



Drip fertigation influences yield, nutrient uptake and soil properties of peanut (*Arachis hypogaea*)

N K JAIN^{1*}, R S YADAV² and RAM A JAT³

ICAR-Directorate of Groundnut Research, Junagadh, Gujarat 361 001, India

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ABSTRACT

The present field experiment was conducted at ICAR-Directorate of Groundnut Research, Junagadh (Gujarat) for two consecutive summer of 2014 and 2015 to investigate the influence of drip fertigation on yield, nutrient uptake and soil properties of peanut (*Arachis hypogaea* L.) in Saurashtra region of Gujarat. There were 10 treatments including 100% normal fertilizers (NF) with surface method of irrigation as control which were replicated three times. The study revealed that drip fertigation with 100% NF (T₁₀) produced significantly higher pod yield over control and was at par with other treatments. However, haulm yield was significantly higher under the application of 100% WSF fertigation half at sowing and one-fourth each at 20 and 40 DAS (T₄) over T₆ to T₉ and was at par with other treatments including control. Soil moisture status showed declining trend with successive increase in plant age but could not reach the level of significance. Drip fertigation with 100% NF (T₁₀) registered markedly higher uptakes of N (114.4 kg/ha), P (30.5 kg/ha) and K (67.2 kg/ha) over all the treatments. As compared to initial status, available soil NPK status improved after harvest at all soil depths and showed declining trend with increase in soil depth. The study indicated the saving of 25% NPK fertilizers by adopting 75% WSF fertigation through drip irrigation at sowing in summer peanut with comparable yield.

Keywords: Drip fertigation, Nutrient uptake, Peanut, Soil fertility, Water soluble fertilizers

In India, peanut (*Arachis hypogaea* L.) occupies an area of 4.85 M ha with production and productivity of 6.97 M tonnes and 1436 kg/ha, respectively (Anonymous 2020a). Due to assured and higher profit and productivity, the area under *rabi*-summer peanut has increased in the recent years, as it is cultivated in the area where sufficient irrigation water is available and less attack of biotic and abiotic stresses on the crop compared to *kharif* (Rana *et al.* 2014). Though the peanut pod yield during *rabi*-summer is higher (1934 kg/ha) compared to *kharif* (1339 kg/ha) in the country (Anonymous 2020a) but it is still quite low compared to what is being obtained in USA (≈4600 kg/ha) and China (≈3700 kg/ha) (Anonymous 2020b). In arid and semi-arid areas, availability of irrigation water and nutrients are the most important factors that limit productivity of the crop, therefore, judicious management of water and nutrients is crucial for improving the crop productivity (Hebbar *et al.* 2004, Varughese and Habeeburrahman 2015). As peanut crop responds well to

application of water and nutrients, and fertilizers applied by conventional methods are not utilized fully by the crop, hence, it is imperative to increase its yield through micro irrigation with fertigation. It is the most efficient and agronomically sound method of fertilizer application, as it ensures application of water-soluble fertilizer and other agro-chemicals uniformly with irrigation water directly in the active root zone during critical periods in the required doses, thereby saves water and nutrient and consequently improves fertilizer use efficiency over conventional method. It is well documented that fertilizer requirement can be reduced by 15–25% with fertigation through drip without affecting the yield (Hongal and Nooli 2007, Nath *et al.* 2016). However, very limited studies have been done on fertigation in peanut (Jain *et al.* 2017, Soni and Raja 2017, Karthika and Ramanathan 2019). Keeping this in view, the present investigation was undertaken.

MATERIALS AND METHODS

The present field experiment was conducted for two consecutive summer during 2014-15 at the research farm of ICAR-Directorate of Groundnut Research (longitude 70°36'E, latitude 21°31'N, elevation of 60 m above MSL), Junagadh, Gujarat, India. The experimental site soil (0-15 cm) was medium black clay classified as Typic Haplustepts, moderately calcareous and slightly alkaline in reaction (pH 7.9). It was low in organic carbon (4.9 g/kg), and available

Present address: ¹HRM Unit, Indian Council of Agricultural Research, New Delhi; ²ICAR-Central Arid Zone Research Institute, Jodhpur; ³ICAR-Indian Institute of Soil and Water Conservation Research Centre, Vasad, Anand, Gujarat. *Corresponding author e-mail: nkjpp1971@gmail.com.

nitrogen (130.1 kg/ha), while medium in phosphorus (16.9 kg/ha) and potassium (255.6 kg/ha) status.

