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Development and field evaluation of an intercropping machine for corn and bean

A. Mondani[1]- S. H. Karparvarfard[2*]

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Introduction

Maximum efficiency of natural resources, reduced risk of production, improved fertility of soil, and increased production per area enjoyment have made intercropping a preferential practice compared with cropping. One of the fundamental problems in this kind of cropping is non-existence of suitable machines. In this research, a new intercropping machine has been designed and built for intercropping of corn and bean with precise ratios and different planting patterns.

Materials and Methods

The experiments were conducted at the Badjgah Research Station, Shiraz University, located in NW Shiraz, Iran. The soil texture was clay loam (16% sand, 48% silt, and 35% clay). The plot size was 9 m wide and 12 m long. The total number of the plots were 9. The basic components of intercropping machine were an adjustable frame to adjust row spacing for each unit planter about 550 mm horizontally independently (the row spacing between corn and bean planting lines was considered 375 mm), a hinged frame for adjustment of seeding depth and possible poor emergence of plants due to very deep or shallow planting, metering case frames for installing the vacuum metering disk units around which the seed drums have a row of 36 holes of 4.5 and 5.5 mm diameter for corn and bean, respectively, seed delivery tubes, a suction fan, shovel openers used for bedder planting for corn and lister planting for bean, a knife covering attachment, seed-firming wheels, interchangeable gears which are mechanical chain drives for 43 varying seeding rates driven by carrying wheel drives, two metal seed hoppers whose lower side walls' slope can be adjust at a maximum level of 45°. A front wheel assist, Massey Ferguson tractor (MF-399) (ITM, Tabriz, Iran) with a maximum engine power of 81 kW was used for field test of intercropping machine. Moldboard plow was used for primary tillage and the depth of plowing was 25 cm. Next, by an offset disk harrow, the field was disked twice for pulverizing lumps, mulching the surface and firming the underneath soil to provide a smooth uniform seedbed. In this study, the common bean seed (var. *Derakhshan*) and corn hybrid seed (SC-704) with 93 and 83 percent of germination and 97 and 98 percent of purity, respectively, were used. This machine was operated in five different distance patterns between corn and bean seeds on each row: 55 mm and 215 mm in the first pattern, 85 mm and 185 mm in the second pattern, 110 mm and 150 mm in the third pattern, 130 mm and 120 mm in the fourth pattern, and 160 mm and 100 mm in the fifth pattern for corn and bean, respectively. For all patterns, the depth of planting for corn and bean seeds was chosen as 20, 40, and 60 mm. In addition, the forward speed was assumed to be constant (4 km h^{-1}). By using split plots with three replicates and SAS software (2002), the results were analyzed.

Results and Discussion

The multiple index, miss index, precision index, and quality of feed index was evaluated. The analysis of variance for bean planting unit showed that difference distance between seeds and various planting depth were significantly higher for multiple index ($P< 0.01$), but their interactions were not significant ($P\geq 0.05$). Also, with decreasing the seeds distances, the multiple index was increased ($P<0.05$). Moreover, comparing the results of the average multiple index in different levels of planting depth indicated that the multiple index was decreased when at higher depths of planting ($P< 0.05$). The seeds distance and planting depth were significantly higher for miss index and quality of feed index ($P< 0.01$), but their interactions were not significant for either index ($P> 0.05$). The precision index was significant was affected by different levels of seeds distance ($P< 0.05$) and was higher for different levels of seeds planting depths ($P<0.01$), but their interactions were not significant. In corn planting unit, the results showed that the different distances between seeds and planting depths were significantly higher for multiple index, miss index, quality of feed index, and precision index ($P<0.01$). Also their interactions were significant for multiple index ($P< 0.05$), but the other indices showed no significant interactions ($P > 0.05$).

1- Graduate Student, Biosystems Enginering Department, Shiraz University, Shiraz, Iran
2- Associate Professor, Biosystems Engineering Department, Shiraz University, Shiraz, Iran
(*- Corresponding Author Email: karparvr@shirazu.ac.ir)

Conclusions

Data data suggested a higher quality index once corn and bean were respectively plated at 160 and 215 mm seed distance with a planting depth of 60 mm being optimum for each corn and bean.

Keywords: Bean, Corn, Intercropping, Planter, Quality of feed index