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INFLUENCE OF IRRIGATION AND CROP RESIDUE MULCHING ON YIELD AND WATER PRODUCTIVITY OF TABLE PURPOSE GROUNDNUT (*ARACHIS HYPOGAEA*) IN HUMID TROPICAL ISLAND

N. Ravisankar*, M. Balakrishnan, S.K. Ambast, R.C. Srivastava, N. Bommayasamy and T. Subramani

Central Agricultural Research Institute,
Port Blair, Andaman and Nicobar Islands-744 101, India

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ABSTRACT

Field experiment was conducted during dry season of 2008-10 at Andaman and Nicobar Islands to study the influence of irrigation at critical stages and mulching on yield and water productivity of table purpose groundnut under humid tropical conditions. Experiment was laid out in split plot design with three replications by assigning irrigation at critical stages ('No irrigation', 'one irrigation at pegging', 'two irrigation at life and pegging', 'three irrigation at life, flowering and pegging' and 'four irrigation at life, flowering, pegging and pod development') to main plot and crop residue mulching ('Paddy straw', 'banana leaf', and '*Gliricidia* leaf' and 'No mulch') to subplots. Growth and yield attributes were significantly influenced by irrigation and mulching. Application of two irrigations at life (3 DAS) and pegging (55-60 DAS) resulted in higher pod yield (3 549 kg/ha) compared to three and four irrigations which registered 2.6 and 7.7% yield reduction. Higher net returns (Rs. 41 599/ha), B:C ratio (1:8), energy ratio (15.3) and lower specific energy (4.0 MJ/kg) was recorded with two irrigations . However, one irrigation at pegging registered higher water productivity of Rs. 66/m^3. Among the crop residue mulches, paddy straw mulch registered higher pod yield (3 425 kg/ha), water productivity (Rs. 33/m^3), net returns (Rs. 39 280/ha), B:C ratio (1:6) and energy ratio (15.0).

Key words: Irrigation, Mulching, Table purpose groundnut, Water productivity.

INTRODUCTION

India is one of the largest producer of groundnut along with the United States of America, China and Argentina. Hand Picked and Selected (HPS) groundnuts also called as table purpose groundnut have very large potential in domestic as well as international markets. In India, Andaman and Nicobar Islands are one of the most preferred destination for eco tourists. Commodities which are having direct link with tourism are having higher economic value and table purpose groundnut is one such crop and its products can be consumed in many forms like boiled and fried peanuts. The Islands are having around 7685 ha of valley lands wherein only paddy is grown during June to November due to water logging. Out of 3074 mm of annual average rainfall, 2789.9 mm of rainfall is received in 126 rainy days during May- November while only 284.4 mm is received in 17 rainy days during December-April leading to acute shortage of water for irrigation (Pramanik *et al.*, 2000). Table purpose groundnut can be grown as rice fallow crop in Islands as sandy loam soil is suitable for groundnut cultivation. Sowing at the appropriate time can lead to saving in irrigation due to utilization of residual soil moisture by the crop. Generally, paddy is harvested leaving portion of the straw in the land due to standing water in the field. Considerable quantity of this straw can be used for mulching to conserve moisture. *Glyricidia* is grown in the road side fence and field bunds at many places all across the islands, which can also serve as a suitable mulch material. Irrigation at critical stages and moisture conservation with mulching practices can increase the land and water productivity along with profitability. Considering the importance of irrigation and moisture management for table purpose groundnut, an experiment was conducted to study the influence of irrigation and

*Corresponding author's e-mail: agrosankar2002@yahoo.co.in

mulching on crop and water productivity along with profitability and energetics of table purpose groundnut under island conditions.

