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Evaluation of Competitive Indices of Spring Groundnut (*Arachis hypogaea* L.) Influenced by Skip Row Geometry and Intercropping Systems

Krishan Kant Haritwal[1*], K.S. Saini[1], Shruti Mohapatra[2] and Abhishek Patidar[1]

[1]*Department of Agronomy, PAU, Ludhiana-141004, Punjab, India*
[2]*Department of Agricultural Economics, OUAT, Bhubaneswar-753001, India*

**Corresponding author*

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A B S T R A C T

The experiment was conducted on intercropping of spring groundnut (*Arachis hypogaea* L.) with spring groundnut + maize (fodder), spring groundnut + cowpea (fodder), spring groundnut + cluster bean (fodder), sole spring groundnut sole maize (fodder), sole cowpea (fodder) and sole cluster bean (fodder) in spring season of 2016 at research farm, department of agronomy, Punjab Agricultural University, Ludhiana. Two genotypes of spring groundnut comprise TAG 37 A and SG 99 were taken in main plots and seven intercropping systems in sub plots in a split plot design with three replications. Land equivalent ratio (LER), Area time equivalent ratio (ATER), aggressivity (A), competitive ratio (CR), monetary advantage index (MAI), the difference was non-significant in TAG 37 A and SG 99 genotypes. LER, ATER, aggressivity (A) revealed that, all applied intercropping efficient than sole cropping. The lowest amount of competition index (CI) (1.60) was observed in the treatment of spring groundnut + maize (fodder). The highest amount of MAI (39210.6) was observed in the treatment of spring groundnut + maize (fodder).

Introduction

Groundnut (*Arachis hypogaea* L.) is the major oilseed crop of India which accounts for about half of the major oilseeds produced in the country. It occupies sixth and third position as a source of edible oil and vegetable protein in the world respectively. India ranks first in oilseed production in the world and oilseed sector is the prime sector governing the agricultural economy of the country.

Groundnut is also known as king of oilseeds and it belongs to the family *Leguminosae* and sub-family *Papilionoideae*. The scientific name of groundnut (*Arachis hypogaea* L.) is taken from the Greek word “arachis” which means legume and “hypogaea” means below ground, indicating to the development of pods in the soil. Groundnut is also referred as poor men’s cashew nut and wonder nut as well as monkey nut. The different agro-ecological conditions prevailing in India is favorable for growing all the nine annual oilseeds which includes seven edible oilseeds. Among these groundnut rank first followed by rapeseed-mustard, soybean, sunflower etc. Groundnut seed contain high quality edible oil (48-50%), depending upon the agronomic conditions and varieties. It is also a rich source of protein (25-34%), carbohydrates (10-20%) and vitamins (E, K and B complex). Intercropping research in different countries reveals that in addition to increasing the ecological and economic diversity, intercropping brings an increase in production or yield benefits, more efficient use of water resources, land, nutrients and labors, reduction in problems caused by pests, diseases and weeds (Awal *et al.,* 2006) together with improving the environmental conditions for plant growth (Alizadeh *et al.*, 2010). Among the most significant benefits of intercropping is increasing production per unit area than sole cropping (Banik *et al.,* 2006) due to the better use of environmental factors such as water, nutrients and light (Alizadeh *et al.,* 2010). However, the advantage of intercropping is obtained when correspondent species are different in the form and spatio-temporal of natural resources in which different physiological and morphological characteristics will be able to make optimal use of environmental factors when cropped in the vicinity of each other.

