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EFFECT OF IRRIGATION REGIMES, MULCHING AND NUTRIENT MANAGEMENT ON MOISTURE EXTRACTION PATTERN AND PRODUCTIVITY OF SUMMER GROUNDNUT (*Arachis hypogaea* L.)

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Abstract

An experiment was conducted to assess the effect of irrigation, mulching and nutrient management on moisture extraction pattern and productivity of summer groundnut during summer, 2015 and 2016 at the Department of Agronomy, I.Ag.Sc., BHU, Varanasi. The treatments consisted of three irrigation regimes (I_1- 60 mm CPE, I_2- 80 mm CPE and I_3- 100 mm CPE) and two mulching (M_1- paddy straw mulch and M_2- dust mulch) in the main plots and four INM treatments (F_1- 100% NPK, F_2- 75% NPK + 25% N through FYM+ 20 kg S through gypsum, F_3- 75% NPK+ 25% N through vermicompost+ 40 kg S through gypsum and F_4- 75% NPK+ 25% N through FYM+ 60 kg S through gypsum) in sub plots. Experimental plots were arranged in a split plot design with three replications. The results of experiment indicated that the application of irrigation at 60mm CPE, paddy straw mulching and an application of 75%NPK +25N through FYM +60 kg sulphur through gypsum separately was extracted highest amount of soil moisture from the 0-60 cm soil layers and these treatments also recorded significantly highest pod and haulm yield during both the years.

Key words **:** *Groundnut, Irrigation regimes, INM, Mulching, Yield*.

Groundnut is the 4th most important oilseed crop of the world and India is one of the largest groundnut producing counties which contributes about 21.9% of world production and 28.73% of area (Mohite *et al*., 2017). India ranks first in respect of area, while China in production and USA in productivity (Anonymous, 2013). In India, 80% of groundnut produced is used for oil extraction, 11% as seed, 8%used as direct food and only 1% of groundnut produced is exported (Anonymous, 2011). Indian has a diverse climate; as such groundnut is grown throughout the year in *kharif, rabi*, summer and spring seasons in one or other part of the country. The productivity of crops under irrigated condition is not stable due to various reasons (Choudhary *et al*., 2017). The average productivity is relatively low in rainy season compared to other seasons. Groundnut has specific moisture needs due to its peculiar feature of producing pods underground. Some worker are of the opinion that early moisture stress restricts the vegetative growth which in turn reduces the yield, while others say that the peak flowering and pegging period is most sensitive as the peg cannot penetrate through dry and hard surface. The *rabi* crop avails the residual moisture and the scanty rainfall during winter and produces substantial yield as compared to the *kharif* crop and few supplementary irrigations would improve the yield. Because of high productivity under assured irrigation, groundnut cultivation in summer season is gaining popularity. In irrigation scheduling, a climatologically approach based on IW/CPE ratio or CPE has been found most appropriate. This approach integrates all the weather parameters that determine water use by the crop and is likely to increase production (Behera *et al*., 2015 and Kamble *et al*., 2017).

The practice of mulching has been widely used as a management tool in many parts of the world. It dampens the influence of environmental factors on soil by increasing soil temperature controlling diurnal/seasonal fluctuations in soil temperature. However, the effect varies with soils, climate, kind of mulch material used and the rate of application (Ghosh *et al*., 2006). The surface mulch favourably influences the soil moisture regime by controlling evaporation from the soil surface, improves infiltration, soil water retention, decreases bulk density and facilitates condensation of soil water at night due to temperature reversals. Modification of the soil microclimate by mulching favours seedling emergence, root proliferations and suppress weed population (Pawar *et al*., 2004, Bhadur *et al*., 2016 and Verma *et al.,* 2017).

Groundnut is an oil and protein rich crop, but usually grown under low soil fertility and in rainfed areas. The productivity of groundnut in India is still low mainly due to low consumption of fertilizer in spite of prominent nutrient deficiencies. Integrated nutrient management, involving the conjunctive use of chemical fertilizers and organic sources assumed great importance recently due to paucity of fertilizers and need to sustain productivity (Patil *et al*., 2017). Groundnut is an exhaustive crop and removes large amount of macro and micro-nutrients from soil which cannot be met by single nutrient source. The supply of nutrients through, biofertilizer, organic and inorganic sources has been found to be the best option for increasing productivity and maintaining sustainability, and hence there is ample scope of increasing productivity through combined use of various nutrient sources.

Table-1 : Effect of irrigation regimes, mulching and integrated nutrient management on percent moisture extraction from different soil depth in groundnut.