MATERIALS AND METHODS

Field experiments were conducted during dry season of 2008-10 at field crop research farm of Central Agricultural Research Institute, Port Blair to evaluate irrigation at critical stages along with mulching materials for table purpose groundnut. The soil of the field was sandy loam having neutral pH (6.6), medium in organic carbon (0.65%), available N (283.6 kg/ha), phosphorus (16.8 kg/ha) and potassium (194.9 kg/ha). The rainfall received during the crop growth period was 27.5 and 185.3 mm in 2008-09 and 2009-10 respectively. Experiment was laid out in split plot design with three replications. Five irrigation treatments ('No irrigation', 'one irrigation at pegging (55-60 DAS)', 'two irrigations at life (3 DAS) and pegging', 'three irrigations at life, flowering (45-50 DAS) and pegging' and four irrigations at life, flowering, pegging and pod development (75-85 DAS)') were assigned to main plot while 4 mulching treatments ('paddy straw', 'banana leaf' and '*Gliricidia* leaf' and 'no mulch') were taken in sub plots. Irrigation was applied at 5 cm depth while mulching materials were applied at 45 DAS @ 2500 kg/ha as per the treatment. Paddy straw and banana leaf were naturally sterilized for three days before application to avoid any pest attack from residues. Table purpose groundnut variety "ICGS 76' was sown on 26 December 2008 and 31 December 2009 as per the soil moisture conditions with the spacing of 30 X 10 cm. Early date of sowing was undertaken as per the previous experimental result in which it was observed that sowing in 52^{nd} standard week led to higher pod yield (Ravisankar *et al.*, 2010). Recommended dose of 20:30:20 kg NPK/ha was applied as basal dose in the form of urea, single super phosphate and muriate of potash. As there was no pest or disease attack, no spraying was done. All the other recommended packages were adopted as per the schedule. Observations on growth and yield parameters were recorded at harvest stage as per standard procedures. As demand for green fodder is high during the dry season, green haulm yield was recorded along with dry pod yield. Economics were calculated based on the actual cost of cultivation. Output energy was calculated by assigning the energy value of 25 MJ/kg for dry pods and 10 MJ/kg for green haulms. Energy ratio was calculated using the formula of output energy divided by input energy while specific energy was calculated by using the formula of input energy divided by dry pod yield and expressed in MJ/kg (Mittal *et al.*, 1985). All the observations were statistically analyzed for its test of significance in the individual years and mean data is presented.

RESULTS AND DISCUSSION

Growth parameters: Irrigation and mulching significantly influenced the plant height. Two irrigations at life and pegging resulted in taller plants (46.1 cm) (Table 1), followed by three irrigation at life, flowering and pegging (41.3 cm). No significant difference in height of plants was observed between one and four irrigations. Irrigation at critical stages would lead to an increase in growth of plants while being a legume crop, table purpose groundnut is highly sensitive to excessive moisture which might be the cause for reduced growth with increase in irrigation. The number of branches/plant was not significantly influenced by irrigation at critical stages. Among the crop residue mulches, mulching at 45 DAS with paddy straw resulted in taller plants (42.2cm) followed by banana leaf (40.6 cm) and *Gliricidia* leaf (39.85 cm). Shorter plants were observed under no mulch. Effective conservation of moisture by paddy straw could be the cause for increase in plant height at harvest. Number of branches was not influenced by mulching practices. The result of Kathirvelan and Kalaiselvan (2007) also corroborates the findings.

Yield attributes: All the yield attributes except shell weight/plant and 100 kernel weight were significantly influenced by irrigation at critical stages. Irrigation at life and pegging resulted in significantly higher pods/plants (30.7), pod weight/plant (47.6) and 100 pod weight (174.1). Similarly kernels/plant and kernel weight/plant was also higher (Table 1) in two irrigation leading to higher shelling percentage (67.5%). Three and four irrigations registered lower yield attributes which did not significantly contribute to increase in yield. One irrigation at pegging alone did not contribute much to the yield contributing factors as it registered no significant difference with no irrigation in respect of all the parameters. The reduction in yield parameters with increase in number of irrigations was due to excess soil moisture owing to frequent irrigation at flowering, pegging and

TABLE 1: Influence of irrigation and mulching practices on growth and yield attributes of table purpose groundnut (mean of 2 years).

