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Research Article

THE EFFECT OF PLANTING DATE AND SEED INTERCROPPING RATIO ON DRY MATTER DISTRIBUTION IN MAIZE INTERCROPPED WITH SOYBEAN

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ABSTRACT
In order to investigate the effect of planting date and seed mixing ratio on dry matter distribution in maize and soybean, a split plot experiment in as randomized complete block design with three replications was carried out in Shahid Salemi Field located in Ahvaz in 2013. The treatments included four planting dates (D1 = July12, D2 = July 22, D3 = August 1, and D4 = August 11) as the main factor and the mixing ratio of maize and soybean at four levels (P1 = maize monoculture, P2 = 50% maize intercropped with 50% soybean, P3 = 75% maize intercropped with 25% soybean, P4 = 25% maize intercropped with 75% soybean) as the sub factor. The results showed that the effect of different levels of intercropping ratio on dry weight of the plant organs and total dry matter was not significant, but the intercropping ratio of 25% maize and 75% soybean was determined as the superior intercropping ratio. In this ratio, the maize allocated the highest total dry weight (14.37 t/ha) and the highest leaf dry weight (3.51 t/ha) and the highest corn ear dry weight (6.97) to itself in intercropping. Moreover, the results showed that the effect of planting date on total dry weight and dry weight of plant organs was significant. Accordingly, the planting dates of July 12 and 22 were reported as the superior planting dates in soybean. According to the results, early planting of soybean can produce more dry matter by means of the shadowing of maize and can have heavier weight compared to the later planting dates and thus the highest total dry matter in soybean was obtained in the planting date of July 22 by 13.20 t/ha and the highest dry matter of stem and leaf was obtained in planting date of July 12 by 3.55 and 3.63 t/ha, respectively.

Keywords: *Planting Date, Maize, Intercropping Ratio, Soybean, Dry Matter Distribution*

INTRODUCTION
Intercropping is known as one of the most important viable agricultural systems in many developed countries which is highly significant due to the variety of products and the increase of profits within the time and area units (Mahfooz *et al.,* 2004). According to the obtained results when two different species with various plant height, vegetation, and planting pattern are intercropped concurrently they make the least competition with each other and this leads to the increase of intercropping yield compared to monoculture (Klindet *et al.,* 2007). The main reason of the superiority and the increase of intercropping product is the high efficiency of the use of limited water resources and nutrients, the decrease of weeds growth (Tahir *et al.,* 2003), and the decrease of damage caused by pests and diseases (Bolson, 1997). Due to high sensitivity of soybean to the day length, its yield is affected by planting date more than any other factors. Planting date has a great effect on the maturity time, seed size, grain yield, and biological yield (Kouchaki, 1994). Singh *et al.,* (1968) found that intercropping maize with soybean led to the increase of produced biomass by 20-40%. Ghamari *et al.,* (2011) reported that there was a significant difference between the treatments in terms of the dry weight of corn cob at 1% level in the maize intercropped with soybean. Mansoori (2010) stated that the effect of planting ratios on dry weight of corn cob was significant at 1% level. Tohidi Nejad *et al.,* (2004) reported that the highest dry forage was obtained through 25:75 intercropping (maize-sunflower). Manjit *et al.,* (2009) evaluated intercropping (mustard-pea) and reported that the highest dry matter belonged to 66: 33 and 75: 25 ratios. Mahfooz and Meigor (2004) reported that intercropping canola with pea had a significant effect on biological yield. Farahani *et al.,* (2004) stated that sufficient chance for biomass production and the inconsistency between growth and maximum temperature led to the increase of stem dry weight in soybean. Darby and Laure (2002) stated that the increase of leaf dry weight in soybean was due to the increase of the number of soybean leaves

which produced more leaves per area unit. Higher rate of dry matter in early planting date is due to long vegetative and reproductive growth period (Anderson *et al.*, 1985). Farahani *et al.*, (2012) stated that the earlier the soybean cultivars are planted, the greater would be the total biomass. Majidian and Esfahani (2013) claimed that planting date had a significant effect on leaf dry weight in maize. They also reported that planting date had a significant effect on total dry matter of corn , so that delay in planting until June 26, led to the highest dry weight of maize. Darby and Laure (2002) said that delay in planting generally would decrease the yield of maize forage. Since the review of different sources 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 distribution of dry matter in maize and soybean are considered as the general objectives of the research.

