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Research Article

THE EFFECT OF PLANTING DATE AND SEED INTERCROPPING RATIO ON YIELD AND YIELD COMPONENTS OF MAIZE INTERCROPPED WITH SOYBEAN

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ABSTRACT
In order to investigate the effect of planting date and seed mixing ratio on the yield and yield components of maize and soybean, a split plot experiment in as randomized complete block design with three replications was carried out in Ahvaz in 2013. The treatments included three planting dates (D1 = July12, D2 = July 22, and D3 = August 1) as the main factor and the mixing ratio of maize and soybean at five levels (P1 = maize monoculture, P2 = Soybean monoculture, P3 = 50% maize intercropped with 50% soybean, P4 = 75% maize intercropped with 25% soybean, P5 = 25% maize intercropped with 75% soybean) as the sub factor. The results showed that the intercropping ratio only had a significant effect on the number of rows per year in Maize and the highest number of rows per year by 13.5333 belonged to 100% maize monoculture and the lowest number by 12.488 belonged to 75% maize intercropped with 25% soybean. The effect of planting date on the yield and yield components of maize was significant except on 1000-grain weight. The results showed that the highest number of grains per row of year belonged to the third planting date by 30.217 grains. The effect of intercropping ratio and the interactive effect of planting date and intercropping ratio on the grain yield of soybean were significant. The results showed that the lowest grain yield belonged to the treatment with 25% maize intercropped with 75% soybean by 810.14 g/m^2. The highest and the lowest grain yield respectively belonged to the first planting date by 1619.51 g/m^2 and the third planting date by 888.43 g/m^2. Moreover, the results showed that the highest number of pods per plant belonged to the first panting date by 47.533 pods per square meter.

Keywords: *Planting Date, Maize, Intercropping, Ratio, Soybean, Yield and Yield Components*

INTRODUCTION
Polyculture farming is one of the methods of sustainable agriculture and consistent with the nature. Development of polyculture farming and intercropping is one of the strategies for optimal utilization of production inputs and achieving the goals of sustainable agriculture (Yadegari, 1994). In intercropping method, the production enhancement, soil fertility maintenance, erosion control, and in general optimal utilization of resources are provided by taking advantage of crop diversity principle in farm (Mazaheri, 1998). In many intercropping experiments in which one species of legumes is intercropped with one species of grain, the yield of intercropping is better than monoculture farming (Morris, 1993). The yield of intercropping systems depends on selecting appropriate traits for creating the minimum competition and maximum cooperation and application of appropriate agronomic operations such as the mixing ratio and the pattern of intercropping (Mutungamiri *et al.,* 2001). Maize is an annual monocot tropical grass which belongs to Poacea family, Zea genus, Mays species and is a short day, one-base, and cross pollinating plant. Oktom *et al.,* (2004) stated that the number of grains per year was affected by planting date and as the growth period increased, the number of grains per year increased, too. Contarero *et al.,* (2002) reported that the delay in maize planting date led to the decrease of the number of ears per plant and the number of grains per year and ultimately the yield decreased as well. Kamara *et al.,* (2009) stated that delay in planting led to the increase of pollination days and silking and the decrease of dry matter, yield, and yield components, ultimately. Pirzad (2001) reported that the yield of maize intercropped with bean increased significantly compared with its monoculture. Venzi *et al.,* (2005) observed that intercropping maize with broad bean increased the maize grain yield. The decrease of maize grain yield in monoculture compared to intercropping might be due to the decrease of necessary space for growth and

consequently the competition for water, nutrients, and light (Kartrus *et al.*, 2000). Beti *et al.*, (2002) stated that 1000-grain weight was affected by the planting date and delayed planting decreased the weight of 1000-grain in soybean. Oktom *et al.*, (2004) stated that the early planting time in soybean increased the number of seeds and pods, but the number of seeds per pod decreased compared with later planting date. Rader *et al.*, (2003) declared that earlier planting date of soybean increased the soybean yield. Sharifi *et al.*, (2006) reported that the weight of 1000-grain was not significantly affected by intercropping systems. Lang *et al.*, (2001) showed that intercropping wheat with soybean led to the increase of wheat grain yield by 28% to 30% compared with monoculture.

Since the review of different sourced indicated the usefulness of intercropping one legume with one grain cereal, evaluating the effect of the ratio of maize intercropped with soybean and proper planting date on the yield of maize and soybean and determining the usefulness parameters of intercropping are considered as the general objectives of the research.

