

# Effects of Sowing Techniques and Seed Rates on Oilseed Rape Seedling Emergence, Crop Establishment and Grain Yield

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## ABSTRACT

Sowing techniques and type of seeding machines, play an important role in seed placement, and seedling emergence which ultimately affect crop growth and grain yield. The selection of suitable planting methods is dependant upon the time of planting rapeseeds, irrigation methods, amount of residue in the field and type of planting machines. A field experiment was conducted at Zanjan University research station in 2006. The main goals were to determine the effects of different seeding techniques and machines, and also different rates of oilseed rape application on seedling emergence, plant establishment and final grain yield. A factorial experimental design in the form of randomized complete block was applied with four replications to measure the effects of the above factors. Two different pneumatic and common mechanical planter were used. Seeds were sown on flat and raised-bed with three levels of 5.5, 7, 8.5 kg seeds per hectare. Results showed that the planting machines had significant ( $P \leq 0.05$ ) effect on seedling emergence. Mechanical planter had higher seedling emergence than pneumatic planter. Mechanical planter sowing the amount of 8.5 kg/ha seed showed higher seedling emergence ( $P \leq 0.05$ ) than others. Uniformity on row and proper seed depth of mechanical planter was significantly greater ( $P \leq 0.01$ ) than pneumatic planter. Flat planting method showed more uniformity on rows ( $P \leq 0.05$ ) than raised-bed. Pneumatic planter improved better post-winter plant establishment in comparison with mechanical planter ( $P \leq 0.05$ ). Finally, grain harvested using pneumatic planter with flat planting method was greater when 8.5 kg/ha seed was applied at sowing in the experiment conditions. However, grain yield was not statistically different.

**Keywords:** Oilseed rape; planter; planting method, oilseed rape yield, Iran

## 1. INTRODUCTION

Planting of rapeseed has been accepted for several centuries. This plant was discovered 1500 years b.c. (Azizy, et al., 1999). Now, 22 million hectares of this crop is under cultivation in 53 countries around the world. China, Canada, Australia and India are the most important producers of rapeseed (Shahidi, et al., 1999, Azizy, et al., 1999). Common grain planters are used for planting rapeseeds, especially the cereal grain drills are recommended in Iran. Also planting methods and seed rates are different. So selection of planters and planting methods should be

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considered for proper seed placement, seedling emergence and higher grain yield (Asoodar, 2001; Gruber *et al.*, 2004; Asoodar, *et al.*, 2006).

Whereas more than 80% vegetable oil for human consumption in Iran is provided from importation and yearly more amounts of foreign exchange sources has been used for food importation, the importance effect of mechanized cropping rapeseed was appeared. Now, rapeseed is planted by pneumatic and mechanical planters in Iran. An evaluation of common rapeseed planters has revealed that mechanical grain drills could produce higher seedling emergence, emergence rate index, post-winter establishment, proper seed depth, uniformity on rows and grain yield compared to other planters (Yousefzadeh, 2004, Schneider *et al.*, 2006). Afzalnia (1998) indicated that mechanical planter produced greater seedling emergence and uniformity on rows than pneumatic planters. However, Hammerschmid (1990) showed that pneumatic planters with higher uniformity on row and lower seed damage than mechanical seeders. The selection of suitable planting method is dependant upon the time of rapeseed planting, irrigation, amount of crop residue in the field and type of planting machines. Also, using furrowers affected crop root growth and controlling weeds.

Seeding, using row crop planters as raised-bed planting would preferable than flat land planting. Ozpinar (2004) reported that cotton raised-bed planting had higher seedling emergence and grain yield compared with flat land planting. Also Oswald, *et al.* (2002) indicated that corn brought more grain yield when it was sown on raised bed in comparison with flat-planting. Narang *et al.* (1994) reported wheat yielded under flat-planting was about 4-5 ton per hectare in India, while, Aguino (1998) indicated that 6 tons per hectare of wheat was harvested from raised-bed planting in the north of Meczico.

