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Effect of irrigation scheduling and nitrogen management on growth and yield of summer groundnut (*Arachis hypogaea* L.)

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Abstract
An experiment was conducted at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during summer season of the year 2019 to study Effect of irrigation scheduling and nitrogen management on growth and yield of summer groundnut (*Arachis hypogaea* L.). The soil of experimental field was loamy sand in texture having good drainage, low in available nitrogen (166.52 kg/ha), low in available phosphorus (44.53 kg/ha) and medium in available potassium (286.28 kg/ha) with 8.15 soil ph. The experiment were four irrigation schedules (IW: CPE ratios 0.4, 0.6 and 0.8 and irrigation at critical growth stages flowering, branching, pod formation and pod development stages) and five nitrogen management treatments *viz*. N_0 (Control), N_1 (100% RDN through chemical fertilizer), N_2 (75% RDN through chemical fertilizer + 25% RDN through vermicompost), N_3 (50% RDN through chemical fertilizer + 50% RDN through vermicompost), N_4 (100% RDN through vermicompost) were tried. Higher value growth characters and yield characters were recorded under treatment I_2 (0.8 IW: CPE ratio). Nitrogen management treatment N_3. (50% RDN through chemical fertilizer + 50% RDN through vermicompost) recorded significantly increase growth characters, pod yield and haulm yield. The treatment combination I_2N_3 (0.8 IW: CPE ratio and 50% RDN through chemical fertilizer + 50% RDN through vermicompost) recorded higher pod yield and Haulm yield.

Keywords: Groundnut, irrigation, nitrogen, vermicompost

1. Introduction

Groundnut (*Arachis hypogaea* L.) is known to be a unique and important legume cum oilseed crop of India accounting 33% of world's groundnut area and about 27.3% production. It belongs to Leguminoseae family. It is a multipurpose crop contains high edible oil (45 to 51%) and protein (26%). India is the second largest producer of groundnut in the world which produces around 6.49 million tonnes of groundnut from 4.76 million hectares of land with a productivity of 1550 kg/ha (Anonymous, 2015) [1]. Gujarat ranks first both in area and production in the country. The area under groundnut is 1.41 million hectares with production of 2.33 million tones and productivity is 1650 kg/ha (Gayathri, 2018) [6]. Scheduling irrigation to crop is mostly based on physiological growth stage and latest approach of scheduling irrigation through irrigation water depth, cumulative pan evaporation (IW: CPE ratio). It is important for scheduling irrigation to identify the most suitable frequency, time and depth of irrigation for higher yield of groundnut.

Among all the essential elements, nitrogen is a critical and limiting element for the growth and development of most of the plants. Nitrogen is also integral part of chlorophyll, which is the primary absorber of light energy needed for photosynthesis. Vermicompost is organic manure produced by earthworm feeding on biological waste material and plant residue. It contains on an average (2.1-2.6%) N, (1.5-1.7%) P and (1.4-1.6%) K Application of vermicompost showed higher growth and yield attributes, grain yield as well as gross and net returns in groundnut. Meager information on irrigation scheduling along with nitrogen management through different sources on groundnut crop in this region and keeping all the above aspects in view and in order to test the combined effect of both the factors with its various level of application.

2. Materials and Method

A field experiment was conducted at College Agronomy Farm, BA College of Agriculture, Anand Agricultural University, Anand, (Gujarat) during the summer season of the year 2019. Geographically, Anand is situated on 22˚35' N latitude and 72˚55' E longitude, With an elevation of 45.1 m above the mean sea level. The climate of Anand is semi-arid and sub-tropical. The soil of experimental field was loamy sand in texture having good drainage, low in available nitrogen (166.52 kg/ha), low in available phosphorus (44.53 kg/ha) and medium in available potassium (286.28 kg/ha) with 8.15 soil ph. Groundnut variety Gujarat Groundnut 34 (GG 34) was used as a test crop in the study. The treatment comprising four levels of irrigation (I_1 0.6: IW: CPE ratio, I_2: 0.8 IW: CPE ratio, I_3: 1.0 IW: CPE ratio and I_4: irrigation at flowering, branching, pod formation and pod development stages) and five levels of nitrogen management (N_0: Control, N_1: 100% RDN through chemical fertilizer, N_2: 75% RDN through chemical fertilizer + 25% RDN through vermicompost, N_3: 50% RDN through chemical fertilizer + 50% RDN through vermicompost, N_4: 100% RDN through vermicompost). Four irrigation treatments were allotted to main plot while five treatments of nitrogen management were embedded as sub plot in split plot design with three replications.

