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Influence of Intercropping System and Different Irrigation Regimes on the Peak Growth Stage of Groundnut *(Arachis hypogaea)*

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Abstract A field trial was conducted during *kharif* season of 2017 and 2018 to study the influence of groundnut *(Arachis hypogaea)* based intercropping system as influenced by different irrigation regimes. During the development stage groundnut intercropped with blackgram resulted higher in plant height (30.6 cm), number of branches/plant (6.12), LAI (3.12) and DMP (25.0 g/plant). Irrigation scheduling of IW/CPE ratio 0.75 significantly improved the growth of groundnut crop with higher plant height (29.5 cm), number of branches/plant (5.99), LAI (3.02) and DMP (24.2 g/plant). In terms of yield, pod yield of 6.96 g/plant with haulm yield of 14.6 g/plant during 2017 and 6.27 g/plant with 13.4 g/plant of haulm yield were recorded during 2018. Similarly, IW/CPE ratio of 0.75 recorded pod yield of 6.74 g/plant with haulm yield of 13.9 g/plant during 2017 and 6.04 g/plant with 12.6 g/plant of haulm yield during 2018 werer recorded. From the study, groundnut + blackgram intercropping system with irrigation scheduling at 0.75 IW/CPE ratio enhances the growth and yield of the system.

Keywords Groundnut intercropping, Irrigation scheduling, Pod yield, Haulm yield.

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Introduction

Groundnut (*Arachis hypogaea* L.) is an oil seed crop from the family of Leguminosae, originated from South America. It is growth in the tropical and sub tropical regions of the world and commonly known as poor man's almond (or) wonder nut.

Cultivation of groundnut along with other crops (as intercrop) provides greater stability with higher system productivity in unit area and time as the cultivation of sole crop is highly vulnerable to weather conditions resulting in reduction in yield and economic losses. In an intercropping system, compatibility is the key factor where both the crops need to be mutually benefited. Hence, selection of crops with less competition for radiation, CO_2, nutrients, soil moisture and space, is essential for success of the system (Natarajan and Willey 1986, Behera et al. 2015).

Proper utilization of water is essential, as the water scarcity nowadays has increased due to industrialization, intensive agriculture and climate change.

In groundnut, irrigation at critical growth stages and irrigation based on the crop evapotranspiration results in improved water use efficiency (Ibrahim et al. 2002). The major challenge in the intercropping system is scheduling of irrigation as the consumptive water use is differ between the crops.

Therefore, the major opportunity for increasing efficiency of water use at farm level lies in understanding the irrigation scheduling for a particular agro-climatic zone in such a way that it does not compensate with the yield of crops. In the present study attempts were made to determine the production potential and econmics of groundnut based intercropping system in the North-East State of Tamil Nadu and to identify an appropriate irrigation schedule for the same region with increased water use efficiency.

Materials and Methods

Field trial was conducted during the year 2017 and 2018 (*kharif* season) at Oilseeds Research Station, Tindivanam, Tamil Nadu, India. The farm is situated in North Eastern part of Tamil Nadu with latitude and longitude of $12^0$21.2290´ N and $79^0$66.93838´ E at MSL of 45.6 m. The soil of the experimental field belongs to 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%). The nutrient status of the soil was low in available nitrogen (246 kg/ha), medium in phosphorus (24.1 kg/ha) and potassium (204 kg/ha). The mean maximum and minimum temperature of the location during 2017 and 2018 were 32.4^{0}C, 24.9^{0}C and 35.3^{0}C, 26.4^{0}C respectively. During both the years, occurrence of rainfall in the experimental location was abnormal and lost as runoff. The cropping period recorded mean annual rainfall of 11.5 mm, 973.1 mm and mean evaporation of 5.8 mm, 6.15 mm during 2017 and 2018.

