www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(4): 682-685

www.thepharmajournal.com
Received: 20-02-2019
Accepted: 21-03-2019

Syed Abul Hassan Hussainy
Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Vaidyanathan R
Professor and Head, Oilseeds Research Station, Tamil Nadu Agricultural University, Tindivanam, Tamil Nadu, India

Correspondence
Vaidyanathan R
Professor and Head, Oilseeds Research Station, Tamil Nadu Agricultural University, Tindivanam, Tamil Nadu, India

Influence of groundnut (*Arachis hypogaea*) based intercropping under different levels of irrigation on the performance of intercrops

Syed Abul Hassan Hussainy and Vaidyanathan R

Abstract
A field experiment was conducted during *kharif* season of 2017 and 2018 to study the influence of intercropping under different levels of irrigation on the performance and nutrient dynamics of groundnut. Groundnut intercrops involving castor, blackgram, sesame and pearlmillet recorded higher plant height, dry matter production, yield attributes and equivalent intercrop yields under irrigation scheduling of IW/CPE ratio of 0.75. The Relative production efficiency favoured the intercropping system over the sole cropping system with values varying from19% to 99.6% over the conventional sole cropping system. Higher relative production efficiency was realised with castor as it outperformed as a companion crop but suppressed the groundnut yields. Application of water at IW/CPE ratio of 0.75 comprising 7 irrigations (excl. sprouting and life irrigation) enhanced the productivity in terms of equivalent intercrop yield as well as sole crop yield.

Keywords: Groundnut intercropping, Irrigation scheduling, Intercrop equivalent yield, Relative production efficiency

Introduction
Groundnut (*Arachis hypogaea* L.) is an annual legume originated from South America belongs to the family Leguminosae. It is a principal food and oilseed crops of tropical and sub-tropical regions of the world commonly called as poor man's almond (or) wonder nut.
Groundnut as a sole crop is affected by adverse weather conditions resulting in economic losses and this can be overcome by intercropping system which also offers greater stability along with improved system productivity per unit area per unit time. Crop compatibility is the most essential factor for a practicable intercropping system where both the crops are mutually benefitted. The success therefore depends on the appropriate selection of companion crop where, competition between them for radiation, CO_2, nutrients, soil moisture and space etc., is minimised (Natarajan and Willey, 1986) [5].
Water scarcity nowadays due to increased industrialisation, intensive agriculture and climate change has made its proper utilisation very crucial. Increased water use efficiency in groundnut could possibly be attained through proper irrigation scheduling based on the crop evapotranspiration and providing irrigation at critical growth stages (Ibrahim *et. al.*, 2002) [3]. The major hurdle in intercropping system is in providing the water requirement of the system as crops vary in consumptive water use.
Therefore, the study was aimed to determine the production potential of groundnut based intercropping system and to identify an appropriate climatological irrigation schedule for the North-eastern state of Tamil Nadu favouring increased system productivity equipped with higher monetary returns with meagre water loss.

Materials and Methods
The field experiment was conducted during kharif season of 2017 and 2018 at Oilseeds Research Station, Tindivanam, Tamil Nadu, India. The farm is geographically located in North eastern part of Tamil Nadu at 12º21.2290´ N latitude and 79º66.93838´ E longitude at an altitude of 45.6 m above MSL. The soil of the experimental field was sandy loam (20.4% course sand, 30.6% fine sand, 26.2% silt and 22.6% clay) in texture, neutral in reaction, medium in organic carbon (0.56%), low in available nitrogen (246 kg/ha), medium in phosphorus (24.1 kg/ha) and potassium (204 kg/ha). During the crop growth the mean maximum and minimum temperature of the location were 32.4 ^{0}C and 24.9 ^{0}C during 2017

and 35.3 ^{0}C and 26.4 ^{0}C during 2018. The experimental site received abnormal rainfall in both the consecutive years and most of it was lost as runoff. The mean annual rainfall received during the two seasons was 11.5mm and 973.1mm respectively. The mean evaporation recorded 5.8 mm and 6.15 mm respectively in the two years.

The experiment was laid out in split plot design with three replications. It consisted of five intercropping treatments in the main plot *viz.*, sole groundnut, groundnut + castor (6:1), groundnut + blackgram (6:1), groundnut + sesame (4:1) and groundnut + pearl millet (4:1) and three climatological based irrigation scheduling using IW/CPE ratio in the sub plot *viz.*, 0.50, 0.75 and 1.0 respectively. Intercropping of groundnut with castor (7,936 plants/ha) and blackgram (47,619 plants/ha) maintained a plant population of 285,714 plants/ha and intercropping of groundnut with sesame (22,222 plants/ha) and pearl millet (29,630 plants/ha) retained 266,666 plants/ha. From the recommended fertilizer for groundnut 25:50:75 kg NPK, 50% of nitrogen and potassium and 100 % phosphorous applied as basal and 45 days after sowing remaining 50% of nitrogen and potassium applied to all treatments along with gypsum (400 kg/ha). Based on IW/CPE ratio, remaining irrigations were applied as per treatment and were measured with an 18-inch cutthroat flume. The soil moisture was determined using gravimetric method. The soil samples were collected using a screw auger at the depth of 0 – 15cm, 15 – 30cm and 30 – 45cm, 45 – 60cm and 60 – 75cm to determine the total consumptive use and soil moisture extraction pattern of the crop.