In recent years it has become more necessary to improve sowing techniques through preferred seedbed preparation and early crop growth (Eskandari, 1999; Asoodar *et al.*, 2000 and Asoodar and Barzegar, 2006; Gruber and Claupein, 2006). Current regular planting systems put the seeds in soils without controlling the seed depth variation which resulted in reduced seedling emergence (Tessier *et al.*, 1991; Riethmuller, 1995; Rainbow *et al.*, 1992; 1994; Eshraghi *et al.*, 2007). Also using the correct type of furrow openers gave better crop emergence and establishment which is due to improve depth control and seed to soil contact (Asoodar, *et al.*, 2006; Asoodar and Desbiolles, 2004; Buttar *et al.*, 2006). Most of agricultural lands in Iran are under cultivation and it is not economical to extend or develop new cultivated lands for increasing crop yield (Seyedan, 2002; Behrens *et al.*, 2006). So, the efforts of agricultural scientists are on the effects of different seed varieties and the better way of using technology and new methods of crop cultivation. The role of using the innovated farm machinery is one of the important applications for increasing crop production (Asoodar, 2001). Day (1967) and Hossain (2005) indicated that flat and raised-bed planting methods of wheat not shown significant effect on grain yield, but the amount of yield under raised-bed planting had higher grain yield.

Increasing the amount of seed rape from 3 kg/ha to 7 kg/ha, decreased duration of seedling emergence and number of spikes in rapeseed (Rahnama, 2002). Yazdandoust *et al.*, (2002) reported maximum grain yield for rapeseed by using 6 kg/ha of oilseed rape at planting (Jasinska *et al.*, 1989). Anderson and Bengtson (1992) in a field experiment obtained maximum rapeseed grain yield with 10 kg/ha rate of seed and row distance of 12 cm in Swede. Also Popa *et al.*, (1989) suggested 10 kg/ha rate of seed according to their studies. Sadegipor *et al.* (1998) indicated that 17, 25 or 50 plants per square meter had not significant effect on grain yield of

spring rapeseed. But the use of fertilizer would increase crop yield (Sieling, and Kage. 2006; Rathke, and Diepenbrock, 2006).

## 2. MATERIALS AND METHODS

### 2.1 Location and Soil

The field experiment was conducted at the University of Zanjan research station (latitude 48°24' N, longitude 36°40'E), 5 km east of Zanjan city, at an average altitude of 1610 m. Soil used for the experiment was a sandy loam soil. The climate was characterized by a cold and mean annually rainfall is 265.8 mm.

### 2.2. Experimental Design

A factorial experiment in the form of randomized complete block design was applied with four replications. Experimental plots were 2.5×20 and 3×20 for mechanical and pneumatic planter, respectively.

Planter treatments were:

1) Machine Barzegar planter (locally-made for planting wheat) equipped with shoe openers and fluted rollers seed-metering devices (a<sub>1</sub>, mechanical planter).

Rau pneumatic combination seeder, without furrow opener and with pressurized air and fluted seed-metering system (a<sub>2</sub>, pneumatic planter).

Planting methods treatments were:

1) flat planting (b<sub>1</sub>)

2) raised-bed planting (b<sub>2</sub>)

seed rates treatments were 5.5 (c<sub>1</sub>), 7 (c<sub>2</sub>) and 8.5 (c<sub>3</sub>) kg seeds per hectare.

### 2.3 Planting Machines Preparation

Okapi variety of rapeseed was a common seed for most planting area was used for the experiment. For flat planting, openers of mechanical planter separated and spaced among openers about 30 cm. For preparation of pneumatic combination seeder, rollers behind separated and spaced among openers by 30 cm. For raised-bed planting, furrowers were used with the similar mechanical seeder. The planting depth was about 2.5 cm in all treatments. To control weed seeds before planting, 2 liters per hectare of Treflan herbicide was applied. 2.5 liters per hectare of Galant herbicide was used for weed control after plant emergence.

### 2.4 Measurements

Seed depth uniformity was measured after final seedling emergence by using the equation (1) (Senapati, 1989):

$$Se = (1 - Y/D) \times 100$$

Equation (1)

Where:

Se = proper seed depth coefficient (%)

D = mean of measured seed depth

Y = differential of mean

Also, emergence rate index was calculated by using the equation (2) (Afzalnia, 1998).

