A new approach to use rice husk and different types of opener in punch planting of common bean

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Abstract

This study attempts to improve planting common bean in different soils. Punch planting method was used and the effect of different openers and rice husk mulch as a new idea in punch planting was tested. A factorial experiment in Completely randomized design was implemented in the farm of Shahrekord University. Shahrekord has a temperate and cold region with dry and warm summer. Common bean was planted to test the seedbed shape (bar, conical and grooved), sowing depth (6 and 9 cm) and the seedbed mulching (with husk and without it). The percentage of emerged plants at the time of dividing in two leaves, average height of bushes in flowering and average leaf number of each bush in flowering, the rate of height growth and the number of leaves over day and night (appropriate time of measurement from budding to flowering was considered) were measured. The grooved shape and seed coverage using rice husk mulch are recommended. There were no significant differences in depth factor.

Keywords: bud, germination, growth indicators, mulch, *Phaseolus vulgaris*, seedbed shape

Introduction

Soil erosion is a big problem in farming lands. Punch planting is one of methods for remarkably reducing erosion and the cost of seedbed preparation. It is a sowing technique where holes are created in the ground with a minimum of soil disturbance, and seeds are inserted into them, without soil disturbance outside the holes (Rasmussen, et al., 2012). This may result in reduced weed emergence in crop rows, because of minimum soil disturbance (Rasmussen, 2003; Rasmussen, et al., 2011) and earlier crop emergence following uniform sowing depth and good contact between seeds and soil (Gray, et al., 1995). A punch planter is conceptually ideal for no-till planting because it disturbs a minimal amount of soil and is useful for crops sensitive to precision spacing (Molin, et al., 1998). Grains are planted in a such way and they have a main place economically after cereals. Among them, common bean due to its adaptability to climatic conditions of the most parts of Iran is regarded as one of significant products in this connection. Common bean is one of plants needing sufficient space and practically soft soil to be able to emerge bud. This characteristic is severely threatened in hard soil, especially in soil with bound. Therefore, many buds do not have opportunity to emerge from soil. Similarly, due to the lack of adequate stability of beginning stem of common bean, it is very fragile to soil hardness and so farmers are not eager to plant common beans in lands with slightly hard soil. This matter is worse in lands with sprinkler irrigation because produced soil bond due to sprinkler irrigation makes troubles and hinders the emergence of common bean buds. Therefor, seeds inside a punch in punch planting method are not covered and traditional methods of irrigation causes that water current conducts soils in the punches, produces soil bound and ultimately disorders the bud growth. Applying mulch of husk as a suitable coverer for seedbed is presented as a new idea in punch planting.

Some done researches in punch planters are mentioned. Jafari and Fornstrom (1972) designed and constructed a punch planter specifically for sugar beets using a wheel with six conical punches on circumference. The seed metering system had a vertical rotating disc to drop single seeds into the ground holes. Adekoya and Buchele (1987) recognized that the application of punch planter apparatus as an agreeable idea in no-till planting method was very useful because of little amount of scattered soil. Debicki and Shaw (1996) developed a spade-punch planter and tested with soybean, corn, and sugar beet seeds. This planter had a vacuum seed meter synchronized with a revolving spade soil opener. Tests showed that successful deposition of different varieties of seeds at different speeds of operation can be accomplished when the seed meter is mounted in an optimum position relative to the spades. Molin, et al. (1998) designed and constructed a punch planter for planting corn in no-till conditions. A commercial vacuum seed meter was used. Field tests were conducted with two types of residue and three different amounts in a no-till area at 2 $m*s^{-1}$. No significant differences were observed in the seed spacing criteria due to type and amount of residue. Miles and Reed (1999) developed a simple, novel solution to the problem of transfer, acceleration and delivery of seeds and granules using a venturi air jet device. Using lettuce as a benchmark crop, the new drill performed well (84% emergence) and significantly better than a conventional coulter drill (71%). Molin (2002) constructed a punch wheel that had the ability to adjust its diameter so seed spaces could vary from 0.16 to 0.21m. Dowlati and Karparvarfard (2005) recommended the speed of 6.4 $km*h^{-1}$ for dibble punch planter with pneumatic seed metering device. Ismail and El-Hanify (2009) studied the effect of oscillating tube mechanism on seed distribution in a punch planter. Traveling speed of 0.6 $m*s^{-1}$ and oscillating tube radius of 12 cm and connecting tube rod of 180 mm was recommended. Frabetti, et al. (2011) developed a punch planter to sow corn seeds in no-tillage system. The performance of its seed metering and delivery systems was evaluated. They reported that increase in velocity and increase in the number of punches in a punch wheel decreased the number of doubles and increased the number of missing seeds. The punch planter had a satisfactory performance, with a global mean of 91% for normal seed selection and delivery. Fu and Zhang (2013) analyzed a design process to improve the speed and accuracy of case retrieval of a spade punch planter for digital design. They proposed a method to design knowledge representation based on object oriented theory, and elaborated the construction methods of knowledge and resource database which include multi-level case database, knowledge rules database based on association table and spare parts model database of three layer structure.