MATERIALS AND METHODS

Experimental Location

The research was conducted in Ahvaz at latitude 36°24´N, longitude 45°9´E and 20 m above the sea level. The soil of the experiment site had a clay-loam texture with pH = 7.85 and EC= 3.3.

The experiment was carried out as a split plot in the form of randomized complete block design with three replications. The treatments included three planting dates ((D1 = July12, D2 = July 22, and D3 = August 1) as the main factor and the mixing ratio of maize and soybean at five levels (P1 = maize monoculture, P2 = Soybean monoculture, P3 = 50% maize intercropped with 50% soybean, P4 = 75% maize intercropped with 25% soybean, P5 = 25% maize intercropped with 75% soybean) as the sub factor.

Land preparing operations included the land irrigation before plowing, plowing the land to the depth of 30 cm, disking to the depth of 15 cm and trowel. Then, the rows as wide as 60 cm were made by the furrower. After preparation, the land was plotted based on the plan. There were 6 planting lines as long as 8 m in each plot. The distance between planted soybean and maize grains was 20 cm and the cultivation was carried out in a pile. The density of maize and soybean was considered to be 8 and 45 plants/m^2, respectively. After eliminating the margin effect eight plants were finally selected from the two middle lines of plots and the means of the number of grain rows and the number of grains per row were calculated. In order to calculate the weight of 1000-grain, two 500-grain samples were randomly selected from the masses of each treatment by the counter and were weighed in gram. The grains of the ears of 10 plants from each plot were separated and then mixed and the total weight with normal humidity was measured by a digital scale. Then, some samples were selected from the plants and after weighing they were placed in the oven at 72 °C for 48 hours and the moisture content was calculated after they got dry. Then, the total weight of grain with 14% moisture was calculated and through dividing it by the harvested area of each plot, the grain yield in each experimental unit was calculated in ton per hectare. In order to measure the number of grains per pod in soybean five plants were selected randomly and the number of grains per pod was counted in five plants and the total was divided by 5. In order to measure the weight of 1000-grain. Two 500-grain samples were determined randomly from the masses of each treatment by the counter and were weighed in gram. Data variance analysis was done by means of SAS software the means were compared by Duncan's multi range tests at 5% and 1% probability levels.

RESULTS AND DISCUSSION

Number of Rows per Ear

The effect of different levels of planting date and intercropping ratio on the number of rows per year was significant at 1% probability level (Table 1). Comparison of the means showed that the highest number of rows per year belonged to the third planting date by 13.8 and the lowest number belonged to the second planting date by 12.200 (Table 3). Distinction of the number of rows per yyear begins at the 6-leaf stage of maize, and its coincidence with high temperature leads to the decrease of plant growth period and consequently the number of rows per yyear will decrease. Estakhr and Chokan (2006) stated that planting

date had a significant effect on the number of grain rows per year and the highest yield belonged to the planting date of June 4 in Zarghan region in Pars Province. The highest number of rows per yyear was related to the cropping ratio of 100% maize monoculture by 13.5333 and the lowest number was related to the cropping ratio of 75% maize plus 25% soybean by 12.488 (Table 3). Examining the interactive effect of planting date and intercropping ratio showed that the highest number of rows per year belonged to D_3P_1 treatment by 14.133 and the lowest number belonged to D_2P_34 treatment by 11.8666 (Fig 1).

Number of Grains per Row

The effect of different levels of planting date on the number of grains per row was significant at 1% probability level (Table 1). Comparison of the means showed that the highest number of grains per row belonged to the third planting date by 30.217 grains and the lowest number belonged to the first planting date by 11.983 grains (Table 3). The number of grains per row is affected by environmental factors particularly temperature and accessible nutrients. According to the obtained results, during the first and the second planting dates since the grain inoculation is coincidence with heat stress the number of grains decreases and thus if the maize planting is delayed the number of grains per area unit decreases significantly. According to the researchers, the decrease of crop growth rate (CGR) after corn silking leads to the decrease of the number of grains per corn (Atri, 1999). Oktom *et al.*, (2004) stated that the number of grains per corn is affected by planting date and as the growth period increases, the number of grains per corn increases, too. Investigating the interactive effect of planting date and intercropping ratio on the number of grains per row showed that the highest number belonged to D_3P_5 treatment by 31.867 grains and the lowest number belonged to D_1P_5 treatment by 10.400 grains. As the rate of maize decreased and the rate of soybean increased in intercropping ratio (25% maize + 75% soybean) and also due to the heat stress in the first planting date which led to the decrease of inoculation, the number of grains per row decreased in D_1P_5 treatment. Kamara *et al.*, (2009) stated that in strip intercropping of maize with soybean the maize plants in the side rows of the strip perform more photosynthesis by receiving much of the solar radiation and have more ability to fill the grains.