The experiment was laid out in randomized block design with three replications. It consists of 10 treatments namely, T₁ : control [100% normal fertilizers (NF) with surface irrigation], T₂ : 100% NF fb drip irrigation, T₃ : 100% water soluble fertilizers (WSF) fertigation (at sowing), T₄ : 100% WSF fertigation [½ at sowing and ¼ each at 20 and 40 DAS], T₅ : 100% WSF fertigation (¼ each at sowing, 20, 40 and 60 DAS), T₆ : 75% WSF fertigation (at sowing), T₇ : 75% WSF fertigation (½ at sowing and ¼ each at 20 and 40 DAS), T₈ : 75% WSF fertigation (¼ each at sowing, 20, 40 and 60 DAS), T₉ : 50% NF soil (½ at sowing) + 50% NF fertigation (¼ each at 20 and 40 DAS) and T₁₀ : 100% NF fertigation (at sowing). Normal fertilizers (NF) are the commercial fertilizers which are widely used in agricultural production systems. The crop was fertilized with 25 kg N, 22 kg P and 24.9 kg K/ha (100% recommended dose of fertilizers) through urea, single super phosphate (SSP) and muriate of potash (MOP), respectively in treatments T₁, T₂, T₉ and T₁₀. Poly-feeds of NPK grade 13-40-13 and 20-20-20 were used as WSF and the differences of N and K which were not supplemented by poly-feeds were compensated using urea and MOP. The NF and WSF were applied as per treatments. The crop under treatment 100% NF with surface irrigation (i.e. T₁) received soil application of 100% NF in furrows at the time of sowing and irrigated with surface method of irrigation whereas 100% NF fb drip irrigation (i.e. T₂) involves soil application of 100% NF in furrows at the time of sowing and then irrigated with drip irrigation. In application of 100% NF at sowing in drip irrigation (i.e. T₁₀), full amount of P was applied in furrows while full amount of N and K were applied through drip at the time of sowing. Half of NF was applied in furrows at sowing, and the remaining half of NPK in two equal splits at 20 and 40 DAS in drip irrigation except P which was

applied in soil near furrow (i.e. T₉). The WSF in treatment T₃ to T₈ were supplied through drip as per treatments. The size of the plot was kept as 6.0 m × 2.7 m accommodating nine rows of 6 m per plot. The crop was grown on raised beds of 60 cm width leaving 30 cm furrows on either side. Biodegradable film (7 µ thick, 90 cm width) used as mulch was spread prior to sowing. Holes were made at 20 cm × 20 cm spacing with manually operated and locally fabricated device on the raised beds and 02 seeds/hole were placed and covered with soil. Peanut TG 37A was sown on first week of February during both the years while it was harvested on first and last week of May during 2014–15, respectively. One lateral was placed for three rows on each raised bed in all the treatments except control where water was applied by surface method of irrigation. Water discharged at rate of 4 L/h/dripper. Besides these, crop was raised with full recommended package of practices.

The crop was harvested manually and sun-dried for 4-5 days in the field at physiological maturity, and then the total biomass yield was recorded and expressed as t/ha. Pod yield/plot was recorded after stripping, cleaning and sun-drying, and expressed as t/ha. Haulm yield of each treatment was obtained by subtracting pod yield from biomass yield.

The representative plant samples were collected, oven-dried at 65°C till constant dry weight at harvest, and processed for further analysis of N, P, and K using Adler and Wilcox (1985) procedure. The N, P and K uptake by pod and haulm was calculated by multiplying the pod and haulm yields with their respective nutrient concentrations.

Prior to start of experiment, initial soil samples were collected from 03 depths i.e. 0-15, 15-30 and 30-45 cm from five sites of the experimental field, and a composite sample for each depth was prepared. After second year of harvest (2015), soil samples were collected from each treatment. These were analyzed for pH and electrical conductivity for 0-15 and 15-30 cm depths, and for available N, P and K for