Materials and Methods

The experiment was carried out at Student's Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana which situated at 30° 56' N latitude, 75° 52' E longitude and at an altitude of 247 m above mean sea level. The soil of the experimental field was normal in pH (7.3) and electrical conductivity (0.40 dSm⁻ 1), while low in organic carbon (0.26%) and available N (113.0 kg ha^{-1}), medium in available P (21.98 kg ha^{-1}) and low in available K (122.1 kg ha^{-1}). The experiment was laid out in a split-plot design with three replication with two genotypes i.e. TAG 37 A and SG 99 in main plots and seven treatments viz. spring groundnut + maize (fodder), spring groundnut + cowpea (fodder), spring groundnut + cluster bean (fodder), sole spring groundnut, sole maize (fodder), sole cowpea (fodder), sole cluster bean (fodder) in the sub plots. Spring groundnut was sown in plant geometry 30 cm × 15 cm to maintain uniform recommended plant population with skip one row after two rows of spring groundnut to adjust the intercrop. The intercrops were raised in the skip rows between spring groundnut genotypes as per treatment. Sowing of groundnut and all intercrops were done on 17th March 2016 and harvesting of intercrops (maize, cluster bean, and cowpea) were done on 7th May 2016 while harvesting of spring groundnut was done on 5th July 2016 (TAG 37A) and 20th July 2016 (SG 99). Other package of practices for spring groundnut and intercrops were followed as per PAU recommendation except hand weeding. Total rainfall of 222.4 mm was recorded during the crop season against the 266.9 mm of normal rainfall. Evaporation during the corresponding period was 1039.3 mm against normal evaporation of 1078.3 mm. Daily sunshine hours ranged from 6.5 hours in 11th standard meteorological week (12-18 March) to 12.1 hours in 29th SMW (16-22 July). Fodder crops of maize, cowpea and cluster bean were harvested of the 50 days after sowing on 6th May 2016. Fodder crop observations were taken for green fodder & also dried samples for dry weight of fodder yield. The crop was harvested manually when it attained the physiological maturity. The genotype G1-TAG 37A was harvested on 5th July and SG 99 on 20th July 2016. Respectively the border lines were harvested first and were removed out of the experimental area. Previously selected (tagged) ten plants were harvested separately for recording post-harvest observations and their pod yield was added to final net plot yield. The plot-wise threshing and cleaning operations were done to record pod yield. LER indicates the efficiency of intercropping in using the resources of the environment compared with sole cropping (Mead and Willey 1980).

Land Equivalent Ratio (LER) is according to the following formula:

LER = (Yab/Yaa) + (Yba/Ybb)

Where:

Yaa = pure stand yield of species a

Ybb= pure stand yield of species b

Yab = mixture yield of a (when combined with b)

Yba = mixture yield of b (when combined with a).

Area time equivalent ratio provides more realistic comparison of the yield of intercropping over monocropping in terms of time taken by component crops in the intercrop according to Hiebsch (1978). ATER was calculated by formula area time equivalent ratio.

ATER= (LERa x LERb x DC) Dt

Where:

LERa is land equivalent ratio of crop a

LERb is land equivalent ratio of crop b

DC is duration (days) taken by crop

Dt is days to intercropping system from planting to harvest.

Aggressivity is another index that is often used to indicate how much the relative yield increase in crop 'a' is greater than that crop 'b' and vice versa in an intercropping system. This was proposed by Mc-Gilichrist (1965) and was determined according to the following formula:

$$A_{ab} = \frac{Y_{ab}}{Y_{aa} \times Z_{ab}} - \frac{Y_{ba}}{Y_{bb} \times Z_{ba}}$$

$$A_{ba} = \frac{Y_{ba}}{Y_{bb} \times Z_{ba}} - \frac{Y_{ab}}{Y_{aa} \times Z_{ab}}$$

Where:

A_{ab} is the aggressivity of crop 'a' intercropped with 'b'

A_{ba} is the aggressivity of crop 'b' intercropped with 'a'

Zab is the sown proportion of intercrop a in combination with b

Zba is the sown proportion of intercrop b in combination with a

Competitive ratio (CR) was calculated by the following formula as given by Willey and Rao (1980).

CR = CRa + CRb CRa = LERa / LERb X Zba/ Zab

Where:

LERa and LERb represent relative yield of a and b intercrops
CRa, CRb are the competitive ratio for (a) and (b) intercropping

The monetary advantage index (MAI) was calculated as described by Ghosh (2004).

MAI = monetary value of combined intercrops × (LER−1) / LER.

The higher the index value, the more profitable is the cropping system (Dhima *et al.*, 2007).

Results and Discussion

Land equivalent ratio (LER), area time equivalent ratio (ATER) and Aggressivity (A) of spring groundnut based intercropping system as influenced by genotype and intercropping systems

The data pertaining to the LER are presented in Table 1. Intercropping advantage in terms of LER showed that genotypes did not significantly influence the LER of spring groundnut based intercropping system.

The data on LER of different intercropping systems indicated that LER values were greater than one in all intercropping systems which indicated their yield advantage over sole cropping due the better utilization of environmental resources for growth. Values of partial LER of spring groundnut were higher than the partial LER of intercrops. Partial LER of any intercrops was not > 0.5, so any of the intercropping system did not have a negative effect on partial LER of spring groundnut (Mandimba, 1995).