MATERIALS AND METHODS

Experimental Location

The experiment was carried out in Shahid Salemi Research Center in Ahvaz at longitude 48°40´E and lattitde 31°20´N and 22.5m above the sea level in the summer, 2003. 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 four planting dates (D1 = July12, D2 = July 22, D3 = August 1, and D4 = August 11) as the main factor and the mixing ratio of maize and soybean at four levels (P1 = maize monoculture, P2 = 50% maize intercropped with 50% soybean, P3 = 75% maize intercropped with 25% soybean, P4 = 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. Ammonium phosphate was added to the land before planting along with disking and 180 kg/ha urea was added to the land once at the beginning of planting and once as the surplus. 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. In each pile 4 seeds were placed and thinning was done at 2-3-leaf stage.

Measured Traits and Their Measurement Method: After eliminating the margin effect the middle lines of the plots were finally harvested manually in late November with a sickle so that an area of 1.5 m^2 from each plot was harvested. Harvested samples were carried to the laboratory and after separating the leaves from the stem they were placed in the oven at 75°C for 48 hours in order to determine the dry weight. At last, stem dry weight, leaf dry weight, ear dry weight, pod dry weight, leaf and stem dry weight were measured separately. 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

Total Dry Weight in Maize

The ANOVA results showed that the effect of planting date on total dry weight at 5% level and the effect of intercropping ratio on total dry weight of maize at 1% level were significant (Table 1), so that the highest rate of total dry weight belonged to the treatment with planting date of August 11 by 15.27 t/ha and the lowest rate belonged to the treatment with planting date of July 12 (Table 3). Stocksbory *et al.*, (1994) stated that in early planting of maize due to high temperature at night and also the increase of respiration which causes the consumption of carbohydrates supplies and their less mobilization, the total dry weight might decrease. However, in later planting dates such as August 11, due to cool nights and decrease of respiration and decomposition of produced photosynthetic materials during the day, more dry matter can be expected. Mean comparison of different levels of intercropping ratio showed that the highest total dry weight belonged to the treatment with 25% maize intercropped with 75% soybean by 14.37 t/ha (Table 3). It seems like that the treatment with 25% maize plus 75% soybean was able to produce more dry matter than the other treatments, due to lower density of maize and further use of nitrogen by the maize plants which was fixated by the soybean. The results were consistent with the findings of Farahani *et al.*, (2012). Furthermore, less density of maize and sufficient space for growth

made the stems and leaves grow enough and produce more dry matter. The ANOVA results showed that the interactive effect of intercropping ratios and planting date on total dry weight of maize was significant at 1% probability level (Table 1). Comparison of the means showed that all intercropping ratios at planting date of July 22 and the treatments with 25% maize plus 75% soybean in August 1 and 11 had the highest total dry weight. Greater proportion of soybean in the treatments has enabled the maize to make use of more nitrogen and produce more dry matter. Moreover, the decrease of plant competition due to the decrease of maize density has led to the production of more dry matter compared to the other treatments. The results were consistent with the findings of Singh *et al.*, (1986).

Leaf Dry Weight in Maize

The ANOVA results showed that planting date had a significant effect on leaf dry weight at 1% probability level, but the effect of intercropping ration and the interactive effect of planting date and intercropping ratio on leaf dry weight were not significant(Table 1). The highest leaf dry weight belonged to the treatments with planting date of July 12 and 22 by 3.74 and 3.56 t/ha, respectively and the lowest leaf dry weight belonged to the treatment with planting date of August 11 by 2.91 t/ha (Table3). Sufficient time for vegetative growth and the presence of nutrients particularly nitrogen led to production of more dry matter. The results were consistent with the findings of Darby and Laure (2002). Mean comparison of different levels of intercropping ratio showed that the highest leaf dry weight belonged to the treatment with 25% maize intercropped with 75% soybean by 3.51 t/ha (Table 2). Due to having much growth space in such an intercropping ratio, the maize has been able to produce longer and wider leaves and allocate more dry matter to them at vegetative growth stage. Meanwhile, the maize root has been able to provide necessary nutrients for the maize by further and more efficient absorption of nutrients and contribute to the increase of dry matter (Majidian *et al.*, 2013).

Corn Ear Dry Weight

The ANOVA results showed that planting date and intercropping ratio had a significant effect on dry weight of corn ear at 1% probability level (Table 1), so that the maize planted in August 22 produced more dry matter due to having longer reproductive growth period (Table 3). Therefore, it can be concluded that in later planting dates due to cooler weather and consequently longer reproductive growth period drier matter for the maize can be expected. Comparison of the means showed that the highest dry weight of corn ear belonged to the treatment with 25% maize and 75% soybean by 6.97 t/ha and the lowest dry weight of corn ear belonged to the treatment with 75% maize and 25% soybean by 5.82 t/ha (Table 3). It can be said that suitable space and nutritional conditions have a significant effect on the dry weight. Moreover, available food resources for each maize plant at lower densities can greatly contribute to dry matter production. The results were consistent with the findings of Ghamary *et al.*, (2011).