The trial was laid out in split plot design with three replications. The treatments in the main plot includes five intercropping system viz., sole groundnut, groundnut + castor (6:1), groundnut + blackgram (6:1), groundnut + sesame (4: 1) and groundnut + pearl millet (4:1) and three sub plots with IW/CPE ratio of 0.50, 0.75 and 1.0. The plant population maintained in the intercropping system of groundnut with castor was 7,936 plants/ha and blackgram population of 47,619 plants/ha. The total plant population of 285,714 plants/ha was maintained. In another intercropping system, groundnut with sesame, pearl millet maintained population of 22,222 plants/ha and 29,630 plants/ha with total population of 266,666 plants/ha. The recommended dose of fertilizer (25:50:75 kg NPK) for groundnut was applied in splits. Fifty percent of nitrogen, potassium and 100% phosphorus applied as basal and remaining 50% dose of nitrogen and potassium was applied during 45 days after sowing along with gypsum @ 400 kg/ha. Irrigation was applied based on IW/CPE ratio and measured with an 18-inch cutthroat flume. The total consumptive use and soil moisture extraction pattern of the crop was determined from the soil samples collected at different depth of 0 – 15 cm, 15- 30cm and 30 – 45cm, 45 – 60cm and 60 – 75cm.

At maturity, groundnut crop from each individual plots were uprooted and the pods were removed manually and sun dried. The dried pods were cleaned and net plot yield was weighed and expressed as kg/ha. The intercrops were also harvested at physiological maturity as per standard procedure.

Statistical analysis of variance (ANOVA) was done using SAS/STAT software (SAS Institute 1999). The analysis of the data for the years was done separately and the Artleett's Chi-square test was used to test the homogeneity of variances. Heterogenous 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.

Results and Discussion

Plant growth

The growth of groundnut was significantly influenced by the intercropping system. Groundnut intercropped with recorded superior in plant height (30.6 cm), number of branches per plant (6.12), Leaf Area Index (3.12) and Dry Matter Production (25.0 g/plant) at development stage of the crop which was comparable

Table 1. Effect of intercropping system and irrigation scheduling on Plant height, Number of branches per plant, Leaf Area Index (LAI), Dry Matter Production (DMP), Root depth and Root volume of groundnut (pooled data of 2 years).

Treatments	Plant height (cm)	Brancheds /plant (No.)	LAI	DMP (g/plant)	Root depth (cm)	Root volume (cm^3)
Intercropping						
C_1 : Sole Groundnut	29.7	5.98	3.03	23.6	14.7	53.9
C_2 : Groundnut + Castor	27.2	5.42	2.72	20.4	12.9	47.4
C_3 : Groundnut + Blackgram	30.6	6.12	3.12	25.0	14.9	55.0
C_4 : Groundnut + Sesame	28.5	5.80	2.86	22.0	13.6	50.2
C_5 : Groundnut + Pearlmillet	25.1	5.14	2.46	18.9	12.6	46.6
SE m ±	0.59	0.120	0.070	0.64	0.25	0.79
CD (p=0.05)	1.94	0.390	0.228	2.08	0.82	2.59
Irrigation scheduling						
I_1 : IW/CPE 0.50	26.8	5.31	2.65	19.5	14.9	53.5
I_2 : IW/CPE 0.75	29.5	5.99	3.02	24.2	13.6	50.9
I_3 : IW/CPE 1.00	28.4	5.78	2.85	22.3	12.7	47.5
SEm ±	0.57	0.120	0.072	0.78	0.36	1.13
CD (p=0.05)	1.68	0.353	0.213	2.29	1.06	3.35

with sole groundnut (29.7cm, 5.98, 3.03 and 23.6 g/ plant respectively). Similarly lower plant height (25.1 cm), number of branches per plant (5.14), Leaf Area Index (2.46) and Dry matter Production (18.9 g/plant). The decrease in growth parameters under pearlmillet intercropping could have been due to the inhibition of the root growth in groundnut crop when intercropped with pearlmillet having greater spreading pattern in the adjacent rows leading to intermingling of roots throughout the growth eventually leading to suppressed performance of groundnut. This is in close conformity to the findings of Gregory and Reddy (1982).