Irrigation water of 50 mm (measured with the help of Parshall flume) was allowed to run in each plot at each irrigation. The irrigation treatment was given on the basis of pan evaporation. Daily pan evaporation was measured with the help of USDA Class-A pan evaporimeter installed at the meteorological observatory. Chemical fertilizer was applied through urea and SSP as basal. Entire quantity of vermicompost applied at the time of sowing. Crop was harvested in third week of June. Groundnut (GG-34) was sown on 20 February with seed rate 120 kg/ha. The data recorded during the course of investigation were subjected to statistical analysis as per method of analysis of variance (Panse and Sukhatme, 1978) [8].

3. Result and Discussion

3.1 Effect of irrigation

The data clearly showed that different irrigation scheduling remained akin to plant population (Table 1) and they had no any significant influence on plant population recorded at 20 DAS as well as at harvest. Consequently, the plant population in all the experimental plots was uniform throughout the plant growth period. This shows that the results obtained in the present investigation was the outcome of treatment effect in the experiment rather than other treatment factors.

The results (Table 1 and 2) showed that that application of irrigation at I_2 (0.8 IW: CPE) ratio recorded significantly higher plant height at 60 DAS (20.27 cm), at harvest (50.17 cm) and number of branches/plant (5.84). This might be due to more availability of soil moisture when plant needed for its growth. As a result, soil moisture maintained in readily available range might have provided congenial conditions for favourable growth in term of cell division and increase into cell size resulting in expansion of plant in terms of plant height and number of branches/plant.

Among different irrigation scheduling, significantly the highest dry weight of nodules/plant (80.33 mg) and number of pod plant/plant (21.18) were obtained under treatment I_2 (0.8 IW: CPE ratio). This might be due to availability of optimum moisture condition in rhizosphere which affects the nodulation. The reason for increasing number of pods/plant was frequent water supply and higher amount of water to soil that resulted into increasing uptake of water and provided the longest reproductive phase with larger photosynthetic green surface and reproductive storage capacity, ultimately that was focus on increase number of pod/plant. The present findings are close agreement with those reported by Das *et al.* (2013) [5] and Behera *et al.* (2015) [3].

Data presented in Table 2 indicated that application of irrigation at 0.8 IW: CPE ratio (I_2) recorded significantly higher pod yield (3034 kg/ha) and haulm yield (4005 kg/ha) and remain at par with treatment I_3 (1.0 IW: CPE ratio). This might be due to more vigorous crop growth and higher order of yield attributes under frequent irrigations as the atmosphere had high demand of evapo-transpiration during crop period. The results are in close conformity with Lokhande *et al.* (2018) [7] and Balasubramanian *et al.* (2019) [2].

It is evident from data that application of irrigation at I_2 (0.8 IW: CPE) ratio recorded significantly higher Shelling % (66.83) and Seed index (64.01) it remained at par with treatment I_3 (1.0 IW: CPE ratio). This might be due to increase in number of irrigation applied at shorter intervals and total consumptive use of water. This situation reduces soil moisture stress and thus, provided favourable conditions for soil moisture and nutrient availability to the plants than higher yield attributing characters.

The data presented in Table 3 concluded that there were no any significant differences observed in Harvest index due to different nitrogen management treatments.

Table 1: Effect of irrigation scheduling and nitrogen management through different sources on plant population and plant height of summer groundnut

Treatments	Plant population per meter row length		Plant height (cm)		
	20 DAS	At harvest	30 DAS	60 DAS	At harvest
(A) Main plot treatment, Irrigation scheduling (I)					
I_1: 0.6 IW:CPE	8.64	7.71	8.27	18.56	47.87
I_2: 0.8 IW:CPE	8.61	7.29	8.57	20.27	50.17
I_3: 1.0 IW:CPE	8.50	7.44	8.36	19.10	49.21
I_4: At branching, flowering, peg formation and pod development	8.77	7.46	8.63	16.92	40.62
S.EM.±	0.14	0.12	0.21	0.42	0.77
C.D. at 5%	NS	NS	NS	1.45	2.67
C.V. %	6.14	6.23	9.45	8.68	6.37
(B) Sub plot treatment, Nitrogen management through different sources (N)					
N_0: Control	8.83	7.61	8.54	17.62	44.48
N_1: 100% RDN through chemical fertilizer	8.42	7.37	8.31	17.95	46.24
N_2: 75% RDN through chemical fertilizer + 25% RDN through vermicompost	8.53	7.61	8.31	19.16	48.15
N_3: 50% RDN through chemical fertilizer + 50% RDN through vermicompost	8.81	7.47	8.79	20.01	48.42
N_4: 100% RDN through vermicompost	8.55	7.33	8.34	18.83	47.55

S.EM.±	0.14	0.12	0.22	0.44	0.73
C.D. at 5%	NS	NS	NS	1.26	2.10
C.V. %	5.78	5.37	9.00	8.12	5.38
(C) Interaction effect (I × N)	NS	NS	NS	NS	NS