Partial LER significantly low in spring groundnut + cowpea (fodder) intercropping system than other intercropping systems. All three intercrops possessed different nature of growth, plant height and canopy structure and day to maturity. Therefore, these crops differed in yield potential and competitive ability. Value of partial LER of intercrops was not significantly influenced by genotypes and different intercropping systems. Mengping and Zhangjinsong (2004) also reported that intercropping systems have higher LER than the sole cropping.

The ATER provides a more realistic comparison of yield advantage of intercropping over that of sole cropping because variation in time taken by component crops in different intercropping system. However, crop production is a function of both crop duration (time) and land area. The data regarding to the area time equivalent ratio (ATER) are presented in (Table 1). Intercropping advantage in term of ATER of spring groundnut based intercropping system. Higher value of ATER was observed in spring groundnut + maize (fodder) intercropping system.

The data on Aggressivity (A) value are presented in Table 1. Aggressivity value of spring groundnut was no significant by genotypes in intercropping systems. The Aggressivity of groundnut is positive so, it is consider as the more dominant crop in the intercropping system.

Associated fodder intercrops were the less dominant crops in the presented by the negative value (Ghosh 2004). Among the intercropping systems aggressivity (A) value spring groundnut + maize (fodder) and spring groundnut + cluster bean (fodder) were at par but significantly better than spring groundnut + cowpea (fodder) in intercropping system.

Competitive ratio is way to know the degree with which one crop competes with another component crop. The data regarding CR value are presented in Table 2. The data indicated that competitive ratio CR for spring groundnut was not significantly in genotypes whereas in intercrops was influenced the CR. Higher the CR value indicated to spring groundnut + cowpea (fodder) in intercropping system.

Table.1 Land equivalent ratio (LER), area time equivalent ratio (ATER) and Aggressivity (A) of spring groundnut based intercropping system as influenced by genotype and intercropping system

Treatments	LER	ATER	Aggressivity (A)
Genotypes			
TAG 37A	1.22	1.08	0.58
SG 99	1.23	1.06	0.58
CD (p=0.05)	NS	NS	NS
Intercropping system			
Spring groundnut + Maize (fodder)	1.27	1.09	0.65
Spring groundnut + Cowpea (fodder)	1.15	1.04	0.49
Spring groundnut + Cluster bean (fodder)	1.25	1.08	0.61
CD (p=0.05)	0.03	NS	0.06
Interaction	NS	NS	NS

Table.2 Competitive ratio (CR) and monetary advantage index (MAI) of spring groundnut based intercropping systems in relation to genotype and intercrops

Treatments	Competitive ratio (CR)	Monetary advantage index (MAI) (`)
Genotypes		
TAG 37A	1.70	32561.6
SG 99	1.74	32380.3
CD (p=0.05)	NS	NS
Intercropping system		
Spring groundnut + Maize (fodder)	1.60	39210.6
Spring groundnut + Cowpea (fodder)	1.79	21760.5
Spring groundnut + Cluster bean (fodder)	1.77	36441.8
CD (p=0.05)	0.13	4269.9
Interaction	NS	NS

Therefore, the yield advantage was less in spring groundnut + cowpea (fodder). Less the CR value indicated to spring groundnut + maize (fodder) in intercropping system resulted more yield advantage in spring groundnut + maize (fodder) than followed by spring groundnut + cluster bean (fodder) and spring groundnut + maize (fodder) intercropping system. Monetary advantage index (MAI) in (Table 2). MAI values were positive showed a definite yield advantage in the both genotypes. MAI values difference (Rs 181.3) was higher with TAG 37A than SG 99 genotype. MAI index values showed the economic advantage with TAG 37A genotype as compared to the SG 99 genotype. MAI values were positive which showed a definite yield advantage in all intercropping systems. MAI index values were significantly higher in spring groundnut + maize (fodder) intercropping system. Spring groundnut + maize (fodder) system gave the significantly higher yield advantage than spring groundnut + cowpea (fodder) intercropping system but at par with spring groundnut + cluster bean (fodder) intercropping system.

Intercropping system gives higher LER, ATER, Aggressivity. The lowest amount of competition index (CI) was observed in the treatment of spring groundnut + maize (fodder). The highest amount of MAI was observed in the treatment of spring groundnut + maize (fodder).

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