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

Total dry matter(ton/hec)	Leaf dry weight(ton/hec)	Ear dry weigh(ton/hec)	Df	Sources of variations
0.074	0.314	1.16	2	**Replication**
28.72*	1.53**	33.67**	3	**Planting date**
5.07	0.2	2.19	6	**Ea**
7.15**	0.081n.S	3.48**	3	**Intercropping ratio**
3.53**	0.097n.s	1.68*	9	**Interactive effect**
1.1	0.055	0.706	24	**Eb**
7.94	6.97	13.54		**C.V**

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

The ANOVA results showed that the interactive effect of intercropping ratios and planting date on dry weight of corn ear was significant at 5% probability level (Table 1). Among the studied treatments, the

treatment with 25% maize and 75% soybean produced 8.78 t/ha dry matter of corn ear. Moreover, all intercropping ratios at planting date of July 22 had more dry weight than the other planting dates. This indicates the effect of intercropping ratio on dry matter of corn ear so that the highest dry weight of corn ear belonged to the ratio of 25% maize and 75% soybean. Probably, due to sufficient space for production of more leaves and consequently the increase of photosynthetic level and production of more assimilates and more transfer of them in to the corn ears, more dry matter is accumulated in the corn ears and their dry weight has increased (Majidian *et al.*, 2013).

Total Dry Weight in Soybean

The ANOVA results showed that the effect of planting date on total dry weight of soybean was significant at 1% probability level (Table 2). Comparison of the means showed that the highest total dry weight belonged to the treatments with planting dates of August 22 and August 12 by 13.20 and 10.36 t/ha, respectively (Table 4). Suitable vegetative growth period provided a good chance for the soybean to produce the highest dry weight and to increase its produced biomass as much as possible. Due to lack of time for dry matter accumulation in plant, late planting dates do not provide the plant with the necessary time for its increase, so the total dry weight in soybean is less than that of earlier planting dates. The results are consistent with the findings of Kouchaki (1994). Comparison of the means showed that the treatments with 52% maize and 57% soybean and also 50% maize and 50% soybean by 9.71 and 9.47 t/ha, respectively, produced the highest rate of total dry weight in soybean (Table 4). High plant densities in soybean population and also competition for light and also more effective light due to lower density of maize in intercropping lead to the increase of produced dry matter and ultimately the total dry weight will increases (Darby and Laure, 2002).

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

Total dry matter(ton/hec)	Leaf dry weight(ton/hec)	steam dry weight (ton/hec)	pod dry weigh(ton/hec)	Df	Sources of variations
2.07	0.617	0.544	0.949	2	**Replication**
157.37**	16.15**	17.28**	56.34**	3	**Planting date**
1.69	0.117	0.301	0.53	6	**Ea**
3.98 ns	0.199 ns	0.216 ns	1.54 ns	3	**Intercropping ratio**
5.68 ns	0.277 ns	0.312 ns	2.07 ns	9	**Interactive effect**
5.94	0.36	0.455	1.91	24	**Eb**
26.43	25.6	30.31	29.92		**C.V**

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

Stem Dry Weight in Soybean

The ANOVA results showed that the effect of planting date on the stem dry weight was significant at 1% probability level (Table 2). Comparison of the means showed that the highest stem dry weight by 3.55 t/ha belonged to the planting date of July 12 and the lowest stem dry weight by 0.8 t/ha belonged to the planting date of August 11 (Table 4). Ample opportunities for biomass production and lack of consistency between growth and maximum temperature contributed to the increase of stem dry weight. The results were consistent with the findings of Farahani *et al.*, (2012). The results of the research showed that the effect of intercropping ratios on stem dry weight was not significant (Table 2). Comparison of the means also showed a little difference between the treatments. However, the treatment with 75% soybean and 25% maize by 2.24 t/ha produced the highest rate of stem dry weight (Table 4). It can be said that plant density has had a significant effect on stem dry weight in soybean because the competition for light can increase the plant height and consequently increase the stem dry weight.

