

Original Research Article

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Effect of Potassium on Growth, Yield and Quality of Groundnut (*Arachis hypogaea* L.) Grown in Loamy Sand Soil

P. B. Chaudhary, S. K. Shah*, M. G. Chaudhary, J. K. Patel and K.V. Chaudhary

Castor Mustard Research Station, S. D. Agricultural University, Sardarkrushinagar-385 506,
Distt. Banaskantha (Gujarat) India

*Corresponding author

ABSTRACT

A field experiment entitled, “Effect of Potassium on Growth, Yield and Quality of Groundnut (*Arachis hypogaea* L.) grown in loamy sand soil” was carried out at Castor - Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during summer 2017. The soil of the experimental field was loamy sand in texture; neutral in reaction (pH- 7.2) and electrical conductivity (EC- 0.1 dSm⁻¹); low in both organic carbon (0.2 %) and available N (156 kg/ha); medium in both available P₂O₅ (44.2 kg/ha) and available K₂O (256 kg/ha). Total ten treatments namely, T₁: RDF (25:50:00 kg/ha), T₂: RDF + KSB, T₃: RDF + 20 kg K₂O, T₄: RDF + 40 kg K₂O, T₅: RDF + 15 kg K₂O + KSB, T₆: RDF + 30 kg K₂O + KSB, T₇: 75 % RDF + NPK consortium, T₈: NPK consortium, T₉: RDF + NPK consortium and T₁₀: Absolute control were evaluated in randomised block design with three replications with groundnut variety GG 2 as a test crop. Almost all the growth and yield parameters of groundnut viz., plant height at harvest (58.3 cm), number of pod per plant (29.3), pod yield (2872 kg/ha) and haulm yield (4274 kg/ha) were recorded significantly higher with application of RDF + NPK consortium (T₉) over the rest of the treatments. With regards to oil content of groundnut application of RDF + NPK consortium (T₉) gave significant impact on increment of oil content in kernel (48.35 %). However, the fatty acid profile (%) of groundnut oil was not affected significantly due to different treatments. Higher benefit: cost ratio of 3.70 was observed with treatment RDF + NPK consortium (T₉).

Keywords

Groundnut,
Potassium, KSB,
NPK consortium
and Fatty acid

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Introduction

Groundnut (*Arachis hypogaea* L.) contains high quality edible oil (48 per cent), easily digestible protein (26 per cent) and carbohydrates (20 per cent) therefore considered as ‘king of oilseed’ among the oilseed crops and botanically classified in family *Fabaceae* (Das *et al.*, 2005). Groundnut

provides an inexpensive source of high quality dietary protein and oil to millions of people in world especially in developing countries also it is a source of considerable amounts of mineral elements to supplement the dietary requirements of humans and farm animals. (Asibuo *et al.*, 2008). Peanut oil like other vegetable oil is determined on the ester which is made up of straight chain higher fatty acids

and glycerine. The fatty acids include the unsaturated; palmitic acid and stearic acid, mono unsaturated fatty acids; such as oleic acid, and polyunsaturated fatty acids such as linoleic acid, linolenic acid.

As per estimate, groundnut is grown in India on 4.56 million hectare and production of 6.77 million tonnes with an average productivity of 1486 kg/ha (DAC and FW, 2016). In India, about 80 per cent of the area and 84 per cent of the production of groundnut is confined to the states of Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra. However, it is also grown in Uttar Pradesh, Tamil Nadu, Punjab and west Bengal. Among the ground nut producing states, Gujarat is the topmost state both in area and production.

Within Gujarat, the *Saurashtra* region is considered as 'bowl of groundnut'. It has been witnessed that the area under groundnut is also increasing in potato growing areas of North Gujarat considerably because of suitable agro-climatic conditions and coarse texture soil.

The agricultural soils are over exploited for available plant nutrients when fertilized injudiciously under continuous farming (Marinari *et al.*, 2000). The new epicenter for groundnut crop in light textured potato soils of North Gujarat has no exception.

These soils are low in nutrients and responsive to the applied fertilizers even of potassium. Plants need large quantities of potassium, as much as, or even more than nitrogen. Potassium improves economic crop produce and its quality (Singh, 2007). Potassium is considered one of the primary nutrients responsible for quality of groundnut crop (Sanadi *et al.*, 2008). Long term fertilizer experiments confirm the need of potassium fertilization in the soils of Gujarat (Malavia *et al.*, 1999). Bio-fertilizers can play an important role in meeting the nutrient

requirement of crops. Plant growth promoting bacteria (PGPR) are a group of free living microorganisms that use different methods to increase plant growth (Glick and Bashan, 1997). Farmer is well acquainted with the use of *rhizobium* biofertilizer in groundnut.

Use of PSB is also gaining momentum among the farmers. Use of Potassium Solubilizing Bacteria (KSB) is not much popular among the groundnut farmers. Moreover, the research on use of KSB in groundnut is also very scanty.

Materials and Methods

The field experiment was carried out during summer 2017 at Castor - Mustard Research Station, S.D. Agricultural University, Sardarkrushinagar, Banaskantha (Gujarat, India) located at 72° 19' East longitude and 24° 19' North latitude at 154.52 meters above the mean sea level. The region falls under North Gujarat Agro-Climatic Zone (AES-IV) of Gujarat (Fig 1).