The harvested groundnut crops from the respective net plots were uprooted by hand and the pods were stripped off manually and sun dried. After complete sun drying, the pods were cleaned and net plot yield was recorded and expressed as g/plant. The intercrops were also harvested manually, threshed and sun dried as they attained physiological maturity as per standard procedure. The yields of main crop groundnut yield was converted into Equivalent Yield (CEY) of intercrops based on price of the produce using the formula suggested by Verma and Modgel (1983) [12]:

$$\text{CEY (kg/ha)} = \frac{Y_{ab} \times P_a}{P_b} + Y_{ba}$$

Where, Y_{ba} = Yield of 'b' intercropped with 'a'; Y_{ab} = Yield of crop 'a' intercropped with 'b'; P_a = Price of main crop 'a'; P_b = Price of inter crop 'b'. Relative Production Efficiency (RPE) was calculated to assess the potentiality of the new system using the formula suggested by Urkurkar *et al.* (2008) [11]:

$$\text{RPE (\%)} = \frac{(EYD - EYE)}{EYE} \times 100$$

Where, EYD = Equivalent yield under improved system; EYE = Existing system yield; Positive RPE denotes superiority of the new system and negative denote lesser desirability for change.

The intercrops were not statistically analysed rather averaged and expressed. The performance of intercrops was interpreted in terms of intercrop equivalent yields to the yield of sole crops as influenced by different levels of irrigation. For the groundnut crop, SAS/STAT software (SAS Institute, 1999) was used for the Statistical Analysis of variance (ANOVA). The analysis of the data for the years was done separately and the artlett's Chi-square test was used to test the homogeneity of variances. Heterogeneous variances were applied with Aitken's square root transformation and were pooled using the PROC GLM procedure considering the years as fixed effects. Critical difference (CD) at 5% level of probability and P values were used to examine differences among the treatment means.

Result and Discussion

Castor

Performance of castor was significantly affected under groundnut intercropping system and irrigation scheduling (Table 1). Irrigation scheduling with IW/CPE 0.75 resulted in increased the plant height (202 cm), dry matter production (106 g/plant) and was followed by IW/CPE ratio of 1.0. Higher number of capsules/plant of 35.4 realised a yield of 20.5 g/plant in IW/CPE ratio 0.75 over 12 per cent over the IW/CPE ratio of 0.50. The increase in yield could be attributed to the higher availability and increased translocation of photosynthates to the developing capsules might have resulted in higher crop yield. The irrigation intervals under IW/CPE ratio of 0.75 might have coincided with the critical stages and water requirement of groundnut together increasing the output from the system. The results are in concordance to the results of Raj *et al.* (2010) [6].

The system productivity from IW/CPE ratio of 0.75 recorded an intercrop equivalent yield of 1763 with relative production efficiency of 97.4 per cent over the sole crop of castor. The increased yield of the system was a result of better performance of groundnut as well as castor under the frequency of irrigation which could have matched with the crop water requirement. Similar results were recorded by.

Blackgram

Blackgram exhibited exceptional performance in groundnut intercropping system and was also significantly affected by the different levels of irrigation (Table 2). IW/CPE ratio of 0.75 recorded higher plant height of 33.5 cm with dry matter production of 10.3 g/plant. The yield components like pods/plant yielded 15.3 numbers with a test weight of 3.92 g yielding 3.15 g/plant. The increased yields could be due to the maintenance of optimum soil moisture throughout the crop growth which resulted in better availability of nutrients. Further, the periodicity of optimum soil moisture might have lead to high water potential and stomatal conductance increasing the partitioning of photosynthates to sink increasing the dry matter and yield of the crop. The results are in concordance to the results of Chaudhary *et al*. (2014) [2].

The system productivity as compared to equivalent gram yield realised 1669 kg/ha as compared to 955 kg/ha under sole crop attaining 74.8 per cent higher over the conventional sole cropping system. The relative production efficiency was higher with IW/CPE ratio of 1.0 with 75 per cent but it wasn't sufficient to incur higher equivalent yields as the former. This insists on the irrigation scheduling of water at 75% CPE which might have played a key role in root development by mechanical resistance leading to greater nutrient uptake and higher transpiration resulted in more photosynthesis. The results are in acceptance to the observations of Sirgapure and Fathima (2018) [10].