Irrigation scheduling with IW/CPE ratio 0.75 produced significantly higher plant height, Number of branches per plant, Leaf Area Index and Dry Matter Production of 29.5 cm, 5.99, 3.02 and 24.2 respectively and was comparable with IW/CPE ratio of 1.0 (Table 1). The increase can be attributed to the optimum level of irrigation supplied to the crop throughout the growth period of the crop facilitating better and proper utilization of nutrients. The results are similar to the finding of Lokhande et al. (2018).

Root parameters

Intercropping significantly influenced the root growth of the system. Among the intercropping system groundnut intercropped with blackgram recorded significantly higher root length (14.9 cm) and root volume (55 cm^3) and was comparable to sole groundnut with 14.7 cm and 53.9 cm^3 of root length and root volume respectively. Similarly, higher root length (14.9 cm) was recorded in IW/CPE ratio of 0.50 and significantly higher and comparable root volume was recorded with IW/CPE ratio of 0.75 (53.5 and 50.9 cm^3 respectively). Increased root depth and volume under irrigation scheduling with IW/CPE ratio 0.50 may be due to the inadequate availability of soil moisture which lead to increase in root growth. Similar findings were reported by Debasree and Gunri (2014).

Pod yield and Haulm yield

During the consecutive years, groundnut intercropped with blackgram produced significantly higher pod yield (6.96, 6.27 g/plant during 2017 and 2018 respectively) and haulm yield (14.6, 13.4 g/plant during 2017 and 2018 respectively) and was followed by sole groundnut yielding 6.33 g/plant with haulm yield of 13.5 g/pant during 2017 and 5.65 g/plant with haulm yield of 12.4 g/plant during 2018 (Table 2). Intercropping with blackgram resulted in higher growth of the crop and this increase could be due to

Table 2. Effect of intercropping system and irrigation scheduling on pod yield, haulm yield and harvest index (data of 2 years).

Treatments	Pod yield (g/plant)		Haulm yield (g/plant)		Harvest index	
	2017	2018	2017	2018	2017	2018
Intercropping						
C_1 : Sole Groundnut	6.33	5.65	13.5	12.4	0.319	0.313
C_2 : Groundnut + Castor	5.86	5.23	12.2	11.1	0.325	0.321
C_3 : Groundnut + Blackgram	6.96	6.27	14.6	13.4	0.323	0.318
C_4 : Groundnut + Sesame	6.11	5.44	12.8	11.6	0.324	0.320
C_5 : Groundnut + Pearlmillet	5.18	4.74	10.8	9.93	0.324	0.323
SEm ±	0.14	0.12	0.3	0.3	0.001	0.001
CD (p = 0.05)	0.45	0.40	1.1	1.0	0.002	0.004
Irrigation scheduling						
I_1 : IW/CPE 0.50	5.34	4.76	11.4	10.2	0.319	0.318
I_2 : IW/CPE 0.75	6.74	6.04	13.9	12.6	0.326	0.324
I_3 : IW/CPE 1.00	6.36	5.60	13.4	12.1	0.323	0.316
SEm ±	0.23	0.20	0.4	0.4	0.001	0.001
CD (p=0.05)	0.67	0.59	1.3	1.3	0.003	0.004

better compatibility with the legume crop as a result of lesser root competition. Shorter life span and plant height of blackgram resulted in lesser shading effect on groundnut crop throughout its growth boosting yields. Similar observations were reported by Nambiar et al. (1983), Kumar et al. (2013).

Irrigation scheduling with IW/CPE ratio of 0.75 recorded higher pod yield of 6.74 with haulm yield of 13.9 g/plant during 2017 and 6.04 g/plant of pod yield with haulm yield of 12.6 g/plant during 2018 and was comparable with IW/CPE ratio of 1.0. The increased performance might have been a result of adequate soil moisture content due to optimum irrigation frequency throughout the period of crop growth facilitating better nutrient uptake leaading to better source sink partitioning. This is in concordance to the findings of Singh and Singh (2016).

Conclusion

From the present study it can be concluded that groundnut + blackgram intercropping system is best suited when supplied with seven irrigations (excl. sowing and life irrigation) at an interval of 14 days together produce higher groundnut yield with optimum water consumption.

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