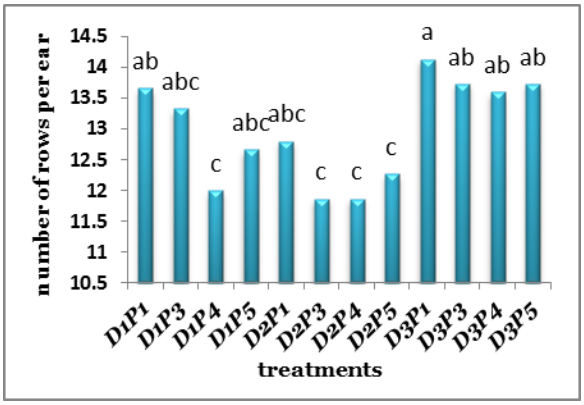

Fig 1: The interactive effect of planting date and intercropping ratio on the number of rows per ear

1000-Grain Weight

The ANOVA results of 1000-grain weight showed that the effect of different levels of planting date, intercropping ratio, and the interactive effect of planting date and intercropping ratio on the weight of 1000-grain were not significant (Table 1). The highest weight of 1000-grain respectively belonged to the first and second planting dates by 351.97 and 351.25 g and the lowest weight belonged to the third planting date by 275/17 g (Table 3). In the third planting date due to the increase of the number of grains the nutrients were distributed , so the weight of 1000-grain decreased , but in the first and second planting dates as the number of grains decreased more nutrients were stored and thus the weight of 1000-grain increased. Late planting dates decrease grain filling period and increase the rate of grain filling compared with earlier planting dates (Atri, 1999). Considering the maize intercropped with soybean, as the number

of grains per row increased there was less competition for absorbing nutrients and consequently, the weight of 1000-grain increased. Reviewing the interactive effect of planting date and intercropping ratio showed that in all treatments the weight of 1000-grain had a high performance. It seems that with regard to the effect of delayed planting date on the decrease of the number of grains per ear, the weight of 1000-grain increased. It could be due to the sharp decrease of the number of grains in the third planting date (Sharifi *et al.,* 2006). Kamara (2009) states that as the plant growth period decreases due to delayed planting date, the production of sufficient matter to be stored in the grain decreases.

Maize Grain Yield

The results showed that the effect of different levels of planting date on the maize grain yield was significant at 1% probability level (Table 1). The highest grain yield belonged to the third planting date by 5615.0 g/m^2 and the lowest grain yield belonged to the first planting date by 2315.9 g/m^2 (Table 3). In the first planting date with regard to the increase of number of rows per year and the increase of 1000-grain weight resulting from the decrease of number of grains per row, the grain yield decreased. According to the results, in the third planting date due to the increase of the number of rows per year and the number of grains per row, the grain yield increased. In the third planting date (August 1) since the temperature increased and the soil got warmer at the beginning of growth season the maize grain yield increased linearly. Comparison of the means showed that the grain yield in all four intercropping ratios was in the same statistical category (Table 3). The obtained results showed that the grain yield in monoculture was not different from the grain yield in intercropping maize with soybean and due to the increase of the number of grains per row and 1000-grain weight, the grain yield increased. Atri (1999) studied two rows of each plant in the maize intercropped with soybean through alternate planting and concluded that the maize grain yield in intercropping was 20% more than monoculture while the soybean grain yield was not significantly different in intercropping and monoculture. Investigating the interactive effect of planting date and intercropping ratio showed that the highest weight of 1000-grain belonged to D_3P_3 by 5940.6 g/m^2 and the lowest weight belonged to $D1P_5$ by 1936.4 g/m^2. In evaluating the intercropping of maize and soybean it was concluded that mixture had the highest usefulness and the decrease of soybean yield was compensated for by the increase of maize yield. Nin *et al.,* (1979) reported that the grain yield of maize intercropped by soybean increased by 19.5% in India. Intercropping maize with soybean significantly increases the maize yield.

