Mysore J. Agric. Sci., 50 (1) : 67-72, 2016

Yield Attributes, Yield and Quality of Groundnut (*Arachis hypogaea* L.) as Influenced by Nutrient Management with Water Soluble and Normal Fertilizers

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ABSTRACT

Investigation was carried out during *kharif* 2014 at GKVK, University of Agricultural Sciences, Bengaluru to study the effect of different levels of water soluble and normal fertilizers and methods of fertilizer application on yield attributes, yield and quality of groundnut in red sandy loam soil. The experimental results revealed that drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF recorded significantly higher number of pod plant^{-1} (35.7), shelling percentage (75.4 %), pod yield (2910 kg ha^{-1}) and haulm yield (2843 kg ha^{-1}). However, it was on par with drip fertigation of normal fertilizers at 50 per cent RDF + water soluble fertilizers at 50 per cent RDF. Higher oil content (46.0 %), oil yield (1009 kg ha^{-1}), protein content (26.2 %) and protein yield (575 kg ha^{-1}) were also recorded with drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF.

Groundnut (*Arachis hypogaea* L.) is a most important oilseed crop belongs to the family Leguminoceae. It contains about 50 per cent oil, 25-30 per cent protein, 20 per cent carbohydrate and 5 per cent fiber and ash which make a substantial contribution to human nutrition (El-Habbasha, 2015). Globally groundnut accounts of an area of 254 lakh hectares with a total production of 453 lakh tones with an average productivity of 1789 kg ha^{-1}. The area under groundnut in India is 52.50 lakh hectares, production of 94.72 lakh tonnes with a productivity of 1804 kg ha^{-1} (Anon., 2014). India occupies the first place in acreage, but, stands second in production (20.9 %) after China (37.3 %). The optimization of the mineral nutrition is the key to optimize the production of groundnut, as it has very high nutrient requirement and the recently released high yielding groundnut varieties remove still more nutrients from the soil. Average groundnut crop, with 20 to 25 q ha^{-1} of economic yield, requires 160-180 kg N, 20-25 kg P, 80-100 kg K. On the contrary groundnut farmers in most part of India use inadequate and imbalance fertilizer nutrients resulting in severe nutrient deficiencies which are the major factors responsible for low yield in groundnut. These facts call for the intensive study on possibility of more effective utilization of nutrients in divided dosages like basal and top dressing.

Water-soluble fertilizers are the fertilizers that can be dissolved in water easily and applied through fertigation as well as foliar spray. It is likely to manage the precise amount of nutrients available to plants with the help of water soluble fertilizers. The factors such as ease of application, innovative production practices, new product offerings, increased availability and mechanized irrigation systems are driving the market for water-soluble fertilizers, globally. Hence, an attempt has been made to find out the effect of nutrient management with different sources and levels of fertilizes on yield, yield attributes and quality of groundnut.

MATERIAL AND METHODS

The experiment was conducted at Zonal Agricultural Research Station, GKVK, University of Agricultural Sciences, Bengaluru during *kharif* 2014. The soil of the experimental site was red sandy loam with medium in available nitrogen (311 kg ha^{-1}), phosphorous (43 kg ha^{-1}) and potassium (209 kg ha^{-1}). During the cropping season a total of 755.2 mm rainfall was received. The average maximum air temperature of 28.5°C in the month of September, 2014 and minimum temperature of 18.7°C during the month of October, 2014 were recorded. The variety used in the investigation was ICGV- 91114 (Spanish Bunch Variety, 105-110 days) duration in *kharif* . The experiment was laid out in randomized complete block