Treatment	Percent soil moisture extraction						Pod yield (kg/ ha)	
	2015			2016				
	0-30 cm	30-60 cm	60-90 cm	0-30 cm	30-60 cm	60-90 cm	2015	2016
Irrigation regimes								
Irrigation at 60 mm CPE	43.4	32.3	24.3	40.9	35.2	31.2	3026	3181
Irrigation at 80 mm CPE	42.4	31.8	25.9	39.5	34.2	31.9	2956	3021
Irrigation at 100 mm CPE	40.8	30.5	24.4	38.3	32.8	31.5	2822	2909
SEm±	0.31	0.15	0.23	0.86	0.34	0.20	22.4	53.0
CD (P=0.05)	0.96	0.48	0.67	2.56	0.97	0.61	67.3	158.0
Mulching								
Paddy straw mulch (10 t/ha)	41.7	30.3	25.0	39.3	33.6	31.4	3006	3202
Dust mulch	42.6	32.1	25.3	39.8	34.6	31.6	2863	2872
SEm±	0.27	0.13	0.18	0.15	0.29	0.12	14.9	42.6
CD (P=0.05)	0.79	0.39	NS	0.46	0.86	NS	46.8	128.1
Nutrient management								
100% NPK	40.4	29.6	26.8	38.4	32.6	31.6	2676	2745
75% NPK + 25% N through FYM+20 kg S through gypsum	42.6	31.8	24.8	40.1	34.7	31.4	2829	2955
75% NPK+ 25% N through Vermicompost+40 kg S through gypsum	41.4	30.3	26.1	39.1	33.7	31.5	3022	3136
75% NPK + 25% N through FYM +60kg S through gypsum	44.3	33.0	22.9	40.8	35.5	31.3	3211	3312
SEm±	0.23	0.11	0.21	0.19	0.20	0.09	10.5	37.7
CD (P=0.05)	0.66	0.34	0.64	0.59	0.61	NS	30.0	113.0

Keeping in view, all these facts, the field trail was conducted to study the effect of irrigation regimes, mulching and INM soil moisture use and productivity of summer groundnut.

MATERIALS AND METHODS

A field study was conducted during the summer season of 2015 and 2016 at Agronomy Farm, BHU, Varanasi (23^{o}.20' N, 83^{o}.03' E and 128.93 m above mean sea-level). The experimental soil was sandy clay loam with pH 7.86. The soil was low in available nitrogen (206.9 kg ha^{-1}) and available phosphorus (17.8 kg ha^{-1}) and medium in available potassium (233.1 kg ha^{-1}) and sulphur (15.6 kg ha^{-1}). Average values for bulk density 1.45 g cm^{-3}, particle density 2.62 g cm^{-3}, filed capacity 19.6%, permanent wilting point 4.30% and EC were 0.181 dSm^{-1}. The experiment was conducted in split plot design with twenty four treatment combinations. The treatments consisted of three irrigation regimes (I_1- 60 mm CPE, I_2- 80 mm CPE and I_3- 100 mm CPE) and two mulch treatments [M_1- paddy straw mulch and M_2- dust mulch] in the main plots and four INM levels (N_1- 100% NPK, N_2- 75% NPK+ 25% N through FYM+ 20 kg S through gypsum, N_3- 75% NPK+ 25% N through Vermicompost+ 40 kg S through gypsum and N_4- 75% NPK+ 25% N through FYM + 60 kg S through gypsum in sub plots. The experiment was replicated three times. Groundnut variety 'HG 37' was sown at row distance of 30x10 cm manually. Irrigation, mulch and nutrients were applied as per the treatments. Climatic data were taken from the institute weather station. Soil moisture determination were made from the soil samples taken from 0-90 cm soil profile at 0-30, 30-60, and 60-90 cm depth intervals in the second replication with the help of screw auger, at the time of sowing, before each irrigation, two-three days after each irrigation and finally at the time of harvest. The samples were collected in aluminium moisture boxes and their fresh weight was recorded. The samples were dried in electric oven at 105^{o}C ± 5^{0}C for 48 hours to the constant weight. The moisture percentage was expressed on oven dry weight basis. From the soil moisture content and available meteorological data, computation of moisture extraction pattern was done. The soil moisture extractions of each profile were summed up over the entire season for each treatment. The estimated potential evapotranspiration values for the period between the date of irrigation and sample and the effective rainfall were added to the depletion in the first layer. The total seasonal extraction (%) from each layer was calculated for different treatments. The crop was harvested by hand on 29th May, 2015 and 20th May, 2016, when about 70% of haulms were dry. The experimental data pertaining to moisture use and yield are analysed statistically to draw a valid conclusion.