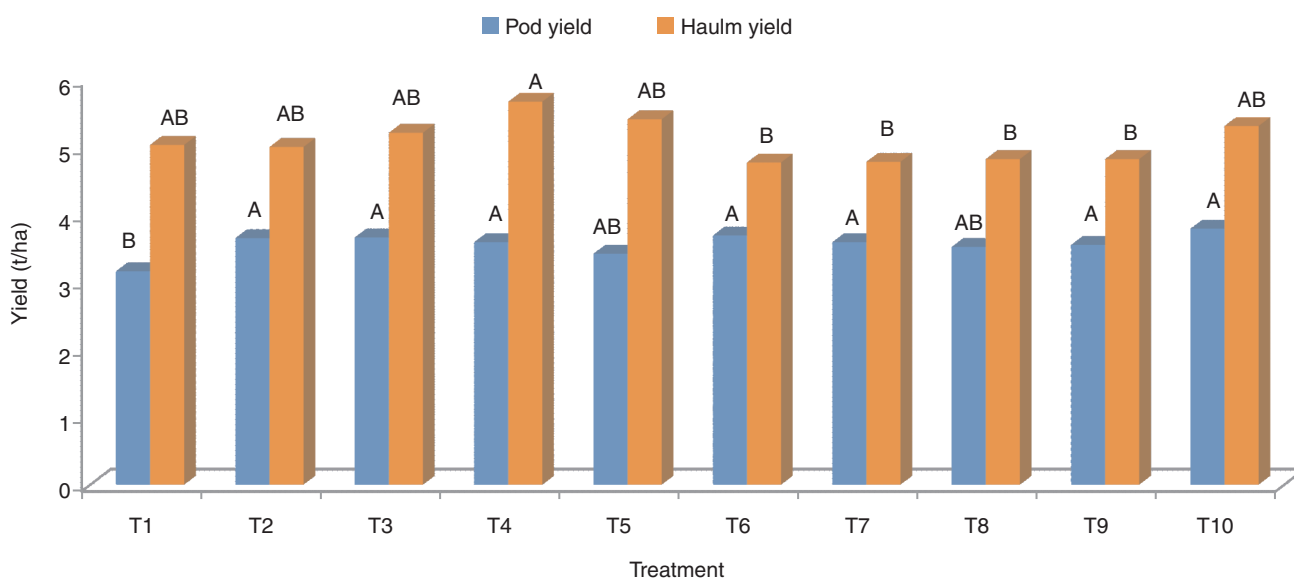


Fig 1 Effect of drip fertigation on pod and haulm yields of peanut (pooled data of 2 years). Means with superscripted different uppercase letter(s) are statistically different using Tukey’s Honest Significant Difference Test at P≤0.05.

0-15, 15-30 and 30-45 cm depths using the methodology as described by Jackson (1973). All the data obtained on yields, nutrient uptake, soil moisture content and soil chemical analysis were subjected to Analysis of Variance (ANOVA) in randomized block design to test the significance of treatment means and ranking of treatment. Before pooled analysis, homogeneity of error variance was also tested through Bartlett's Chi-Square test. Statistical analysis of data was performed online on Indian NARS Statistical Computing Portal (<http://stat.iasri.res.in/sscnarsportal>) using General Linear Model (GLM) procedure in SAS (SAS Institute Inc.). For significant parameters, separation of treatment means and ranking of treatments was done using the Tukey's Honest Significant Difference Test ($P=0.05$).

RESULTS AND DISCUSSION

Yields: All treatments had significant effect on pod yield of peanut over T_1 (i.e. 100% NF with surface irrigation) except T_5 and T_8 (Fig 1). However, non-significant difference in pod yield was obtained under application of 100% NF in soil fb drip irrigation (T_2), drip fertigation with 100% NF (T_{10}) and various levels of WSF applied at different time intervals through drip (T_3 to T_8). Methods of fertilizer application could not bring significant difference in pod yield. The maximum pod yield (3.79 t/ha) was obtained under drip fertigation with 100% NF (T_{10}) closely followed by 75% WSF fertigation at sowing (T_6) which were 20.0 and 16.6% significantly higher over T_1 (control), indicating 25% saving of NPK fertilizers.

This increase in yield might be owing to enhanced supply of N, P and K in the root rhizosphere which increased the uptake of nutrients that boosted luxurious growth of crop. This helped to absorb more photosynthetically active radiation accompanied with increased yield attributes (data not reported). The higher rate of photosynthate translocation from source to sink might have resulted in higher pod yield in peanut. Lots of reports indicated that fertigation with water soluble fertilizer can increase the yield of many crops besides saving 25% of the fertilizer. Sunitha *et al.* (2018) also recorded 25% saving of N fertilizer when cassava mini-setts raised under microirrigation supplemented with fertigation. However, significantly higher haulm yield (5.67 t/ha) was obtained with the application of 100% WSF fertigation $\frac{1}{2}$ at sowing and $\frac{1}{4}$ each at 20 and 40 DAS (T_4) over T_6 to T_9 and was at par with other treatments including control (Fig 1).

Nutrient uptake: Drip fertigation with NF (T_{10}) registered significantly higher uptake of N by peanut crop (114.4 kg/ha) by 18.1% over T_1 i.e. soil application of 100% NF fb surface irrigation but was at par with other treatments (T_2 to T_9) (Table 1). Similarly, drip fertigation with NF (T_{10}) registered significantly more uptake of P (30.5 kg/ha) by 16.9% over T_1 and by 12.5% over T_7 and was at par with other treatments. However, K uptake by peanut crop could not reach to the level of significance due to various treatments but the highest uptake (67.2 kg/ha) was also recorded under T_{10} .