Table 2: Effect of irrigation scheduling and nitrogen management through different sources on Number of branches/plant, Dry weight of nodule/plant, Number of pods/plant, pod yield and haulm yield of summer groundnut

Treatments	Number of branches/plant	Dry weight of nodule/plant (mg)	Number of pods/plant	Pod yield (kg/ha)	Haulm yield (kg/ha)
(A) Main plot treatment, Irrigation scheduling (I)					
I_1: 0.6 IW:CPE	4.97	65.06	19.21	2657	3570
I_2: 0.8 IW:CPE	5.84	80.33	21.18	3034	4005
I_3: 1.0 IW:CPE	5.24	74.86	20.11	2855	3909
I_4: At branching, flowering, peg formation and pod development	4.66	62.53	15.24	2366	3209
S.EM.±	0.15	0.73	0.32	57.0	94
C.D. at 5%	0.52	2.53	1.12	197	323
C.V. %	11.21	4.00	6.62	8.07	9.85
(B) Sub plot treatment, Nitrogen management through different sources (N)					
N_0: Control	4.34	65.75	16.82	2474	3342
N_1: 100% RDN through chemical fertilizer	5.05	69.75	17.91	2585	3467
N_2: 75% RDN through chemical fertilizer + 25% RDN through vermicompost	5.36	70.66	19.42	2879	3843
N_3: 50% RDN through chemical fertilizer + 50% RDN through vermicompost	5.81	71.75	21.46	3086	4163
N_4: 100% RDN through vermicompost	5.32	75.58	19.07	2614	3553
S.EM.±	0.16	0.74	0.34	56	102
C.D. at 5%	0.45	2.14	0.99	161	294
C.V. %	10.45	3.63	6.30	7.10	9.62
(C) Interaction effect (I × N)	NS	NS	NS	Sig.	Sig.

Table 3: Effect of irrigation scheduling and nitrogen management through different sources on shelling, seed index and harvest index of summer groundnut

Treatments	Shelling (%)	Seed index (g)	Harvest index (%)
(A) Main plot treatment, Irrigation scheduling (I)			
I_1: 0.6 IW:CPE	62.23	60.36	42.73
I_2: 0.8 IW:CPE	66.83	64.01	43.17
I_3: 1.0 IW:CPE	65.59	60.09	42.23
I_4: At branching, flowering, peg formation and pod development	59.72	58.66	42.43
S.EM.±	0.66	1.02	0.24
C.D. at 5%	2.27	3.53	NS
C.V. %	4.00	6.49	2.15
(B) Sub plot treatment, Nitrogen management through different sources (N)			
N_0: Control	62.84	60.34	42.50
N_1: 100% RDN through chemical fertilizer	63.66	59.30	42.77
N_2: 75% RDN through chemical fertilizer + 25% RDN through vermicompost	63.51	60.17	42.89
N_3: 50% RDN through chemical fertilizer + 50% RDN through vermicompost	64.12	62.34	42.63
N_4: 100% RDN through vermicompost	63.82	61.75	42.00
S.EM.±	0.61	1.05	0.46
C.D. at 5%	NS	NS	NS
C.V. %	3.34	6.00	3.71
(C) Interaction effect (I × N)	NS	NS	NS

3.2 Effect of nitrogen management

Nitrogen management treatment N_3 (50% RDN through chemical fertilizer + 50% RDN through vermicompost) recorded significantly highest plant height at 60 DAS (20.01cm), at harvest (48.42 cm) and number of branches/plant (5.81). It might be application of vermicompost increase the supply of easily assimilated nutrients including micro nutrients to plant, besides mobilizing unavailable nutrients into available form. It is needed mostly by young, fast growing tissue and resulted in higher number of branches/plant.

Significantly the highest number of pods/plant (21.46) was observed under treatment N_3 (50% RDN through chemical fertilizer + 50% RDN through vermicompost). It might be due to supply of nutrient from diversified sources and prolonged availability of nutrients to the growing plant, which results into tissue differentiation from somatic to reproductive meristematic activity and increase in development of floral primordial, resulting in higher number of pods/plant. The present findings are close agreement with those reported by Raju *et al.* (2013) [10] in safflower and Parihar *et al.* (2014) [9] in mustard.

Data present in Table 2 with respect to pod yield and haulm yield as influenced by nitrogen management through different sources indicated that significantly the highest pod yield (3086 kg/ha) and haulm yield (4163 kg/ha) were recorded under treatment N_3 (50% RDN through chemical fertilizer + 50% RDN through vermicompost). This might be due to synergistic relation between nutrients, increased vigorous growth of plant as well as more nutrient uptake which improved overall growth of plant and development of the floral primordial. Proper fertilization coupled with increased net photosynthesis on the one hand and greater mobilization of photosynthates towards reproductive structures on the other hand, which might have increased the yield attributes. Similar results were obtained by Bhosle *et al.* (2017) [4].