Treatments	Plant height (cm)	Branches /plant	Pods /plant	Pod weight (g) /plant	100 pod weight (g)	Shell weight (g) /plant	Kernels /plant	Kernel weight (g) /plant	100 kernel weight (g)	Shelling %
Irrigation at critical stages										
No irrigation	37.9	10.2	23.0	36.5	165.5	11.2	32.2	23.4	72.5	60.7
One irrigation (pegging)	37.7	10.6	23.6	39.1	167.0	12.0	33.5	25.3	73.0	63.2
Two irrigation (life and pegging)	46.1	11.8	30.7	47.6	174.1	15.4	43.8	30.9	76.0	67.5
Three irrigation (life, flowering and pegging)	41.3	11.6	28.3	43.4	171.6	15.1	41.5	29.6	75.4	64.7
Four irrigation (life, flowering, pegging and pod development)	38.0	10.7	27.8	41.9	168.7	13.0	33.9	26.2	75.3	63.6
SEm±	0.9	0.6	1.3	1.7	2.5	0.8	2.1	1.3	2.1	1.6
CD *(P=0.05)*	2.9	NS	4.2	5.6	8.3	NS	6.9	4.3	NS	5.5
Mulch										
Paddy straw	42.2	11.1	29.9	44.0	173.0	13.8	38.6	28.4	74.5	65.0
Banana leaf	40.6	10.4	25.2	41.9	167.5	13.4	38.3	27.5	74.6	63.8
Gliricidia leaf	39.8	11.7	26.4	41.4	170.7	12.9	36.2	26.6	76.0	64.1
No mulch	39.2	10.6	25.0	39.5	166.5	13.1	34.8	26.0	73.1	62.8
SEm±	0.8	0.6	1.2	1.5	2.6	1.3	1.8	1.2	2.0	1.6
CD *(P=0.05)*	2.4	NS	3.6	4.3	NS	NS	5.3	3.6	NS	NS

*Life: 3 DAS, Flowering: 45-50 DAS, Pegging: 55-60 DAS, Pod development: 75-85 DAS, Mulching at 45 DAS pod development stages as these stages transforms with in the span of 30 to 40 days. The present findings are analogues to those reported by Khade *et al.*, (1997).

Similar to irrigation, mulch have also contributed for increase in yield attributes *viz.*, pods/ plants, kernels/plant and kernel weight/plant. Paddy straw mulching registered higher values of number of pods and kernels/plant (29.9 and 38.6 respectively) as well as pod weight and kernel weight/ plant (44 and 28.4 g respectively) which were significantly higher than 'no mulch' treatment. However, the contribution of banana leaf and *Gliricidia* mulch to the yield attributes was not significant, which might be due to the fact that the coverage of surface area by these mulches were lesser compared to paddy straw thus leading to loss in soil moisture. The findings are in line with Arrora and Bhatt (2009) who also reported that mulch spread on the whole plot resulted in 61 % higher soil moisture than other mulches.

Yield: Pod and green haulm yield was 10% higher during 2008-09 (3 402 kg/ha) compared to 2009-10 (3 061 kg/ha). Higher yield in 2008-09 was mainly due to optimum rainfall (27.5 mm) received up to pod development stage apart from treatment which created optimum soil moisture in the root zone. Lower yield in 2009-10 was due to excessive rain received in the 1st standard week of 2010 reducing the germination.

Groundnut responded significantly to irrigation scheduling based on critical stages. Higher pod yield was recorded with 'two irrigations at life and pegging' (3 549 kg/ha). Application of three and four irrigations at critical stages led to reduction in yield to the tune of 2.6 and 7.7% respectively (Table 2) and it was significantly higher than one irrigation at pegging only. During 2008-09, 'one irrigation at pegging' alone recorded significantly higher pod yield over 'no irrigation', however in 2009-10, both are non significant which is mainly due to higher rainfall

TABLE 2: Influence of irrigation and mulching practices on yield and irrigation water productivity of table purpose groundnut.

Treatments	Pod yield (kg/ha)		Green haulm yield (kg/ha)		Irrigation water productivity (mean of 2 years)	
	2008-09	2009-10	2008-09	2009-10	kg/m^3	Rs/m^3
Irrigation at critical stages						
No irrigation	2852	2722	12081	8510	-	-
One irrigation (pegging)	3330	2846	12258	9171	6.0	66.0
Two irrigation (life and pegging)	3771	3327	13316	10307	3.4	40.3
Three irrigation (life, flowering and pegging)	3645	3274	12875	10273	2.2	25.9
Four irrigation (life, flowering, pegging and pod development)	3412	3139	12875	10086	1.6	18.0
SEm±	131	100	339	302	-	-
CD *(P= 0.05)*	425	328	1107	986	-	-
Mulch						
Paddy straw	3594	3256	13404	10335	2.8	33.0
Banana leaf	3348	3077	12275	10088	2.7	30.9
Gliricidia leaf	3332	3028	13122	9331	2.6	28.8
No mulch	3334	2884	11922	8924	2.4	27.6
SEm±	87	86	303	229	-	-
CD *(P= 0.05)*	250	248	989	746	-	-