As we know that concentration and availability of

Table 1 Effect of drip fertigation on NPK uptake by peanut (Pooled data of 2 years)

Treatment	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
T_1	96.9 ^{B#}	26.1 ^{B#}	56.6
T_2	106.4 ^{AB}	29.3 ^{AB}	61.1
T_3	107.6 ^{AB}	29.4 ^A	65.5
T_4	103.5 ^{AB}	28.4 ^{AB}	66.9
T_5	100.2 ^{AB}	27.8 ^{AB}	63.9
T_6	103.5 ^{AB}	30.0 ^{AB}	57.3
T_7	101.1 ^{AB}	27.1 ^B	61.0
T_8	100.6 ^{AB}	27.4 ^{AB}	58.7
T_9	101.1 ^{AB}	28.6 ^{AB}	60.0
T_{10}	114.4 ^A	30.5 ^A	67.2

T_1 : control [100% normal fertilizers (NF) with surface irrigation], T_2 : 100% NF fb drip irrigation, T_3 : 100% water soluble fertilizers (WSF) fertigation (at sowing), T_4 : 100% WSF fertigation [$\frac{1}{2}$ at sowing and $\frac{1}{4}$ each at 20 and 40 DAS], T_5 : 100% WSF fertigation ($\frac{1}{4}$ each at sowing, 20, 40 and 60 DAS), T_6 : 75% WSF fertigation (at sowing), T_7 : 75% WSF fertigation ($\frac{1}{2}$ at sowing and $\frac{1}{4}$ each at 20 and 40 DAS), T_8 : 75% WSF fertigation ($\frac{1}{4}$ each at sowing, 20, 40 and 60 DAS), T_9 : 50% NF soil ($\frac{1}{2}$ at sowing) + 50% NF fertigation ($\frac{1}{4}$ each at 20 and 40 DAS) and T_{10} : NF fertigation (at sowing), fb: followed by.

#Means with superscripted different uppercase letter(s) are statistically different using Tukey's Honest Significant Difference Test at $P \leq 0.05$.

various nutrients in the soil depends on the soil solution phase which is mainly determined by soil moisture availability. Due to continuous water supply under drip fertigation, higher available soil moisture has led to higher availability of nutrients in the soil and thereby increased the nutrient uptake by the crop. Veeraputhiran (2000) and Jayakumar *et al.* (2014) also reported similar findings.

Soil properties

Soil moisture: Soil moisture status showed declining trend with successive increase in plant age but could not reach to the level of significance due to soil application of NF with drip irrigation, drip fertigation with NF and various levels of WSF applied at different time intervals through drip at any stage of observations i.e. 30, 45, 60, 75, 90 and 105 DAS (Fig 2). Compared to control, drip irrigation/fertigation treatments recorded higher soil moisture content at all the stages of observations. Jat *et al.* (2011) also reported that the application of predetermined amount of water at regular intervals in drip irrigation maintains high moisture content in the soil.

Soil pH and electrical conductivity: Soil pH and electrical conductivity did not differ significantly due to various treatments at 0-15 and 15-30 cm soil depths but showed declining trends with increase in soil depth (Table 2).

Soil nutrient status: N status after harvest improved under all the treatments at all the soil depths (0-15 cm to 30-