Sesame

Intercropping with groundnut significantly affected the growth and yield of sesame (Table 3). Sesame outperformed

when supplied with 25% climatological based deficit irrigation recording a plant height of 87.5 cm and a dry matter production of 49.4 g/plant as compared to 0% deficit irrigation (80cm; 46 g/plant respectively). The capsules per plant registered 71.9 yielding 8.91 g/plant while 50% climatological deficit irrigation achieved 64.2 capsules yielding 7.56 g/plant 17.8 per cent lesser than the former.

Sesame equivalent yield of 1368 kg/ha was visualized under 25% climatological deficit irrigation while the sole crop registered 908 kg/ha with 50.6 per cent lesser on comparison to the equivalent yield. Higher Relative production efficiency achieved under IW/CPE ratio of 0.75 could be a phenomenon involving better cell division and enlargement as a result of adequate irrigation which eventually increased the growth, yield and yield attributes of sesame and realising better equivalent yield under better performance of groundnut in the same irrigation frequency. The results are in similarity to the results of Sarkar *et al.* (2010) [9] and Rupali *et al.* (2015) [7].

Pearlmillet

Pearlmillet played a dominant role under groundnut intercropping system suppressing the growth of groundnut with higher plant height 240 cm and increased biomass of 62.5 g/plant with more number of tillers accounting 6.30 under IW/CPE ratio of 0.75 (Table 4). The 1000 grain weight was not much affected under the different levels of irrigations ranging from 3.54 to 3.59. On comparison to the performance of the intercrop pearlmillet as expected in sole could have attained 4474 kg/ha but, actual sole crop yielded 3725 kg/ha reducing 20.1 per cent which can be attributed to the competition between the pearlmillet crop in the pure cultivation. The relative production efficiency on comparison to the equivalent yield decreased with 23.4 per cent as compared to other intercrops due to the pricing factor of the pearlmillet crop. In general, IW/CPE ratio of 0.75 outperformed in comparison to the other levels of irrigation. This might have been due to the optimum supply of water to the crop which prevented the inducement of moisture stress on the crop throughout the crop growth which ultimately increased the crop growth and yield attributing character realising better crop yields. The results are in close conformity to the results of Saini *et al.* (2018) [8] and Khafi *et al.* (2011) [4].

Relative Production Efficiency

Relative production efficiency (RPE) indicated the advantage of the new system over the existing system in terms of equivalent yield of the crop under intercropping system. The equivalent yield was considered in terms of intercrops in order to estimate the performance as a companion crop and as a sole crop.

Higher overall relative production efficiency was recorded under groundnut + castor system with 91% and was followed by blackgram with 72.4 per cent, sesame with 46.8 per cent and pearlmillet with 21.8 per cent over their respective sole crop yields indicating better efficiency under intercropping system than grown as sole crops. The increase could have been due to lesser competition for resources for intercrops under groundnut intercropping system *viz.,* sunlight as a result of higher plant height, water and nutrient uptake due to deeper rooting system, space with higher row to row spacing as compared to that under sole system. The observations are in similarity with the results of Arun kumar *et al.* (2017) [1].

Table 1: Effect of groundnut based intercropping under different levels of irrigation on the growth and yield of intercropped castor (Mean data of 2 years)

Treatment	Plant Height (cm)	Dry matter (g/plant)	Capsules /plant (No.)	Test weight (g)	Yield (g/plant)	Equivalent yield (kg/ha)	Sole crop yield (kg/ha)	RPE (%)
Irrigation scheduling								
I_1	175	88.5	33.9	22.1	18.3	1389	795	74.7
I_2	202	106	35.4	21.9	20.5	1763	893	97.4
I_3	186	96.1	33.9	22.2	19.3	1667	835	99.6
Mean	188	96.7	34.4	22.1	19.4	1606	841	91.0

Table 2: Effect of groundnut based intercropping under different levels of irrigation on the growth and yield of intercropped blackgram (Mean data of 2 years)

Treatment	Plant Height (cm)	Dry matter (g/plant)	Pods/ plant (No.)	Test weight (g)	Yield (g/plant)	Equivalent yield (kg/ha)	Sole crop yield (kg/ha)	RPE (%)
Irrigation scheduling								
I_1	27.1	8.08	13.5	3.92	2.69	1352	810	66.9
I_2	33.5	10.3	15.3	3.92	3.15	1669	955	74.8
I_3	32.0	9.24	14.5	3.95	2.92	1557	890	75.0
Mean	30.9	9.21	14.4	3.93	2.92	1526	885	72.4