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$$ERI = \sum_{i=f}^L \frac{[\%di - \%(di-1)]}{D} \quad \text{Equation (2)}$$

Where:

d = seedling emergence percent at D day

(d-1) = seedling emergence percent at (D - 1) day

D = number of post-plant days

F= number of post-plant days at emergence of primary plant

L = number of post-plant days when emergence has completed

Seedling emergence percentage was calculated by the equation (3) (Hemmat, 1996):

$$m = \left( \frac{ppsm}{(spsm) \times P \times G} \right) \times 100 \quad \text{Equation (3)}$$

Where

*Ppsm* = number of plants emerged per square meter

*Spsm* = number of seeds sown per square meter

*P* = seed purity percentage

*G* = Germination percentage

Crop yield including straw and grain, was measured at maturity. The data was analyzed using SAS statistical package for analysis of variance. Means were compared by using the least significant difference analysis (LSD).

### 3. RESULTS AND DISCUSSION

#### 3.1. Seedling Emergence and Rate Index

Planting machines and interaction between type of planters and rate of seeding were shown to be significant ( $P \leq 0.05$ ) where seedling emergence was compared. Mechanical planter ( $a_1$ ) had higher seedling emergence than pneumatic planter ( $a_2$ ). lower proper seed depth for pneumatic raised-bed planting might be one of the reason for reduced number of seedling emergence. Mechanical planter with 8.5 kg/ha sowing seeds shown higher seedling emergence ( $P \leq 0.05$ ) than others (figure 2). Also, Yousefzadeh (2004) and Afzalinia (1998) reported the same result that pneumatic planter produced lower number of seedlings than mechanical planter.

The effects of planter types, planting methods and seeding rates were not significant on emergence rate index, but it was higher for mechanical planter than pneumatic planter. This might be due to proper seed depth and uniformity on rows for mechanical planter that put the seeds in 2-3 cm depth, as Yousefzadeh (2004) reported similar results, that mechanical planter produced higher emergence rate index than pneumatic planter.

#### 3.2. Uniformity on Rows

Type of planters showed significant effect on uniformity on row ( $P \leq 0.01$ ). Mechanical planter had higher uniformity than pneumatic planter (fig. 3). Seeds were scattered by pressurized air in the flowing soil using pneumatic planter could be a reason of lower uniformity on row. These results were similar to Yousefzadeh (2004) and Afzalinia (1998) findings. Also, the effect of

planting method was significant on uniformity on row ( $P \leq 0.05$ ) which flat-planting was greater than raised-bed planting (fig. 3).