design (RCBD) with three replications. The treatments consisted of ten nutrient management practices *viz.*, T_1: Surface irrigation with soil application of normal fertilizer (NF) at 100 per cent recommended dose of fertilizer (RDF), T_2: Drip irrigation with soil application of NF at 100 per cent RDF, T_3: Drip fertigation of NF at 50 per cent RDF + water soluble fertilizer (WSF) at 50 per cent RDF, T_4: Drip fertigation of NF at 75 per cent RDF + (WSF) at 25 per cent RDF, T_5: Drip fertigation of NF at 50 per cent RDF + foliar spray of WSF at 12.5 per cent RDF, T_6: Drip fertigation of WSF at 50 per cent RDF + foliar spray of WSF at 12.5 per cent RDF, T_7: Drip irrigation with soil application of WSF at 50 per cent RDF, T_8: Drip irrigation with soil application of WSF at 75 per cent RDF, T_9: Surface irrigation with soil application of WSF at 50 per cent RDF, T_{10}: Surface irrigation with soil application of WSF at 75 per cent RDF. Normal fertilizers (NF) were applied in the form of Di Ammonium Phosphate (DAP) and Muriate of Potash (MOP) and water soluble fertilizers (WSF) were Mono Ammonium Phosphate (12:61:0), Calcium Ammonium Nitrate (CAN) and Potassium Sulphate (0:0:50). In drip fertigation methods, according to treatments, required quantities of fertilizers were applied in eight equal splits at 7 days interval starting from 14 days after sowing to 70 days after sowing. For drip and surface irrigation with soil application of fertilizers, depending on the treatments, required quantities of fertilizers were applied at the time of sowing. When normal fertilizers were used for fertigation, the solution was pre filtered and only the clear supernatant solution was supplied to fertilizer tank for fertigation. With respect to foliar application, only water soluble fertilizers were used at four splits with one per cent concentration in different growth stages of groundnut (25, 40, 55 and 70 DAS). The recommended dose of fertilizers - RDF- 25: 75: 37.5kg N, P_2O_5, K_2O ha^{-1}.

Results and Discussion

Yield and its attributes indirectly depend on growth attributes of any crop. In the present study, drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF produced higher total dry matter and number of pods per plant at harvest than all other treatments except drip fertigation of normal fertilizers at 50 per cent RDF along with water soluble fertilizers at 50 per cent RDF. This was mainly due to foliar application of nutrients may lead to stimulatory effect on cell division, enlargement and the crop responses to utilize nutrients throughout the growth period (Khalilzadeh *et al*., 2012).

Significant differences in growth components of groundnut were also due to use of water soluble fertilizers. Even application of water soluble fertilizers at lower rates was effective and recorded higher growth components due to higher solubility and efficiency compared to application of 100 per cent RDF. Similar results were also reported by Veeranna *et al.* (2001). All the fertigation treatments also noticed significantly higher growth components compared to surface and drip irrigation treatments. This was mainly due to application of fertilizers in different splits with irrigation water which led to increase uptake of nutrients, contributing to better plant growth and increase total dry matter production. The results were in line with the findings of Hebbar *et al.* (2004) in tomato.

Higher number of nodules $plant^{-1}$ (49.4) at 30DAS was recorded in drip fertigation of normal fertilizers at 50 per cent RDF along with water soluble fertilizers at 50 per cent RDF. However, it was on par with drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF. The nodule bacteria function normally only when plants are supplied with adequate availability of phosphorus which might have increased the number of nodules $plant^{-1}$. In drip fertigation nutrients were supplied through split doses to match the needs of crops which might help better nodule formation. This was in accordance with the observation of Sanju, 2013. Also, foliar application of fertilizers facilitated better availability of nutrients in plants leading to higher number of nodules $plant^{-1}$. This result was in line with the findings of Samir Ali (2014).

Yield of groundnut differed significantly due to nutrient management practices. Drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF produced significantly higher pod yield (2910 kg ha^{-1}) and haulm yield (2843 kg ha^{-1}) compared to all

TABLE I

Growth parameters of groundnut as influenced by nutrient management with different sources and levels of fertilizers and method of application

Treatments	Total dry matter (g plant $^{-1}$)	No. of Pegs plant $^{-1}$	No. of nodules plant $^{-1}$	No. of effective nodules plant $^{-1}$
	At harvest		30 DAS	
T_1: Surface irrigation with soil application of NF at 100 % RDF	27.63	3.3	27.9	21.9
T_2: Drip irrigation with soil application of NF at 100 % RDF	35.03	6.4	42.0	34.1
T_3: Drip fertigation of NF at 50 % RDF + WSF at 50 % RDF	42.97	10.0	49.4	41.7
T_4: Drip fertigation of NF at 75 % RDF + WSF at 25 % RDF	41.27	9.1	45.0	39.8
T_5: Drip fertigation of NF at 50 % RDF + foliar spray of WSF at 12.5 % RDF	38.96	8.3	41.8	35.5
T_6: Drip fertigation of WSF at 50 % RDF + foliar spray of WSF at 12.5 % RDF	44.89	10.2	47.5	42.2
T_7: Drip irrigation with soil application of WSF at 50 % RDF	31.20	4.8	30.6	28.3
T_8: Drip irrigation with soil application of WSF at 75 % RDF	35.10	7.1	43.8	38.2
T_9: Surface irrigation with soil application of WSF at 50 % RDF	26.62	3.3	26.2	20.5
T_{10}: Surface irrigation with soil application of WSF at 75 % RDF	30.43	5.3	36.5	24.0
S.Em±	1.24	0.39	1.45	1.70
C.D @ 5%	3.71	1.17	4.30	5.04