Table 3: Effect of groundnut based intercropping under different levels of irrigation on the growth and yield of intercropped sesame (Mean data of 2 years)

Treatment	Plant Height (cm)	Dry matter (g/plant)	Capsules/plant (No.)	1000 grain weigh (g)	Yield (g/plant)	Equivalent yield (kg/ha)	Sole crop yield (kg/ha)	RPE (%)
Irrigation scheduling								
I_1	73.1	43.8	64.2	3.12	7.56	1086	785	38.4
I_2	87.5	49.4	71.9	3.09	8.91	1368	908	50.6
I_3	80.0	46.0	70.8	3.08	8.33	1276	848	50.5
Mean	80.2	46.4	69.0	3.09	8.28	1243	847	46.8

Table 4: Effect of groundnut based intercropping under different levels of irrigation on the growth and yield of intercropped pearlmillet (Mean data of 2 years)

Treatment	Plant Height (cm)	Dry matter (g/plant)	Tillers/ plant (No.)	1000 grain weight(g)	Yield (g/plant)	Equivalent yield (kg/ha)	Sole crop yield (kg/ha)	RPE (%)
Irrigation scheduling								
I_1	189	49.4	5.91	3.54	24.6	3535	2970	19.0
I_2	240	62.5	6.30	3.59	30.2	4596	3725	23.4
I_3	209	59.2	6.09	3.56	28.6	4259	3475	22.6
Mean	213	53.3	6.10	3.56	27.8	4130	3390	21.8

Conclusion

From the present study it can be indoctrinated that groundnut intercropping system increases the monetary returns from the system. Providing irrigation at IW/CPE ratio of 0.75 increased the system productivity realising higher intercrop equivalent yields than the sole crop. Castor resulted in superior yields in intercropping situation with higher relative production efficiency of 91% but suppressed the performance of groundnut.

References

1. Arunkumar P, Maragatham N, Panneerselvam S, Ramanathan SP, Jeyakumar P. Water requirement of groundnut under different intercropping system and WUE in groundnut equivalent rate, The Pharma Innovation Journal. 2017; 6(11):322-325.
2. Chaudhary AN, Vihol KJ, Mor VB. Water use efficiency, yield, available nutrient and economics of greengram (*Vigna radiate* (L.) Wilczek) as influenced by plant density and irrigation management. Trends in Bioscies. 2014; 7(22):3761-3764.
3. Ibrahim AA, Stiger C, Adam HS, Adeeb AM. Water use efficiency of sorghum and groundnut under traditional and current irrigation in the Gezira scheme, Sudan. Irrigation Science. 2002; 21(3):115-125.
4. Khafi HR, Mehta AC, Bunsa BD, Dangaria CJ, Davda BK. Response of summer pearl millet (*Pennisetum glaucum* L.) to irrigation scheduling. Crop Research. 2011; 41(3):28-30.
5. Natarajan M, Willey RW. The effect of water stress on yield advantages of intercropping systems. Field Crop Research. 1986; 13(1):117-131.
6. Raj AD, Patel BS, Mehta RS. Effect of irrigation methods on growth, yield and economics of hybrid varieties of castor (Ricinus communis). Indian Journal of Agricultural Sciences. 2010; 80(9):795-800.
7. Rupali RD, Bhale VM, Deshmukh KM. Yield, growth and quality of summer sesame (*Sesamum indicum* L.) as influenced by irrigation and nitrogen levels. International Journal of Agricultural Sciences. 2015; 11(2):301-306.
8. Saini AK, Patel AM, Saini LH, Patel KM, Patel GM. Influence of irrigation, fertility and hydrogel levels on yield and yield attributes of summer pearl millet (*Pennisetum glaucum* L.) in Gujarat. Journal of Pharmacognosy and Phytochemistry. 2018; 7(2):2910-2913.
9. Sarkar A, Sarkar S, Zaman A, Rana SK. Performance of summer sesame (*Sesamum indicum* L.) under different irrigation regimes and nitrogen levels. Indian Journal Agronomy. 2010; 55(2):143-146.
10. Shirgapure KH, Fathima PS. Growth and yield of pulses as influenced by irrigation levels in southern dry zone of Karnataka. Journal of Pharmacognosy and Phytochemistry. 2018; 7(1):2444-2448.
11. Urkurkar JS, Chitale S, Tiwari A, Savu RM, Tomar HS. Identification of promising rice (*Oryza sativa*)-based cropping system for increasing productivity and sustainability for Chhattisgarh plains. Journal of Farming System and Research Development. 2008; 14(1):50-5.
12. Verma SP, Modgal SC. Production potential and economics of fertilizer application as resources constraints in maize, wheat crop sequence. Himachal Journal of Agricultural Research. 1983; 9(1):89-92.