Number of Pods per Soybean Plant

The effect of different levels of planting date and the number of pods per plant was significant at 1% probability level and the intercropping ratio was significant at 5% probability level (Table 2). Comparison of the means showed that the highest number of pods per plant belonged to the first planting date by 47.533 pod/m^2 and the lowest number belonged to the third planting date by19.583 pod/m^2 (Table 4). In the first and second planting dates the number of lateral branches was more and consequently, the number of formed pods in plants increased. Mokhtarpoor *et al.,* (2008) stated that the delay in planting date led to the decrease of number of pods per plant, final yield of seed, and plant height which was consistent with the results of the research. There was no significant different between different intercropping ratios in terms of the number of pods per plant. Investigating the interactive effect of planting date and intercropping ratio showed that the highest number of pods per plant belonged to D_1P_2 treatment by 58.267 and the lowest number belonged to D_3P_5 treatment by 16.333 pods per plant. Number of pods is the most important component of soybean grain yield which decreased through delayed planting. Peterson *et al.,* (2004) conducted an experiment and stated that the earlier planting date of soybean increased the number of seeds, number of pods, and harvest index, but the number of seeds per pod decreased compared with later planting dates.

Number of Grains per Pod

The ANOVA results showed that the effect of different levels of planting date, intercropping ratio, and the interactive effect of planting date and intercropping ratio on the number of grains per pod were not significant (Tables 1, 2). Comparison of the means showed that the highest number of grains per pod belonged to the second planting date by 2.12 grains. Mokhtarpoor *et al.,* (2008) studied the soybean and

stated that the highest number of grains per square meter belonged to the planting date of July 21. Number of grains per pod was stable to density variations and changed a little. This component is mainly affected by genetic structure. Hossein *et al.*, (2009) stated that the number of grains per plant was affected by intercropping.

Table 1: The ANOVA results of the studied traits of maize

Sources of variations	df	Number of rows per year	Number of grains per row	1000-grain weight	Grain yield
Replication	2	1.167*	76.991**	467.683n.s	1953052.23n.s
Planting date	2	7.707**	76.991**	23374.854n.s	33541772.12**
Ea	4	0.367	20.37	796.162	692760.03
Intercropping ratio	3	1.666**	9.034n.s	277.988n.s	297475.62n.s
Interactive effect	6	0.359n.s	15.311n.s	231.581n.s	537218.3n.s
Eb	18	0.317	10.155	560.418	726669.31
C.V		4.343	14.434	7.258	20.677

***: Significant at 1% level* **: significant at 5% level* *ns: non-significant*

Table 2: The ANOVA results of the studied traits of soybean

Sources of variations	df	Number of pods per plant	Number of grains per pod	1000-grain weight	Grain yield
Replication	2	156.96n.s	0.215n.s	18.293n.s	1893.074n.s
Planting date	2	2634.31**	0.037n.s	1194.767**	165778.378**
Ea	4	51.25	0.047	616.975	74083.293
Intercropping ratio	3	275.751*	0.11n.s	134.141n.s	10.44907.578**
Interactive effect	6	79.243n.s	0.059n.s	106.204n.s	281747.761**
Eb	18	85.061	0.051	152.498	32614.687
C.V		25.337	10.866	10.024	14.862

***: Significant at 1% level* **: significant at 5% level* *ns: non-significant*

Table 3: Mean comparison of the effects of planting date and intercropping ratio on the studied traits of maize

Number of rows per year	Number of grains per year	1000-grain weight(gr)	Grain yield(gr/m^2)	Treatments
				Planting date
12.916ab	11.983b	351.97a	2315.9b	D1
12.200b	24.033a	351.25a	4436.9a	D2
13.800b	30.217b	275.17b	5615a	D3
				Intercropping ratio
13.5333a	23.067a	319.53a	4211.5a	P1
12.9778ab	22.167a	332.28a	4257.2a	P3
12.488b	22.389a	328.72a	4166.1a	P4
12.888ab	20.689a	323.98a	3855.7a	P5

According to Duncan's test the means of the factors with similar letters in each column are not significantly different at 5% probability level

Table 4: Mean comparison of the effects of planting date and intercropping ratio on the studied traits of soybean

Number of pods per plant	Number of grains per pod	1000-grain weigh(gr)	Grain yield(gr/m^2)	Treatments
				Planting date
47.533a	2.099a	116.48a	1619.5a	D1
42.083a	2.129a	134.66a	1137.3ab	D2
19.583b	2.02a	118.43a	888.4b	D3
				Intercropping ratio
42.067a	2.085a	118.244a	1578.19a	P1
33.978a	0.866a	122.444a	1396.65a	P3
29.844a	2.235a	124.722a	1075.41a	P4
39.711a	2.032a	127.356a	810.14b	P5