other treatments (Table II). However, it was on par with drip fertigation of normal fertilizers at 50 per cent RDF along with water soluble fertilizers at 50 per cent RDF. The increased yield in reduced fertilizer dose was mainly attributed to availability of sufficient quantity of nutrients due to higher solubility of water soluble fertilizers, which minimizes loss of nutrients, resulting in higher yield. Similar observations were reported by Ponnuswamy and Santhy (2008).

Significant differences in yield of groundnut were also due to drip fertigation. Drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF resulted in 75.9 per cent higher pod yield over surface irrigation with soil application of normal fertilizers at 100 per cent RDF. Since, nutrient supply through drip irrigation increased availability of nutrients, as they were supplied at eight equal splits, leading to efficient utilization of applied fertilizer. Similar results were also reported in groundnut by Jain *et al.* (2012). The higher yield was further associated with high frequency of irrigation water which maintained the adequate moisture level in the crop root zone throughout the growth period. The results confirmed the findings of Vijayalakshmi *et al.* (2011).

Further, foliar application of water soluble fertilizers enhanced supply of nutrients, subsequent mobilization and translocation of nutrients to reproductive structure *viz.*, pods, grains etc. This is in accordance with the findings of Sandhya Rani *et al*. (2014). Significantly lower pod yield (1530 kg ha^{-1}) was noticed in surface irrigation with soil application of water soluble fertilizers at 50 per cent RDF, which was on par with surface irrigation with soil application

TABLE II

Yield attributes and yield of groundnut as influenced by nutrient management with different sources and levels of fertilizers and method of application

Treatments	No. of pods plant $^{-1}$	Pod weight (g. plant^{-1})	Shelling (%)	Haulm yield (kg ha $^{-1}$)	Pod yield (kg ha $^{-1}$)
T_1 : Surface irrigation with soil application of NF at 100 % RDF	20.3	16.5	67.7	1698	1654
T_2: Drip irrigation with soil application of NF at 100 % RDF	26.7	20.9	72.8	2140	2184
T_3: Drip fertigation of NF at 50 % RDF + WSF at 50 % RDF	33.3	25.6	73.6	2670	2790
T_4: Drip fertigation of NF at 75 % RDF + WSF at 25 % RDF	31.7	24.9	72.6	2552	2650
T_5: Drip fertigation of NF at 50 % RDF + foliar spray of WSF at 12.5 % RDF	3.6	24.1	71.4	2482	2535
T_6: Drip fertigation of WSF at 50 % RDF + foliar spray of WSF at 12.5 % RDF	35.7	27.3	75.4	2843	2910
T_7: Drip irrigation with soil application of WSF at 50 % RDF	23.1	18.7	71.7	1813	1778
T_8: Drip irrigation with soil application of WSF at 75 % RDF	27.2	20.8	72.3	2218	2225
T_9: Surface irrigation with soil application of WSF at 50 % RDF	18.3	15.8	67.2	1580	1530
T_{10}: Surface irrigation with soil application of WSF at 75 % RDF	24.0	17.7	72.3	1926	1827
S.Em±	1.06	0.99	0.48	64.91	83.04
C.D @ 5%	3.14	2.94	1.43	192.8	246.7

of normal fertilizers at 100 per cent RDF (1654 kg ha^{-1}).