The data presented in Table 3 indicated that there were no any significant differences observed in shelling %, seed index and Harvest index due to different nitrogen management treatments.

3.3 Interaction effect (I×N)

Interaction effect of irrigation and nitrogen management treatments on grain yield of groundnut was found significant (Table 4). The significantly higher pod yield (3270 kg/ha) and haulm yield (4371 kg/ha) were recorded under treatment combination I_2N_3 (0.8 IW: CPE ratio and 50% RDN through chemical fertilizer + 50% RDN through vermicompost). This might be due to more vigorous crop growth and higher order of yield attributes under frequent irrigation with adequate supply of nutrient through vermicompost during crop period resulted in higher grain yield. The interaction effect between irrigation scheduling and nitrogen sources levels with respect to oil content was found non-significant.

Table 4: Interaction effect of irrigation scheduling and nitrogen management through different sources on pod yield (kg/ha) of groundnut

Irrigation (I)	Nitrogen sources (N)				
	N_0	N_1	N_2	N_3	N_4
I_1	1910	2631	2855	3170	2714
I_2	2949	2959	3037	3270	2953
I_3	2912	2617	3008	3126	2610
I_4	2036	2133	2703	2778	2179
S.EM.±	112				
C.D. at 5%	322				

Table 5: Interaction effect of irrigation scheduling and nitrogen management through different sources on haulm yield (kg/ha) of groundnut

Irrigation (I)	Nitrogen sources (N)				
	N_0	N_1	N_2	N_3	N_4
I_1	2636	3379	3914	4387	3535
I_2	3983	3853	4116	4371	3943
I_3	3879	3796	3868	4130	3632
I_4	2737	2837	3606	3762	3104
S.EM.±	204				
C.D. at 5%	588				

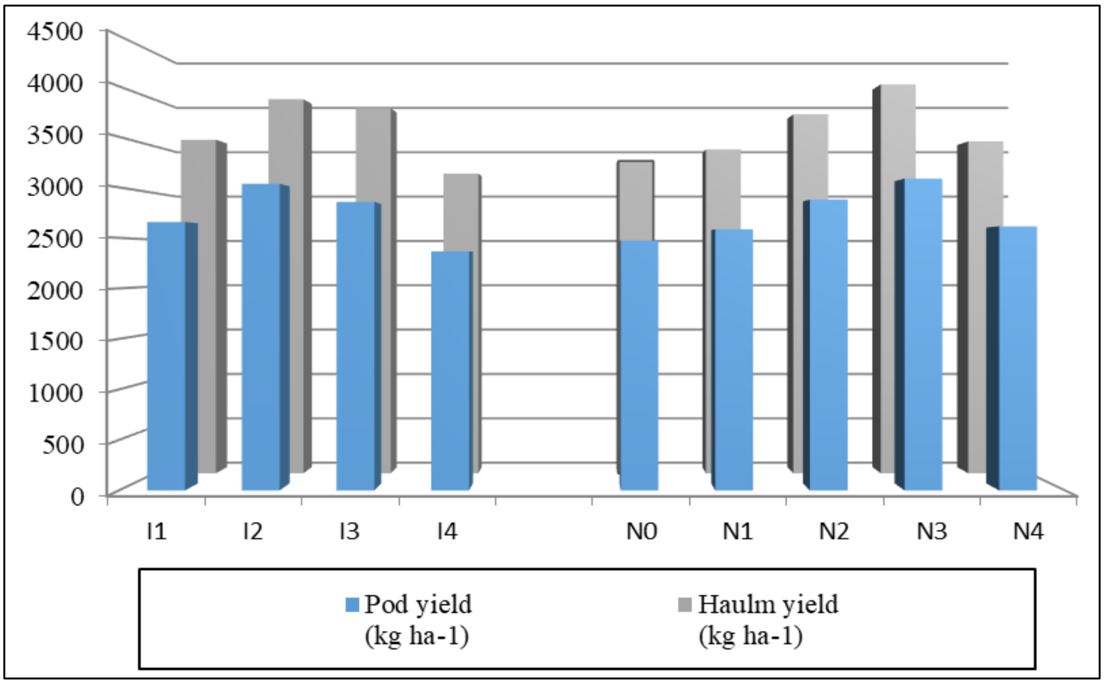

Fig 1: Effect of irrigation scheduling and nitrogen management through different sources on pod yield and haulm yield (kg/ha)

4. Conclusions

From the foregoing results, it is concluded that for securing higher pod yield and haulm yield of the groundnut crop cv. GG 34 should be irrigated at 0.8 IW: CPE ratio in conjunction with 50% RDN through chemical fertilizer + 50% RDN through vermicompost as a basal application.

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