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Intercropping of popcorn (*Zea mays everta*) and cowpea (*Vigna unguiculata* L.Walp) could improve yield and better weeds control

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Abstract

In order to evaluation of effect of popcorn + cowpea intercropping on yield and weeds biomass an experiment was conducted as factorial based on RCB in Islamic Azad University of Tabriz. Studied factors included maize sowing dates (12th, 19th and 26th May) and sowing percentage of cowpea as 12.5%, 25%, 37.5%, 50% and 100% of recommended density rate (5, 10, 15, 20 and 40 plants per square meter). Based on results weeds biomass in intercropping of the crops with 12.5% and 25% of recommended density rate experienced reduction of 4.5 g m^{-2} compared to the maize mono-cropping and 6 g m^{-2} compared to the mean of intercropping of the crops with 37.5% and 50% of recommended density rate. Intercropping of popcorn with cowpea with 12.5% and 25% of its recommended density was recommended for farmers.

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Introduction

Popcorn (*Zea mays* var. *everta*) is the most widely grown as a grain crop with annually 1110 million tons production throughout the Iran. Cowpea (*Vigna unguiculata* L.) is a poor competitive plant with weeds and its ability to compete with weeds in Iran relies heavily on the application of herbicides (Majnoun Hosseini, 2008).

Intercropping including legumes is an old and widespread practice in the low-input systems. However, during the 20th century, farmers around the world replaced legume rotations and other traditional sources of nitrogen (N) with synthetic N fertilizers and increased use of pesticide inputs (Willey, 1979). Today, the food and feed markets are experiencing increased awareness of environmental damage arising from the use of such non-renewable chemical resources.

In an experiment conducted by Najari Sadeghi *et al.* (2013) hundred seed weight of bean ranged from 37 g in row intercropping pattern and earlier sowing time of bean than marigold up to 46.4 g in bean mono-cropping. When bean sowing was delayed to marigold in strip intercropping pattern, produced seeds with 100 seed weight same as mono-cropping pattern. In Onuh *et al.* (2011) study on mung bean/melon/maize intercrop, mung bean mono-cropping resulted in higher leaves number and finally grain yield.

Laster (2006) reported that soybean and bean intercropping in 1:1 ratio gave the highest monetary return and LER of nearly 2 and the yield advantage was more in intercropping than all sole-cropping systems. Mazaheri and Oveysi (2004) reported that SC604 and SC704 intercropping in 1:1 ratio gave 15.3% and 7.8% greater grain yield compared to the 1SC704:3SC604 and 3SC604:1SC704 combinations, respectively.

The main objective of this study was to evaluation of effect of intercropping popcorn (*Zea mays* var. *everta*) with cowpea (*Vigna unguiculata*) in different sowing dates on crop yield and weeds biomass.

Materials and methods

Experimental procedure

The field experiment was conducted on a sandy loam soil at the Agricultural Research Station of Islamic Azad University of Tabriz, Iran, during 2013 growing season. Tabriz is located in the north-west of Iran; the climate is semi-arid and cold and average annual precipitation is 270 mm. The experimental field had been in a bean-wheat rotation cycle for the last two years.

Cultivation details

The experimental area was ploughed in the fall and manured with 12 t ha^{-1}. Field were cultivated, disked, furrowed and then plotted in spring before sowing the seeds. Fertilizers used before sowing were 160 and 60 75 kg ha^{-1} of ammonium phosphate and potassium sulfate, respectively. Cowpea seeds were inoculated with *Rhizobium* before sowing for the cowpea symbiosis to work, and then were sown immediately.

Studied treatments

The studied treatments were sowing date of corn related to cowpea (D_1=7 days earlier, D_2= simultaneously with maize, D_3=7 days later than cowpea) and sowing rate of cowpea (I_1=12.5%, I_2=25%, I_3=37.5%, I_4=50% of its recommended density, and I_5= lentil mono-cropping with 40 plants per square meter as optimum density, included a mono-cropping of corn as control). The crops were harvested at physiological maturity. The plots were harvested manually.

Statistical analysis

All data were analyzed factorially based on randomized complete block design, using MSTAT-C software. The means of the treatments were compared using the least significant difference test at $P<0.05$.