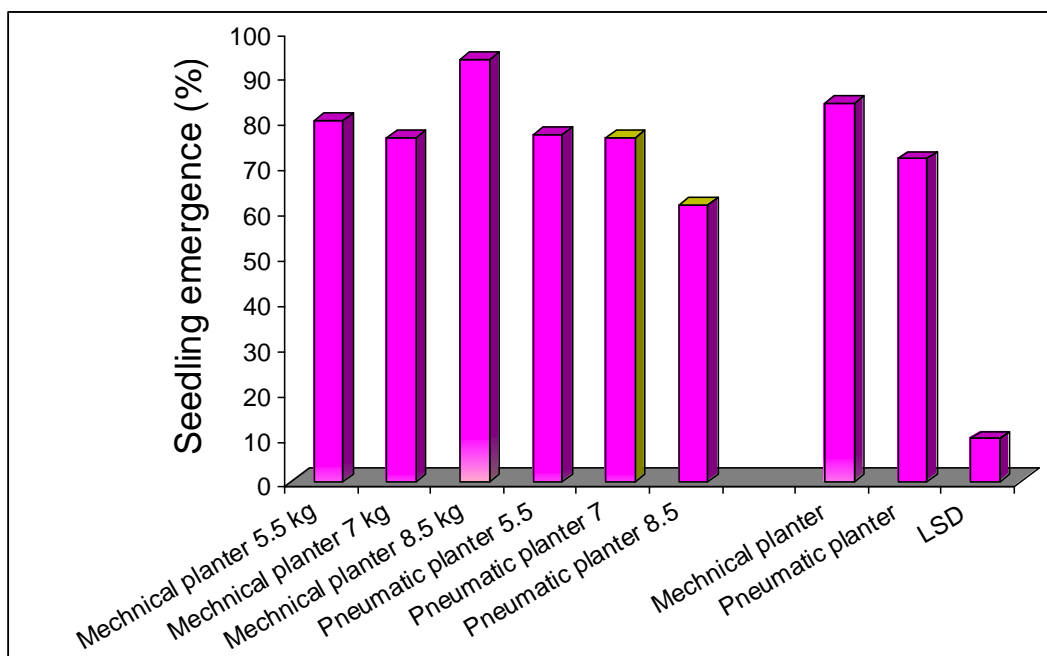


Figure 2. Effect of planter types and interaction among planters and rate of seed on seedling emergence percentage

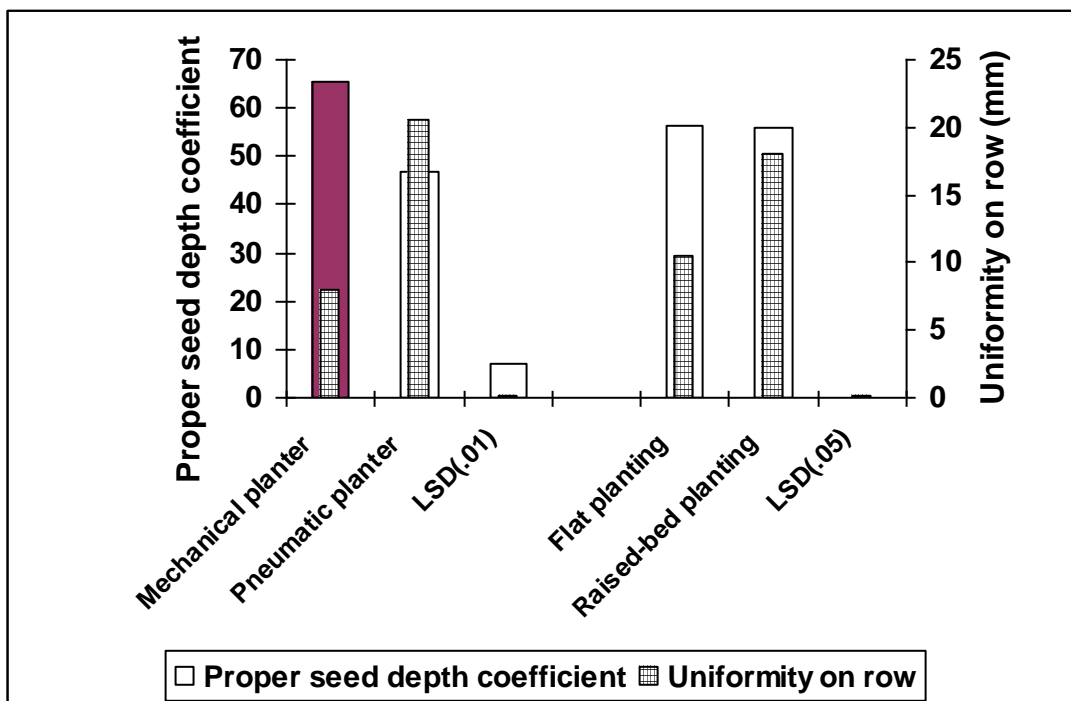


Figure 3. Effect of planter types and planting methods on seed depth and uniformity on row

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### 3.3 Proper Seed Depth

Type of planter had significant effect on seed placement ( $P \leq 0.01$ ). Proper seed depth of mechanical planter was higher than pneumatic planter (figure 3). Pneumatic planter was not equipped with furrow openers and also the reduced efficiency of seed depth control wheel could be the reasons of lower proper seed depth.