of 185.3 mm received during 2009-10. Two irrigations at life and pegging registered 13 and 22% increase in yield over irrigation at pegging alone and no irrigation. There is saving of two irrigations amounting to 11 cm depth in irrigating crop at life and pegging stages only. Higher pod yield with two irrigation at life and pegging could be attributed to significant increase in yield contributing factors such as number of pods and kernels/plant, kernel weight/ plant and shelling percent owing to optimum soil moisture from germination to flowering and pegging to pod development. Three and four irrigation at life, flowering, pegging and pod development along with rainfall created excess soil moisture at critical stages which in turn have affected the pod formation and development leading to reduced yield. Hosmani and Janawade (2007) also have reported that the reduction in pod yield was due to excess soil moisture owing to frequent irrigations. Green haulm yield also recorded similar trend as that of pod yield.

Mulching with crop residues influenced significantly pod and green haulm yield. Paddy straw mulch at 45 DAS resulted in significantly higher pod yield of 3 425 kg/ha which is 9.2% higher than without mulch. Mulching with banana leaf and *Gliricidia* did not significantly increase the yield which is mainly due to ineffectiveness of these mulches in moisture conservation.

Water productivity: Application of one irrigation alone at pegging stage resulted in higher water productivity of 6 kg and Rs 66/m^3 followed by two irrigations at life and pegging which registered water productivity of 3.4 kg and Rs 40.3/m^3 (Table 2). However, 60% lower water productivity was recorded with three irrigations at life, flowering and pegging owing to lower yield with more amount of water. Higher water productivity with one irrigation can be attributed to ability of groundnut to yield better under water constraint conditions. Hence, if water availability is a constraint, then irrigation can be applied at pegging stage alone to get the better productivity of water. This corroborates the findings of Abdrabbo (2009). Application of paddy straw mulching resulted in higher water productivity of 2.8 kg and Rs 33/m^3 compared to other mulches and no mulch. The productivity of water in terms of value increased by Rs. 5.40 /m^3 in paddy straw mulch amounting to Rs. 5400/ha in two irrigations

TABLE 3: Influence of irrigation and mulching practices on economics and energetics of table purpose groundnut (mean of 2 years).

Treatments	Gross returns* (Rs/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	B:C ratio	Output Energy (MJ/ha)	Input energy** (MJ/ha)	Energy ratio	Specific energy (MJ/kg)
Irrigation at critical stages								
No irrigation	52099	22700	29399	1.3	172627	13349	12.9	5.4
One irrigation (pegging)	57034	22960	34074	1.5	184343	13380	13.8	4.8
Two irrigation (life and pegging)	64819	23220	41599	1.8	204624	13411	15.3	4.0
Three irrigation (life, flowering and pegging)	63464	23480	39984	1.7	202224	13442	15.0	4.3
Four irrigation (life, flowering, pegging and pod development)	60836	23740	37096	1.6	198902	13473	14.8	4.3
SEm±	1129	-	897	0.1	5794	-	0.4	0.2
CD ($P=0.05$)	3683	-	2927	0.3	18896	-	1.2	0.5
Mulch								
Paddy straw	63250	23970	39280	1.6	204328	13591	15.0	4.2
Banana leaf	59374	23970	35404	1.5	192136	13591	14.1	4.7
Gliricidia leaf	58925	23970	34955	1.5	191761	13591	14.1	4.9
No mulch	57054	20970	36084	1.7	181950	12871	14.1	4.5
SEm±	975	-	648	0.1	4641	-	0.2	0.1
CD ($P=0.05$)	2815	-	1872	0.2	13404	-	0.7	0.3

compared to no mulch. Higher water productivity with paddy straw mulch could be the result of better moisture conservation and reduced loss of moisture due to weeds leading to higher pod yield. Ghosh *et al.* (2006) observed that application of organic mulch consistently helped in retaining higher moisture at 0-15 cm soil depth which is 15 % higher than no mulch.