Leaf Dry Weight in Soybean

The ANOVA results showed that the effect of planting date on the leaf dry weight was significant at 1% probability level, but the effect of intercropping ration and the interactive effect of planting date and intercropping ratio on the leaf dry weight were not significant (Table 2). Comparison of the means showed that the highest leaf dry weight in soybean by 3.63 t/ha belonged to the planting date of July 12 and the lowest leaf dry weight by 0.96 t/ha belonged to the planting date of August 11 (Table 4). The longer period of vegetative growth can lead to production of more leaf dry matter in soybean and as the length of growth period increases the leaf dry weight in soybean increases, too. Farahani *et al.,* (2012) reported that the increase of leaf dry weight in soybean was probably due to the increase of the number of leaves in soybean which produced more leaves in area unit. Comparison of the means indicated that there was no significant difference between the treatments with different intercropping ratios (Table 4). However, among the studied treatments, the one with 25% maize and 75% soybean by 2.44 t/ha produced more leaf dry weight than the other treatments. Comparison of the means showed that the highest leaf dry weight belonged to the treatment with the interaction of planting date of July 12 and 25% and intercropping ratio of 25% maize and 75% soybean by 3.74 t/ha. Suitable time for dry matter production and also competition for light and nutrients can lead to the increase of leaf dry weight or it can be due to the increase of the number or size of the leaves.

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

Total dry matter(ton/hec)	Leaf dry weight(ton/hec)	Ear dry weigh(ton/hec)	Treatments
			Planting date
11.54b	3.74a	3.91c	**D1**
12.84b	3.56a	6.92ab	**D2**
13.22ab	3.35ab	6.14b	**D3**
15.27a	2.91b	7.84a	**D4**
			Intercropping ratio
12.88b	3.11a	6.6b	**P1**
12.81b	3.38a	5.83b	**P2**
12.8b	3.36a	5.82b	**P3**
14.37a	3.51a	6.97a	**P4**

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 Effect of Planting Date on Pod Dry Weight

The results showed that the pod dry weight was significantly affected by planting date at 1% probability level, but the intercropping ratio had no significant effect on pod dry weight (Table 3). Among the studied treatments, the highest pod dry weight by 7.51 t/ha belonged to the treatment with planting date of July 22 and the lowest pod dry weight by 2.76 t/ha belonged to the planting date of August 11 (Table 4). One of the factors affecting dry matter accumulation is the sufficient time for this action. Since the planting date of July 22 provides enough time for the soybean to produce dry matter the increase of dry matter in soybean can be attributed to the longer growth period.

Comparison of the means showed that the treatment with 75% maize and 25% soybean produced the highest rate of pod dry matter by 5.03 t/ha (Table 4). Appropriate time and space during the growth period can affect the number of pods per area unit and produce more pods per area unit (Mansoori *et al.,* 2010). The results showed that the interactive effect of planting date and intercropping ratios on the pod dry weight in soybean was not significant (Table 3).

However, the treatment with panting date of July 22 and 75% maize and 25% soybean produced the highest rate of pod dry weight. The reason can be the longer growth period and the sufficient space for

growth which produced more stems and consequently the number of pods and the pod dry weight increased.

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

Treatments	Total dry matter(ton/hec)	Leaf dry weight(ton/hec)	steam dry weight (ton/hec)	pod dry weigh(ton/hec)
Planting date				
D1	10.36 b	3.63 a	3.55 a	3.16 c
D2	13.20 a	2.92 b	2.77 b	7.51 a
D3	8.77 c	1.95 c	1.76 c	5.05 b
D4	4.53 d	0.96 d	0.8 d	2.76 c
Intercropping ratio				
P1	0	0	0	0
P2	9.71 a	2.38a	2.05 a	4.16 a
P3	8.39 a	2.18 a	2.23 a	5.03 a
P4	9.71 a	2.44 a	2.24 a	4.68 a

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

Conclusion

The results showed that the effect of different levels of intercropping ratio on dry weight of the plant organs and total dry matter was not significant, but the intercropping ratio of 25% maize and 75% soybean was determined as the superior intercropping ratio. In this ratio, the maize allocated the highest total dry weight (14.37 t/ha) and the highest leaf dry weight (3.51 t/ha) and the highest corn ear dry weight (6.97) to itself in intercropping. Moreover, the results showed that the effect of planting date on total dry weight and dry weight of plant organs was significant. Accordingly, the planting dates of July 12 and 22 were reported as the superior planting dates in soybean. According to the results, early planting of soybean can produce more dry matter by means of the shadowing of maize and can have heavier weight compared to the later planting dates and thus the highest total dry matter in soybean was obtained in the planting date of July 22 by 13.20 t/ha and the highest dry matter of stem and leaf was obtained in planting date of July 12 by 3.55 and 3.63 t/ha, respectively.

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