### 3.4. Pre and Post-winter plant establishment

All treatments had not significant effect on pre-winter plant establishment but pneumatic planter showed higher pre-winter plant establishment than mechanical planter (fig. 4). Type of planter had significant effect on post-winter plant establishment ( $P \leq 0.05$ ). Pneumatic planter had greater post-winter plant establishment than mechanical planter (fig. 4). Suitable preparation seed bed by rotivator attached in front of pneumatic planter caused high post-winter plant establishment. Interaction among planter type and planting method showed significant effect on post-winter plant establishment ( $P \leq 0.01$ ) and pneumatic planter with flat-planting method had more post-winter plant establishment than others (fig. 4). Post-winter plant establishment of mechanical planter decreased 4 percent compared with pre-winter plant establishment, but post-winter plant establishment of pneumatic planter increased 3 percent compared with pre-winter plant establishment.

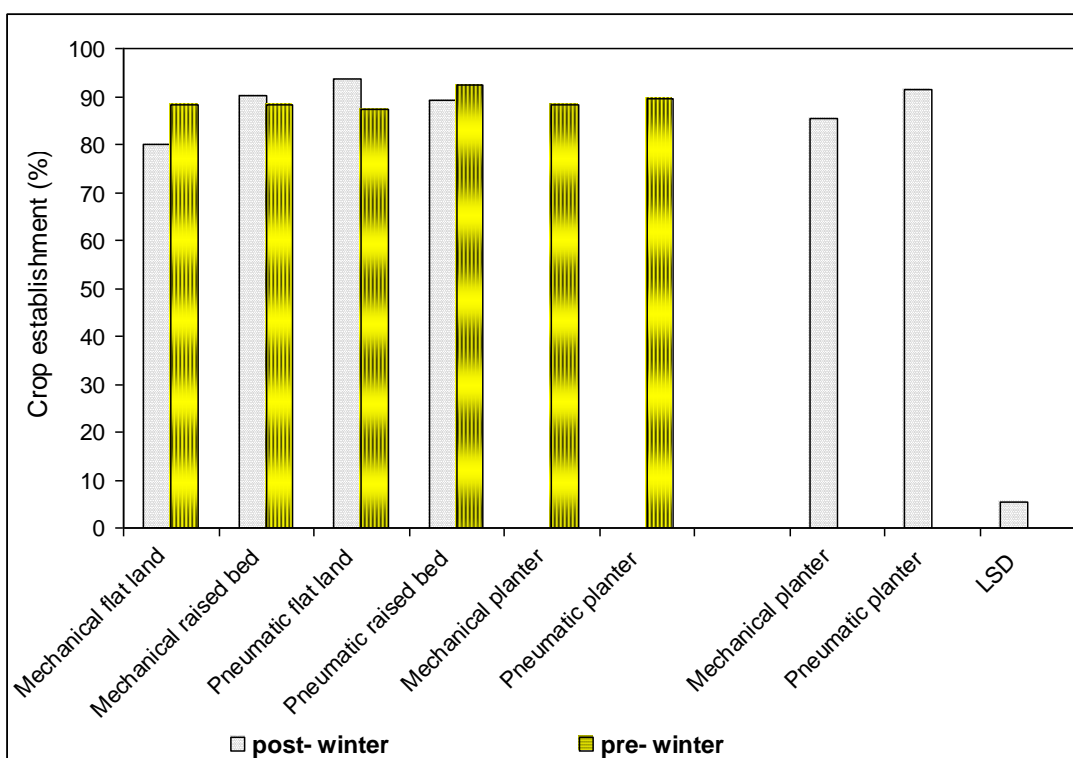


Figure 4. Effect of planter type and interaction among planter and planting method on pre and post-winter establishment

### 3.5. Grain Yield

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All treatments shown no-significant effects on crop grain yield. These findings were similar to Day (1967), and Hossain *et al.* (2005) who reported that raised-bed and flat planting method shown not significant effects on resulted grain yield. Yield of raised-bed planting method (3679 kg/ha) was higher (fig. 5) than flat planting (3489 kg/ha). In contrast, this comparison for other crops, Ozpinar (2004) reported flat and raised-bed planting in cotton, and Oswald *et al.*, (2002) in corn and Hossain *et al.*, (2005) in wheat that yield of raised-bed planting was significantly greater. Also Aubertot *et al.*, (2004) and Adamsen and Coffelt (2005) reported that seeding time and seeding methods were influenced grain yield. According to the results (fig. 5) pneumatic planter produced higher grain yield (3697.7 kg/ha) than mechanical planter (3462 kg/ha). However, in spite of higher seedling emergence percentage for mechanical planter the post-winter plant establishment and grain thousand weight of pneumatic planter was greater than mechanical planter. It might be a strong reason for producing higher grain yield of pneumatic planter. In these 12 experimental treatments, combination of pneumatic planter and flat-planting method with 8.5 kg seed per hectare had greatest grain yield, but not significant compare to other treatments.