Yield of any crop directly depends on its yield attributes. Yield components of groundnut also significantly influenced by nutrient management practices (Table I). Significantly higher number of pod plant^{-1} (35.7) was noticed in drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF, which was on par with drip fertigation of normal fertilizers at 50 per cent RDF + water soluble fertilizers at 50 per cent RDF (33.3). Significantly lower number of pods plant^{-1} (18.3) was recorded in surface irrigation with soil application of water soluble fertilizers at 50 per cent RDF, which was on par with surface irrigation with soil application of normal fertilizers at 100 per cent RDF (20.3). This was in concordance with Sundaram and Kanthaswamy (2005) and Pawar *et al.* (2013). Higher pod weight plant^{-1} (27.3 g) and shelling percentage (75.4 %) were also observed with drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF. Similar results of increased yield attributes due to drip fertigation of water soluble fertilizers had been reported by Sanju *et al*. (2014).

Significantly higher oil percentage (46.0 %) and oil yield (1009 kg ha^{-1}) was recorded in drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF over drip irrigation and surface irrigation treatments (Table II). Higher oil yield was mainly attributed to higher kernel yield. This was mainly due to foliar application favourably increased uptake of nutrients and good response by plants resulted in higher

oil yield. This was in conformity with the findings of Munirathnamma (2014). Drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF resulted in 105.9 per cent higher oil yield over surface irrigation with soil application of normal fertilizers at 100 per cent RDF. Even significantly higher oil yield was noticed in all fertigation treatments over surface and drip irrigation treatments. Similar results were also obtained by Sukeshni Wane *et al*. (2009) in groundnut.

Higher protein content (26.2 %) and protein yield (575 kg ha^{-1}) was recorded in drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF (Table IIi), which could be due to higher availability of nitrogen through foliar application at different crop growth stages resulting in enhancement of protein content of kernels, suggesting that hydrocarbons synthesized during photosynthetic processes are diverted to reproductive part and form more proteins. This was in consonance with Venkatesh and Basu (2011). Drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF resulted in 130.9 per cent higher protein yield over surface irrigation with soil application of normal fertilizers at 100 per cent RDF. Higher protein yield was also attributed to higher kernel yield. It was furthermore noticed that all fertigation treatments recorded higher protein content over surface and drip irrigation treatments. The results were in line with the findings of Sanju *et al*. (2014) in groundnut.

This study has shown that drip fertigation of water soluble fertilizers at 50 per cent RDF along with foliar spray of water soluble fertilizers at 12.5 per cent RDF increased the yield and quality of groundnut significantly. This accounted for 75.9 per cent higher pod yield over surface irrigation with soil application of normal fertilizers at 100 per cent RDF (conventional method). However, it was on par with drip fertigation of normal fertilizers at 50 per cent RDF + water soluble fertilizers at 50 per cent RDF. Higher quality parameters *viz.*, oil, protein per cent and yield were attributed to higher yield attributes and yield in groundnut.

TABLE III

Quality of groundnut as influenced by nutrient management with different sources and levels of fertilizers and method of application

Treatments	Oil content (%)	Oil Yield (kg ha^{-1})	Protein content (%)	Protein Yield (kg ha^{-1})
T_1: Surface irrigation with soil application of NF at 100 % RDF	43.8	490	22.3	249
T_2: Drip irrigation with soil application of NF at 100 % RDF	44.8	712	24.5	389
T_3: Drip fertigation of NF at 50 % RDF + WSF at 50 % RDF	45.8	941	26.0	534
T_4: Drip fertigation of NF at 75 % RDF + WSF at 25 % RDF	45.5	875	25.7	494
T_5: Drip fertigation of NF at 50 % RDF + foliar spray of WSF RDF at 12.5 %	45.3	820	25.1	454
T_6: Drip fertigation of WSF at 50 % RDF + foliar spray of WSF RDF at 12.5 %	46.0	1009	26.2	575
T_7: Drip irrigation with soil application of WSF at 50 % RDF	44.1	562	23.2	295
T_8: Drip irrigation with soil application of WSF at 75 % RDF	45.0	724	24.8	399
T_9: Surface irrigation with soil application of WSF at 50 % RDF	43.4	446	21.9	225
T_{10}: Surface irrigation with soil application of WSF at 75 % RDF	44.3	586	23.7	313
S.Em±	0.33	31.48	0.35	15.11
C.D @ 5%	0.99	93.53	1.03	44.90

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(*Received :* October, 2015 *Accepted :* January, 2016)