The effect of different types of opener in a punch planter has not been studied in previous researches. This study aims to inversigate different types of opener and to apply mulch of husk as a new idea for seedbed cover in punch planting.

Materials and Methods

A land with the latitude of 32°25' N and the longitude of 50°50' E, situated in farms of Shahrekord University, was selected. Shahrekord has a temperate and cold region with dry and warm summer. Its Average of annual precipitation is 325 mm (Chaharmahal Va Bakhtiari Meteorological administration, 2014). The farm was fallow for five years. Its soil was flattened, plots were prepared, planting the seeds of common bean (*Phaseolus vulgaris* L.) and making punches was accomplished similar to Hauser (1982) method (Figure 1). Soil physical characteristics were assessed in the laboratory. The soil texture was silty clay loam with the following percentage of its component particles: sand 18.37%, clay 38.77%, silt 42.86%.

Figure 1. Punch planting and covering seedbed with mulch

A suitable instrument was made to prepare punches for first irrigation under appropriate humidity. After planting the seeds of common beans (one seed in each punch), the mulch of rice husk was used as the seed cover in some of the build punches (Figure 1). In some of punches, just one seed (without any coverage) was placed in two intended depths. The punches were flattened briefly to make the mulch surface flat to the soil in each plot. Planting operation begun in the last week of May, 2007 (cultivation period was one crop year). The operation was performed as factorial experiment in a Completely randomized design. Three studied factors are as follows:

the factor of seedbed shapes (A) (Figure 2):

- A1 = bar shape (bar thickness is 22 mm)
- A2 = conical shape (base diameter is 32 mm and the height of cone head is 75 mm)
- A3 = grooved shape (triangular with the angle of 35 degrees and thickness of 8 mm at the top of triangle and 25 mm in base)

the factor of planting depth (B):

B1 = 6 cm

B2 = 9 cm

the factor of seed coverage (C):

C1 = without coverage (no mulch)

C2 = covered with the mulch (rice husk).

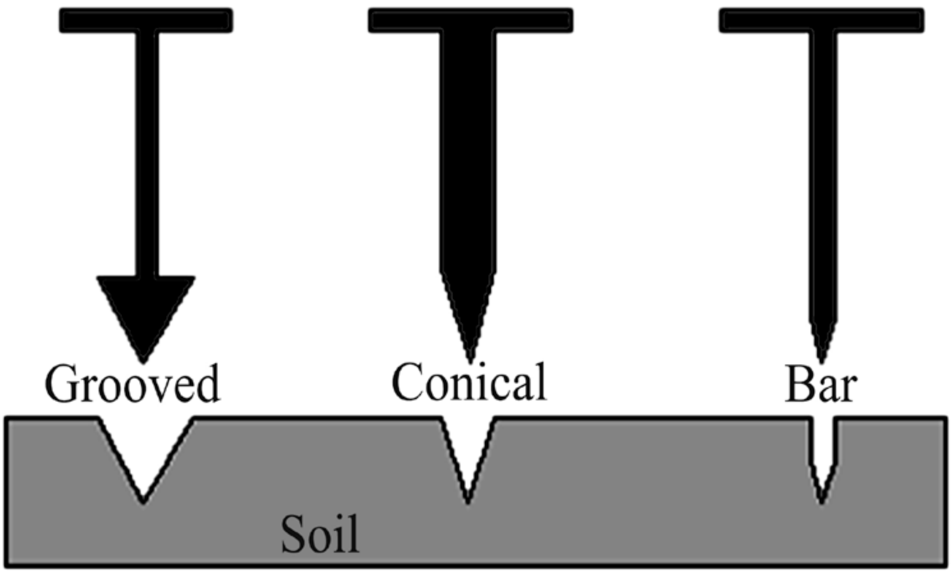

Figure 2. Three type of opener plunger (seedbed shapes)

Overall, twelve treatments (3 forms of seedbed × 2 forms of depth × 2 forms of seed coverage) were examined in 4 repetitions. Operation was performed on 48 plots with the area of each plot 4 m^2. In each plot, 20 seeds were planted with space of 40 centimetres and irrigation was occurred every 6 days. The experiment was carried out in spring and summer.