RESULTS AND DISCUSSION

Moisture extraction pattern : Among the irrigation regimes, at 0-30 cm and 30-60 cm soil depth, the highest

Table-2 : Per cent moisture extraction pattern from soil profile (0-90 cm) in potato as affected by irrigation regimes, methods and nitrogen management combinations

Treatment	2014-15			2015-16		
	0-30 cm	30-60 cm	60-90 cm	0-30 cm	30-60 cm	60-90 cm
$I_1M_1F_1$	41.5(51.3)	31.6(39.1)	26.9(33.2)	38.3(56.1)	32.2(47.2)	29.5(43.3)
$I_1M_1F_2$	42.0(63.3)	32.5(49.0)	25.5(38.5)	39.5(70.2)	33.9(60.3)	26.5(47.1)
$I_1M_1F_3$	41.9(57.4)	31.8(43.5)	26.3(36.1)	38.7(63.8)	32.8(54.1)	28.4(46.9)
$I_1M_1F_4$	42.8(68.0)	33.3(53.4)	23.9(38.3)	40.1(76.0)	34.3(65.1)	25.6(48.7)
$I_1M_2F_1$	42.8(51.2)	28.6(34.2)	28.5(34.1)	38.2(54.8)	32.5(46.7)	29.3(42.1)
$I_1M_2F_2$	43.5(65.2)	30.0(45.0)	26.4(39.6)	39.6(69.7)	34.1(59.9)	26.3(46.2)
$I_1M_2F_3$	42.9(56.4)	29.3(38.5)	27.8(36.5)	38.7(60.3)	33.6(52.3)	27.7(43.2)
$I_1M_2F_4$	44.6(68.8)	30.7(47.4)	24.7(38.1)	40.2(73.2)	34.7(63.2)	25.1(45.7)
$I_2M_1F_1$	33.4(43.4)	24.3(31.6)	23.2(30.1)	38.6(50.3)	32.1(41.8)	29.3(38.1)
$I_2M_1F_2$	42.0(56.3)	30.8(41.2)	22.8(30.6)	39.9(62.8)	34.2(53.8)	25.9(40.8)
$I_2M_1F_3$	37.6(49.5)	26.3(34.7)	22.9(30.2)	39.1(56.9)	33.2(48.4)	27.7(40.4)
$I_2M_1F_4$	45.6(61.1)	34.5(46.2)	21.5(28.8)	41.0(70.7)	35.3(60.9)	23.8(41.0)
$I_2M_2F_1$	41.5(42.2)	31.6(32.1)	26.9(27.3)	38.3(47.8)	33.0(41.2)	28.7(35.8)
$I_2M_2F_2$	43.0(54.1)	32.8(41.3)	24.2(30.5)	40.1(62.5)	34.9(54.4)	25.0(39.0)
$I_2M_2F_3$	42.1(47.0)	31.7(35.4)	26.2(29.3)	38.8(54.5)	33.9(47.6)	27.4(38.5)
$I_2M_2F_4$	44.1(58.2)	33.1(43.6)	22.8(30.1)	40.6(63.9)	35.2(55.4)	24.2(38.2)
$I_3M_1F_1$	41.8(38.1)	30.7(28.0)	27.5(25.1)	38.4(39.8)	33.5(34.7)	28.1(29.1)
$I_3M_1F_2$	43.0(46.6)	32.6(35.4)	24.4(26.5)	40.6(50.1)	35.1(43.3)	24.2(29.9)
$I_3M_1F_3$	42.3(43.1)	30.9(31.5)	26.7(27.2)	39.4(46.0)	34.2(39.9)	26.4(30.8)
$I_3M_1F_4$	46.0(56.2)	33.5(40.9)	20.5(25.1)	41.0(51.0)	35.9(44.7)	23.1(28.7)
$I_3M_2F_1$	41.1(35.3)	31.0(26.6)	27.9(23.9)	38.3(37.7)	32.9(32.4)	28.8(28.3)
$I_3M_2F_2$	42.1(44.2)	32.2(33.8)	25.6(26.9)	40.8(47.7)	35.6(41.6)	23.6(27.6)
$I_3M_2F_3$	41.7(41.2)	31.6(31.2)	26.8(26.5)	39.7(45.0)	34.3(38.9)	26.0(29.5)
$I_3M_2F_4$	42.9(49.6)	33.0(38.1)	24.1(27.9)	41.7(54.9)	36.1(47.5)	22.2(29.2)