Results and discussion

Analysis of variance

Effect of sowing date on corn development height on stem was significant at 5% probability level. Also, effect of sowing percentage on corn development

height on stem was significant at 1% probability level; and on ear length, seed number per ear, weeds biomass and seed yield were significant at 5% probability level (Table 1).

Table 1. Mean squares for studied traits in popcorn.

SOV	df	Corn development height	Ear length	Seed number per ear	Weeds biomass	Seed yield
Replicate	2	100.16	0.54	89.44	135.78	16.01
Sowing date	2	259.01*	6.41	541.10	13.52	125.11
Sowing percentage	4	333.52**	16.00*	1598.00*	131.02*	500.008*
Sowing date× Sowing percentage	8	75.54	5.00	154.00	19.31	78.12
Error	28	125.12	4.12	349.12	35.90	125.75
CV (%)	-	21.21	25.55	12.58	22.19	21.88

*, ** mean significant difference at 5% and 1% probability levels, respectively.

Mean comparisons of data

Corn development height

Based on mean comparisons, when maize was sown simultaneously with cowpea on 19th May, corn developed on height of 94 cm on stem, but were 84 cm and 69.5 cm in 12th May and 26th May, respectively (Fig. 1), that was caused difficulty in mechanical harvesting.

In the study conditions, corn development height ranged from 74 cm in its intercropping with cowpea in 50% of recommended density up to 92 cm in 12.5% of density. In intercropping pattern with 50% of density corn was developed in lower height than control (Table 2).

Ear length

Ear length of corn was in advance when sowing percentage of cowpea increased up to 25% of recommended density. But decreased after that up to 13 cm in 25% of its density (Table 2). Based on Tayfe Nouri (2007) reports, when maize intercropped with bean, ear length in higher bean densities decreased, significantly.

Seed number per ear

Also, variation trend in seed number per ear was similar to ear length (Table 2). *Weeds biomass*

Biomass of emerged weeds in plots was the highest in two treatments of 37.5% and 50% of recommended densities, but only 17.2% from 12.5% and 25% of densities (Table 2).

Table 2. Mean comparisons of effect of sowing percentage of cowpea on some of studied traits.

Sowing percentage	Corn development height (cm)	Ear length (cm)	Seed number per ear	Weeds biomass (g m^{-2})	Seed yield (g m^{-2})
0	79 cd	15.7 b	30 c	21.7 b	508.9 b
12.5	92 a	15.7 b	32.5 a	17.1 c	571.2 a
25	87 b	17.1 a	36 a	17.4 c	565.4 a
37.5	81 c	15.7 b	30 c	23 a	442.7 c
50	74 d	13 c	30 c	22.8 a	444.5 c

Means in each column with the same letter have not significant difference at 5% probability level.

Seed yield

Seed yield among treatments ranged from 586 g m^{-2} in corn intercropping with cowpea in 12.5% and 25% of recommended densities up to 443 g m^{-2} in 12.5% and 50% of densities. Seed yield in mono-cropping of corn was better than its intercropping with cowpea in

two higher densities (Table 2). Sowing date influences stem height, time to ripening, seed size and finally yield (Khanal *et al.*, 2004). Also, Shayegan *et al.* (2009) emphasized on effect of mixing rate on seed yield. Improved cultivars of faba bean and lupin might be alternative grain legumes to pea with a higher seed yield and stronger stem strength but probably with the some of the same obstacles as peas, such as weak competitive ability towards weeds. Intercropping experiments with faba bean and cereals have shown similar advantages (Knudsen, *et al.*, 2004; 1997; Jensen, 1968).

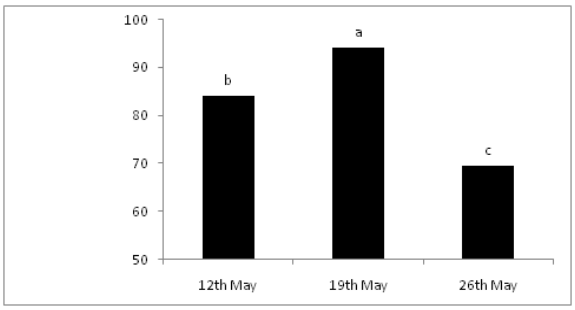

Fig. 1. Effect of sowing date on corn development height on stem.

Conclusion

Based on our results obtained, it was recommended for intercropping of cowpea in 12.5% or 25% of optimum density along with maize.

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