow opener as an advantage is reported by Kushwaha and Foster, 1993. The O₂ furrow opener would also increase grain yield about 36% compared with both O₁ and check furrow openers.

Conclusions

It can be concluded that the newly designed furrow opener (O₂) could improve the energy efficiency with increasing crop yield. Hence, O₂ furrow opener could be recommended for direct planting in rain-fed farming.

Keywords: Direct planting, Dryland farming, Energy efficiency, Farrow opener, Wheat