### 3.6 Harvest Index and Grain Thousand Weight

Harvest index was shown the same for all treatments. But, mechanical planter was greater than pneumatic planter and flat-planting method was higher than raised-bed planting. Interaction among planter type and planting method had significant effect on grain thousand weight ( $P \leq 0.05$ ). Pneumatic planter with flat- planting method had greater grain thousand weight (3.56 g) than others. Also, grain thousand weight of pneumatic planter was higher than mechanical planter.

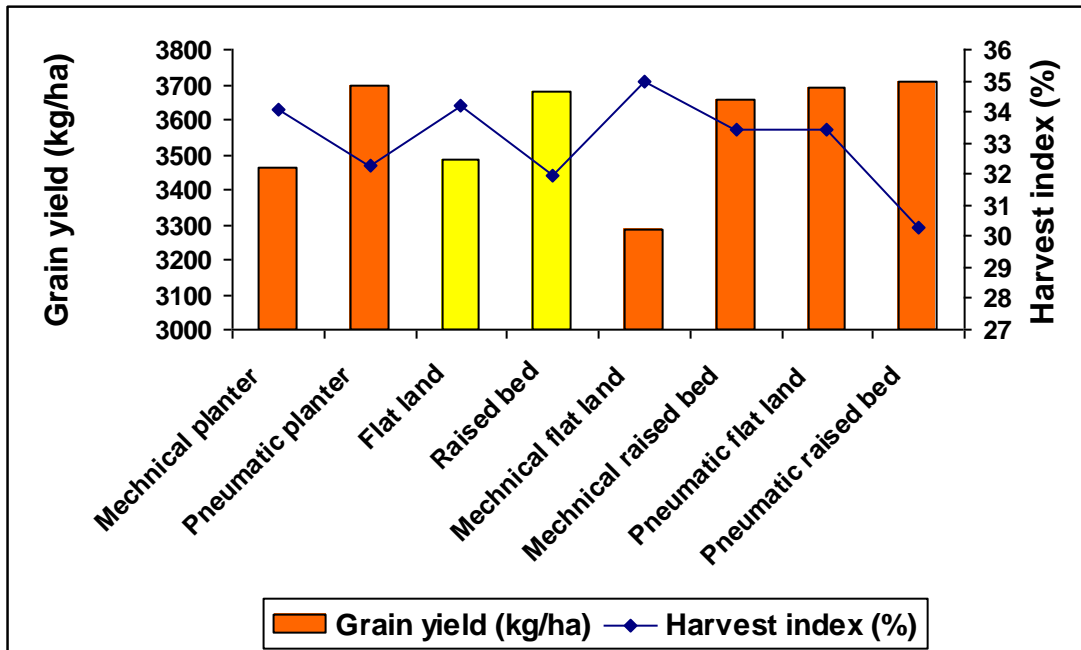


Figure 5. Effect of planter type, planting method and interaction among those on grain yield and harvest index

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#### 4. CONCLUSION

Mechanical planter equipped with runner furrow opener was suitable planter for providing greater rapeseed seedling emergence. Pneumatic combination seeder with tilling soil by rotivator attached on front of it could prepare smoother seed bed which caused great post-winter plant establishment and grain yield.

Rate of seed had not significant effect on grain yield which indicated oilseed rape has high flexibility relative to rate of sowing seed, and able to compensate lower rate with produced side foliage and increased grain yield of plant unit. Combination of using pneumatic planter with flat-planting method applying 8.5 kg seed per hectare produced the highest grain yield.

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