Economics: Irrigation at life and pegging stage of the crop registered higher gross returns (Rs 64 819/ ha), net returns (Rs 41 599/ha) and B:C ratio (1:8) which is significantly higher than no irrigation (Table 3.) Though water productivity is higher in one irrigation at pegging, the net returns (Rs. 34 074/ ha), B:C ratio (1:5) were significantly lower compared to irrigation at 3 DAS and pegging. Owing to reduced yield of pod and green haulm in one, three and four irrigations, gross returns, net returns were also reduced. Though cost of cultivation was higher for two irrigations, significant increase in yield resulted in better economics. Among all the mulches, application of paddy straw mulch recorded 8.9% increase in net returns compared to no mulch. B:C ratio was also higher with the same treatment. The results are in line with the findings of Patel *et al.* (2008).

Energetics: Irrigation at critical stages and mulching with crop residues have significantly influenced the energy ratio and specific energy. Higher energy ratio of 15.3 was recorded with two irrigations at 3 DAS and pegging as the consequence of higher output energy compared to irrigating the crop at other stages. Similarly, the same treatment recorded lesser specific energy (4.0 MJ/Kg) which is the measure of energy required to produce each unit of economic produce (pod yield). Additional irrigation at flowering and pod development recorded lesser energy ratio and also required higher input energy to produce economic yield. Irrigating the crop at pegging stage alone also is not efficient in terms of energetics as it recorded lesser energy ratio (13.8) and higher specific energy (4.8). The results are also analogous to the findings of Singh *et al.* (2004). Owing to the higher output energy as a result of higher pod and green haulm yield, energy ratio and specific energy was better in paddy straw mulch compared to other mulches.

It can be concluded that the application of irrigation at life (3 days after sowing) and pegging (55-60 DAS) stages along with paddy straw mulch at 45 DAS can be recommended considering the advantages in terms of yield, economics and energetics. However application of irrigation at pegging stage alone can be recommended under water constraint condition to realize higher productivity of applied water.

REFERENCES

Abdrabbo A. Abou Kheira. (2009). Macromanagement of deficit irrigated peanut with sprinkler irrigation, *Agri. Water Manage.* **96**: 1409-20.

Arrora Sanjay and Bhatt Rajan. (2009). Impact of improved soil and in-situ water conservation practices on productivity in rainfed foot hill region of North-west India, SK Univerity of Agricultural Sciences and Technology, Jammu p. 1-4.

Ghosh, P K, Devi Dayal, Bandyopadhyay and Mohanty M.. (2006) Evaluation of straw and polythene mulch for enhancing productivity of irrigated summer groundnut, *Field Crops Res.* **99** :76-86.

Hosmani M H and Janawade A D. (2007). Response of rabi groundnut (*Aracis hypogaea* L.) to irrigation schedules and integrated nutrient management in deep black soils of upper Krishna command, *Karnataka J. of Agri. Sci.* **20** : 453-456.

Kathirvelan P and Kalaiselvan P. (2007). Studies on Agro Management Techniques for Confectionery Groundnut under Irrigated Condition. *Res. J. of Agri. and Bio. Sci.*, **3**: 52-58.

Khade V N, Patil B P, Jadhav S N and Basale S S. (1997). Effect of irrigation schedules, planting layout and weed management on the yield of summer groundnut. *J. of Maharashtra Agri. Uni.* **22**: 26-28.

Mittal V K, Mittal J P and Dhawan K C. (1985). Research Project on Energy Requirements in Agricultural Sector, Coordinating Cell, College of Agricultural Engineering, Punjab Agricultural University, Ludhiana.

Patel G N, Patel P T and Patel P H. (2008). Yield water use efficiency and moisture extraction pattern of summer groundnut as influenced by irrigation schedules, sulfur levels and sources. *An open access journal published by ICRISAT (SAT e journal)* **6**: 1-4.

Pramanik S C, Dubey R P, Ravisankar N and Nair A K. (2000). Development of water resources and irrigation potential in A&N Islands *Yojana* **44**(6): 19-20, 32

Ravisankar N, Balakrishnan M, Ghoshal Chaudhuri S, Ambast S K, Srivastava R C, Subramani T and Bommayasamy N. (2010). Evaluation of time, method of sowing and varieties for table purpose groundnut (*Arachis hypogaea*) under Island ecosystem, *Indian J. of Agri. Sci.* **80**: 209-303.

Singh H, Mishra D and Nahar N M. (2004) Energy use pattern in production agricuture of a typical village in arid zone-Part III, *Energy Conversion and Management* **45**(15-16):2453-72.