According to Duncan's test the means of the factors with similar letters in each column are not significantly different at 5% probability level

The Weight of Soybean 1000-grain

The results showed that the difference between different levels of planting date was significant in terms of 1000-grain weight at 1% probability level (Table 2). Boket (1990) stated that the results of the effect of planting date on 1000-grain weight were highly variable, so that some researchers reported that delay planting caused the increase of grain weight, and some reported the the decrease of grain weight and some reported no changes on the grain weight. Panvar *et al.*, (2004) reported that the weight of 1000-grain was not significantly affected by intercropping systems which was consistent with the findings of the research.

Soybean Grain Yield

The ANOVA results (Table 2) showed that there was a significant difference between different levels of planting date, intercropping ratio, and the interactive effect of planting date and intercropping ratio in terms of grain yield at 1% probability level. Comparison of the means showed that the highest grain yield by 1619.51 g/m^2 belonged to the first planting date and the lowest grain yield by 888.43 g/m^2 belonged to the third planting date (Table 4). In the first planting date the soybean growth stages were more adapted with environmental conditions.

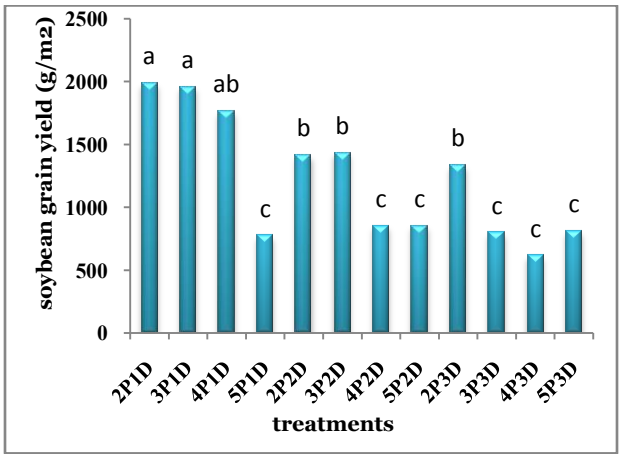

Figure 2: The interactive effect of planting date and intercropping ratio on the soybean grain yield

Mohammadi *et al.*, (1999) stated that the decrease of soybean grain yield in delayed planting was due to the shortening of reproductive period and also the decrease of assimilates and dry matter. Atri *et al.*,

(1999) stated that earlier planting date of soybean increased the yield of soybean which was consistent with the findings of the research. Comparison of the means showed that the lowest grain yield belonged to the intercropping ratio of 25% maize plus 75% soybean by 810.14 g/m^2 (Table 4). Singh and Tripatty (1973) reported that maize intercropped with soybean had a higher yield which was due to the increase of absorbing elements such as nitrogen. Reviewing the interactive effect of planting date and intercropping ratio showed that the highest soybean grain yield by 1985.1 g/m^2 belonged to D_1P_3 treatment and the lowest grain yield by 770.9 g/m^2 belonged to D_2P_4 treatment (Fig 2). Sharifi (2006) studied the two rows of each plant in the maize intercropped with soybean through alternate planting and concluded that the maize grain yield in intercropping was 20% more than monoculture while the soybean grain yield was not significantly different in intercropping and monoculture.

Conclusion

The results showed that in maize the effect of intercropping ratio was only significant on the number of rows per year and the highest number of rows per year belonged to the ratio of 100% maize monoculture by 13.5333 and the lowest number belonged to intercropping 75% maize with 25% soybean by 12.488. The effect of planting date on the yield and yield components of maize except the weight of 1000-grain was significant.

The results showed that the highest number of grains per row belonged to the third planting date by 30.217 grains and the lowest number belonged to the first planting date by 11.983 grains. The effect of intercropping ratio and the interactive effect of planting data and interactive ratio on the grain yield were significant. The results showed that the lowest grain yield was related to the intercropping ratio of 25% maize plus 75% soybean by 810.14 g/m^2.

The highest grain yield was related to the first planting date by 1619.51 g/m^2 and the lowest grain yield was related to the third planting date by 888.43 g/m^2. Furthermore, the results showed that the highest and the lowest number of pods per plant belonged to the first planting date by 47.533 pod/m^2 and the third planting date by 19.588 pod/m^2, respectively.

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