The influence of seedbed shape factors, planting depth and mulch coverage on the percentage of emerged plants at the time of dividing in two leaves, average height of bushes in flowering and average leaf number of each bush in flowering, the rate of height growth and the number of leaves over day and night (appropriate time of measurement from budding to flowering was considered) were measured and analyzed. Statistical analysis was done by SPSS software.

Results and Discussion

The analysis of data variance from measuring the indicators of budding percentage (BP), bush height (BH) (based on centimetre), the average number of bush leaves (NL), the growth rate of bush height (GRH) (based on centimetre over day and night) and the growth rate of the number of bush leaves (GRL) (based on numbers over day and night) was obtained according to Table 1.

Table 1. The analysis of variance of main and interaction effects of indicators

Source	F values				
	Budding percentage(BP)	Bush height(BH) [cm]	Average number of bush leaves(NL)	Growth rate of bush height(GRH) [cm*day^{-1}]	Growth rate of the number of bush leaves(GRL) [1*day^{-1}]
A	10.184*	1.853	3.524*	0.363	3.428*
B	3.345	0.191	0.7	0.712	1.183
C	205.738*	2.076	8.598*	1.865	6.579*
A×B	2.789	0.026	1.192	0.218	0.955
A×C	20.415*	0.415	2.293	2.067	2.497
B×C	3.345	2.9	0.748	4.615*	1.135
A×B×C	0.676	2.473	0.099	0.065	0.026

* Significant effect at the 0.05 probability level according to LSD test

The indicator of budding percentage (BP)

As it is observed, considering the represented results on the budding percentage in Table 1, there is a significant difference between the means of main effects of the seedbed shape and the seed coverage, but there is no significant difference in the main effect of depth. Investigating the difference between the mean of seedbed shape based on Duncan’s test showed that there was a significant difference among the levels of the means of the bar seedbed shape and the grooved seedbed shape as well as conical and grooved seed bed shape levels. The bar and conical seedbed shape did not have a significant difference. It shows that the difference of ten millimetres between the conical and the bar seedbed is not effective to change conditions. The grooved seedbed shape was more proper than the other two levels in increasing the budding percentage. The seed coverage with mulch had better influence than without it in increasing the budding percentage and its effect was significant. Figure 3 and 4 display these comparisons. The interaction effect of the seedbed shape × seed coverage was significant (Figure 5).

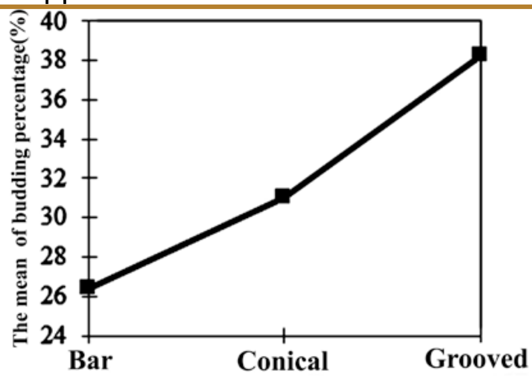

Figure 3. The effect of seedbed shape in the budding percentage

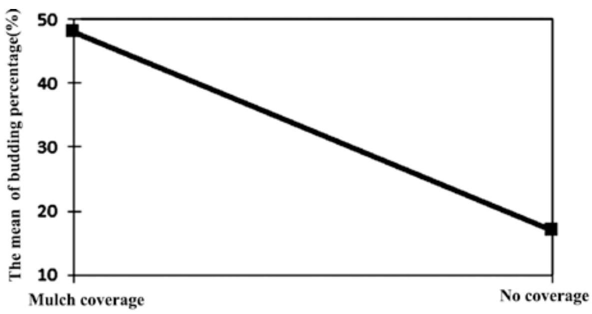

Figure 4. The effect of mulch coverage levels in the budding percentage

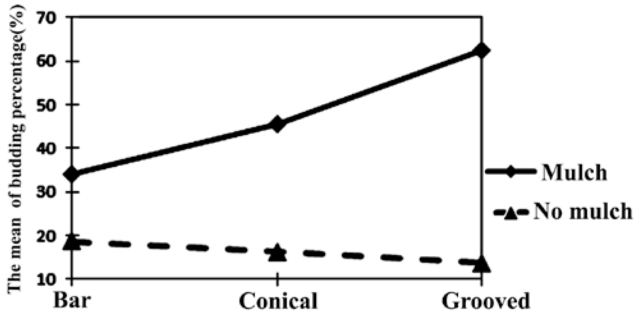

Figure 5. Interaction effect of seedbed shapes × mulch coverage in the budding percentage

Grooved seedbed shape without mulch coverage was not proper. It seems that more space without soil consolidation around seed caused this condition. Although mulch has less consolidation around seed, but it can save more humidity than soil. In grooved seedbed shape, the depth of 6 cm was slightly better than the case of 9 cm, but the conical seedbed shape showed better condition at the depth of 9 cm. The mulch coverage along with grooved seedbed shape provided a more pleasant result. The investigation of mulch coverage revealed that the interaction effect of seedbed shape with the depth was not so remarkable.