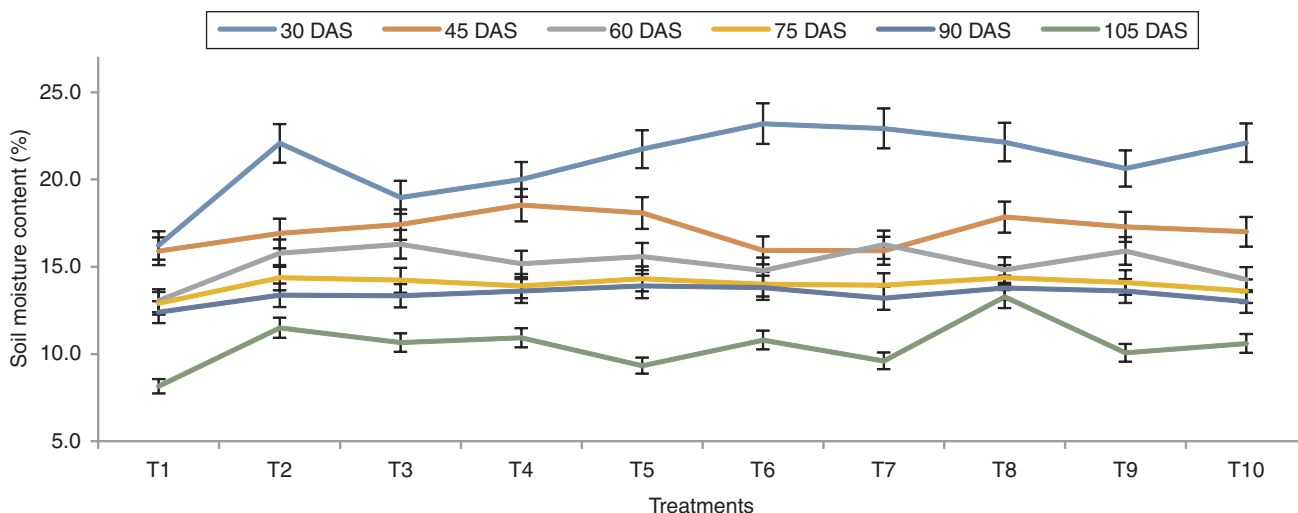


Fig 2 Effect of drip fertigation on soil moisture contents at various growth stages of peanut (pooled data of 2 years). Vertical bars represent the standard error (P=0.05).

Table 2 Changes in available NPK status, electrical conductivity and pH of soil under drip fertigation after two years of peanut cultivation

Treatment	Available N (kg/ha)			Available P (kg/ha)			Available K (kg/ha)			EC (dS/m)		pH	
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T ₁	176.8 ^{A#}	145.9 ^{A#}	133.3	30.8	26.3	21.2	330.0	306.1	258.1	0.82	0.79	7.63	7.50
T ₂	160.1 ^{AB}	137.5 ^A	120.8	24.0	23.4	18.9	309.5	260.1	229.7	0.71	0.66	7.73	7.63
T ₃	156.3 ^B	135.4 ^A	129.2	23.4	21.8	16.9	306.8	259.4	217.4	0.75	0.71	7.93	7.81
T ₄	164.3 ^A	139.6 ^A	118.7	24.8	24.8	22.3	311.0	268.3	217.7	0.69	0.64	7.77	7.67
T ₅	166.3 ^A	143.8 ^A	125.0	29.5	21.4	21.0	319.9	299.0	240.9	0.78	0.61	7.66	7.58
T ₆	141.3 ^B	117.8 ^B	114.9	17.8	19.8	16.9	294.6	257.9	224.2	0.63	0.57	7.65	7.63
T ₇	147.5 ^B	120.8 ^B	116.6	19.4	25.7	19.9	302.0	264.0	244.6	0.76	0.58	7.83	7.79
T ₈	149.6 ^B	131.3 ^{AB}	118.7	22.7	21.1	19.2	309.5	263.5	239.8	0.72	0.70	7.75	7.68
T ₉	165.9 ^A	141.7 ^A	120.8	29.7	21.8	19.5	313.2	280.3	242.0	0.67	0.63	7.80	7.75
T ₁₀	151.7 ^B	133.4 ^A	127.5	23.0	20.0	23.0	314.3	258.3	211.3	0.84	0.79	7.83	7.71
Initial status	130.1	122.5	112.1	16.9	14.5	12.5	255.6	246.8	210.3	0.70	0.64	7.90	7.65

Treatment: as described in Table 1.

45 cm) as compared to initial status (Table 2). Significantly higher soil N status after crop harvest (0-15 and 15-30 cm) was recorded under T₁ (control) over T₃, T₆ to T₈ and T₁₀ at 0-15 cm depth and over T₆ and T₇ at 15-30 cm depth, and was at par with other treatments, and showed declining trend with successive increase in soil depth (Table 2). However, available N status at 30-45 cm depth did not differ significantly due to various treatments. Soil available P status also improved over initial status but could not reach to the level of significance due to various treatments, and showed declining trend with successive increase in soil depth (Table 2). Moreover, treatment T₁ (control) registered the highest available P status at all the soil depths over other treatments. Similarly, available K status also improved over initial status but could not reach to the level of significance due to various treatments, and showed declining trend with successive increase in soil depth. Maximum soil K status

was also noticed under T₁ (control).

The above findings clearly indicated that peanut crop fertigated with 100% NF through drip recorded significantly higher pod yield and nutrient uptake over soil application of 100% NF with surface irrigation (T₁) but were comparable with other treatments. The next best treatments were found to be 100% NF fb drip irrigation (T₂) and drip fertigation with 75% WSF (T₆). Therefore, a fertilizer saving of 25% NPK was possible by adopting fertigation with 75% WSF through drip irrigation at sowing in summer peanut with comparable yield.

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