Note : Figures given in parentheses indicate the absolute value of moisture extraction (cm) from particular layer, I_1-irrigation at 60 mm CPE, I_2-irrigation at 80 mm CPE, I_3-irrigation at 100 mm CPE, M_1-paddy straw mulch, M_2-dust mulch, F_1-100% NPK, F_2-75% NPK+ 25% N through FYM+ 20 kg S through gypsum, F_3-75% NPK+ 25% N through Vermicompost+ 40 kg S through gypsum, F_4-75% NPK+ 25% N through FYM + 60 kg S through gypsum.

soil moisture was extracted (43.4 and 40.9% of total profile use) with irrigation at 60 mm CPE followed by irrigation at 80 mm CPE and 100 mm CPE during both the years, respectively. At 60-90 cm soil depth, the highest soil moisture was extracted (25.9 and 31.9% of total profile use) with irrigation at 80 mm CPE followed by irrigation at 100 and 60 mm CPE during both the years, respectively. At 0-30 cm and 30-60 cm soil depth, the higher soil moisture was extracted under dust mulch followed by under paddy straw mulch during both the years, respectively. Nearly a similar trend was observed for 60-90 cm depth. As regards the INM, at 0-30 cm and 30-60 cm soil depth, the highest soil moisture was extracted with an application of 75% NPK + 25% N through FYM + 60 kg S through gypsum as compared to other treatments during both the years of experimentation, respectively. The lowest soil moisture was extracted with an application of 100% NPK. Nearly a similar trend was observed for 60-90 cm depth.

Among various combinations of irrigation regimes, mulch and INM, at 0-30 cm and 30-60 cm soil depth, the highest soil moisture was extracted during both the years (Table 2) with the combination of irrigation at 60 mm CPE with dust mulch and an application of 75% NPK + 25% N through FYM + 60 kg S through gypsum ($I_1M_2F_4$) followed by application of 75% NPK + 25% N through FYM+ 20 kg S through gypsum ($I_1M_2F_2$). The lowest soil moisture was extracted with the combination of irrigation at 60 mm CPE with paddy straw mulch and an application of 100% NPK ($I_1M_1F_1$). At 60-90 cm soil depth, the highest soil moisture was extracted with the combination of irrigation at 60 mm CPE with dust mulch and an application of 100% NPK ($I_1M_2F_1$) followed by application of 75% NPK + 25% N through vermicompost +40 kg S through gypsum ($I_1M_2F_3$).

Soil moisture extraction pattern revealed that proportionally greater per cent of soil moisture was extracted by the crop from the top soil layer (0-30 cm) as sufficient amount of moisture prevailed under all the treatment combinations. A lower per cent of soil moisture was extracted by the crop from the deeper soil layer. The root activity was comparatively higher in the top as well as deeper soil layers of more frequently irrigated treatment (60 mm CPE). Differences in the amounts of water transpired by differentially fertilised crops were, therefore, mainly due to the effects of canopy cover on evaporation from the soil surface. By contrast, variation in water supply significantly affected the amount of water used and the depth and shape of the extraction bar. In both the years, water extraction was the highest from the surface layers of soil in all three irrigation treatments. This decline in the proportion of water extracted with depth from the surface, from 0 to 90 cm, could be described over both the years. Results are in conformity with the findings of Idnani and Singh (2008) and Verma *et al*. (2013).

Pod yield : The significantly highest pod yield was achieved under irrigation at 60 mm CPE followed by irrigation at 80 mm and 100 mm CPE, respectively (Table 1). The better development of crop under irrigated treatments was a result of better moisture availability, which maintained the internal water balance of the plant. Increase in yield is due to the increase in the yield attribute reported by Zagade and Chavan (2009) and Gupta *et al*. (2015). Paddy straw mulch recorded significantly higher pod as compared to dust mulch. The better development of crop under paddy straw mulch treatment was a result of better moisture availability, which maintained the internal water balance of the plant. Increase in yield is due to the increase in the yield attribute reported by Ravisankar *et al*. (2014) and Guo *et al*. (2014). Among INM treatments, an application of 75% NPK+ 25% N through FYM + 60 kg S through gypsum recorded significantly the highest pod yield followed by 75% NPK+ 25% N through vermicompost + 40 kg S through gypsum, 75% NPK+ 25% N through FYM + 20 kg S through gypsum and 100% NPK, respectively. These results are corroborated with the research results of Vishwakarma *et al*. (2012), Chavan *et al*. (2014) and and Patil *et al*. (2017).

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