The indicator of bush height

The analysis of variance shows that there are no significant differences in all variables for bush height (Table 1). Seedbed shape Influenced on budding but more factors require for getting significant difference in this indiex.

The indicator of leaf number

The variance analysis showed that the influence of main factors of seedbed shape and seed coverage had a significant difference in the means of bush leaf number (measuring at flowering time). The effect of seedbed shapes on the mean of leaf number showed that there were significant differences between the levels of bar seedbed shape and conical seedbed shape using Duncan test at the 0.05 probability level. Similarly, the effect of seed coverage on the mean of the leaf number had a significant difference using LSD test at the 0.05 probability level. Since seedbed with grooved shape had median state between bar and conical shape, its differences was not significant.

The indicator of height growth rate

The variance analysis of the indicator of height growth rate revealed that just the interaction effect of depth × seed coverage had significant effects. The obtained results from the indicator of height growth rate (based on centimetre over day and night) is presented in Figure 6. Increasing depth causes increase in the growth rate in the mulch state because rice husk on the top of seed increases but increasing depth in the no-mulch state causes soil accumulation on the top of seed and it can disturb germination.

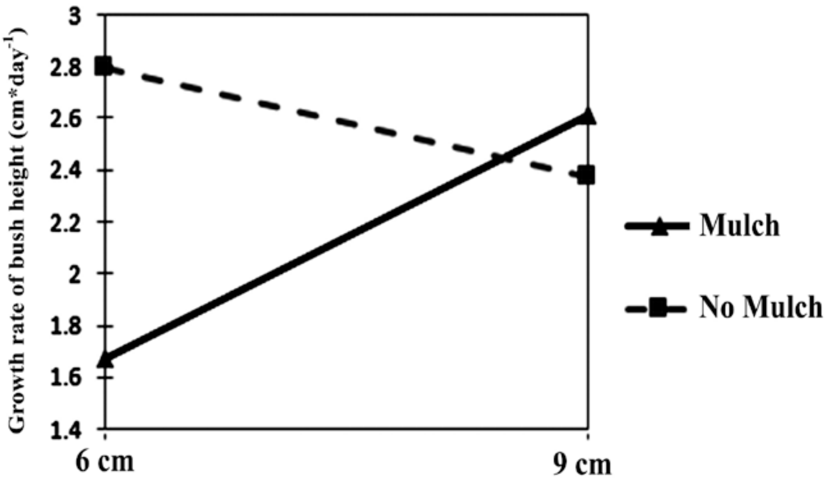

Figure 6. Interaction effects of depth × mulch coverage in growth rate of bush height

The indicator of rate of leaf number growth

As it is observed in Table 1 about the variance analysis of the rate of leaf number growth, other than seed coverage and seedbed shape, there were no significant effects in the resources. The amount of mean was better in the case of conical seedbed shape. The mulch coverage was also increased than the case without it.

It is inferred from the obtained results and data analysis that the application of mulch of husk has a remarkable influence in all indicators. Meanwhile, the obtained results showed that the factor of seedbed shape had significant differences in most indicators, while there were no significant differences for the effect of depth factor. The results are briefly ordered in Table 2.

Table 2. The summary of effective factors on the measured indices

		BP	BH	NL	GRH	GRL
Seed bed shapes	Grooved	●	● (1)	● (2)	●	● (2)
	Conical	-	● (2)	● (1)	-	● (1)
	Bar	-	-	-	-	-
Mulch covering	Husk	●	●	●	-	●
	No husk	-	-	-	-	-
Depth [ns]	6 cm	●	-	-	-	-
	9 cm	-	●	●	●	●

● : Mean better than other levels

[ns] : no difference between the means

Numbers show priority order

Applied openers in this study create V-shaped hole. Baker and Saxton (2007) mentioned the disadvantage of soil compaction in alongside seed zone for V-shaped opener. As seeds are placed in the bottom of created hole by this study method, compacted walls of seedbed do not disturb plant growth.

Conclusions

The grooved seedbed shape and mulch coverage increased percentage of bud emerging, number of leaves and the rate of plant leaf number. In seedbed shape, first grooved and second conical seedbed shape were noticeable. The mulch of rice husk for seed coverage had positive effect on plant because of less resistance than soil and keeping relatively more humidity.There were no significant differences in the depth factor, although the depth of 9 cm showed slight increase than the depth of 6 cm. Plant height did not significantly changed by studied factors.

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