The soil of the experimental field was loamy sand in texture; neutral in reaction (pH 7.2) and electrical conductivity (EC 0.1 dSm⁻¹); low in both organic carbon (0.2 %) and available N (156 kg/ha); medium in both available P₂O₅ (44.2 kg/ha) and available K₂O (256 kg/ha). Groundnut variety GG 2 was evaluation under ten treatments namely, T₁: RDF (25:50:00 kg/ha), T₂: RDF + KSB, T₃: RDF + 20 kg K₂O, T₄: RDF + 40 kg K₂O, T₅: RDF + 15 kg K₂O + KSB, T₆: RDF + 30 kg K₂O + KSB, T₇: 75 % RDF + NPK consortium, T₈: NPK consortium, T₉: RDF + NPK consortium and T₁₀: Absolute Control designed in randomized block design with three replications. Recommended dose of 25 kg N + 50 kg P₂O₅ ha⁻¹ and seed treatment with rhizobium and PSB were applied as common dose to all the treatments except absolute control. The source of N and P₂O₅

were Urea and DAP, respectively. Potassium was applied as MOP. KSB and NPK consortium were applied as seed treatment at time of sowing in respective treatments. Groundnut cv. GG2 was sown with recommended seed rate of 120 kg/ha by maintaining 30 cm distance between two rows. The seeds were sown manually at about the depth of 5 cm in previously opened furrows and covered properly with the soil.

All the appropriate cultural practices and timely plant protection measures were adopted uniformly for all the treatments.

At physiological maturity, five plants were randomly selected from each net plot to measure growth parameters (plant height and number of pods per plant at harvest).

Shelling percentage (%)

A composite sample of 100 g pods was drawn from the bulk of dry pods randomly and shelled. The ratio of kernel weight to pod weight was worked out and expressed in percentage.

$$\text{Shelling percentage (\%)} = \frac{\text{Kernel weight (g)}}{\text{Pod weight (g)}} \times 100$$

Protein content (%)

The groundnut oil seeds were made defatted on soxhlet and the protein content was by Kjeldahl method (AOAC, 2000).

Oil content in kernel (%)

The oil content was determined in percentage by using Bench top Nuclear Magnetic Resonance (NMR) Oxford MQC using the method as suggested by Yadav and Murthy (2016).

Fatty acid profile of groundnut oil

Approximately 60 g dried seeds were collected from each treatment were defatted using Soxhlet apparatus. The oil was converted to Fatty Acid Methyl Ester (FAME) using alkaline catalyzed trans-esterification using 4% KOH solution in methanol. The GC (Thermo-Trace ultra-A1 3000 Auto sampler) was programmed as, inlet temperature 210°C, FID detector temperature 260°C. Oven was kept at 160°C for 2 min. after that an increase of 10°C/min. was applied to raise oven temperature to 200°C, where it was kept at isotherm for 10 min. The gas flow rate in column was 1.5ml/min and the sample injection volume was 0.2 µl. The capillary was -TR fame-30 m × 0.25 mm ID × 0.25 µm film. Fatty acids composition of each treatment sample was estimated in percentage by using Chromcard Software associated with GC.

All the data obtained were statistically analyzed by using the Panse and Sukhatme (1985) procedure.

Results and Discussion

Effect on growth parameter

A perusal of data exhibited in Table 1 indicated that plant population per net plot at harvest was not significantly influenced due to different treatments. Plant height was measured at harvest in different treatments and the data indicated that significantly taller plants (58.3 cm) were observed with treatment RDF + NPK consortium (T₉) over control(T₁₀). Plant height under treatment RDF + NPK consortium (T₉) was at par with all other treatments except NPK consortium (T₈). This might be due to adequate supply of nutrients required for optimum growth and development of groundnut plants under different treatments. Microbial secretion of organic acid might helped in improving soil

conditions required for better root proliferation. Better availability of nutrients like nitrogen, phosphorus and potassium at early stages which in turn helped in better absorption and subsequent utilization of nutrients for synthesis of biomolecules, protein metabolism leading to more plant height. These results are in accordance with the findings of Der *et al.*, (2015).

Number of pods per plant was significantly higher with treatment RDF +NPK consortium (T₉) over control (T₁₀)and it was at par with the treatment RDF + 30 kg K₂O + KSB (T₆)and 75 % RDF + NPK consortium (T₇) over control T₁₀.

This might be due to improvement in vegetative structures for nutrient absorption and photosynthesis, strong sink strength through development of reproductive structures and production of assimilates under the influence of applied NPK consortium as well as KSB and other microorganisms. These results are in accordance with the findings of Chaudhary *et al.*, (2015).

Pod yield, haulm yield and harvest index (%)

Pod yield increased significantly under the treatment of NPK consortium in conjunction with RDF. Significantly higher pod yield (2872 kg/ha) of groundnut was produced under the treatment RDF + NPK consortium (T₉) as compared to rest of the treatments, but it remained at par with the treatment RDF + 30 kg K₂O + KSB (T₆)and 75 % RDF + NPK consortium (T₇).

Further, pronounced effect of NPK consortium on pod yield might be due to its ability to fix nitrogen, mobilize phosphorus and potassium as well as other beneficial hormones, enzymes and siderophores which might have helped in better nutrient uptake, optimum growth and

higher yield. These results are in accordance with the findings of Chandra *et al.*, (2006). Application of RDF + NPK consortium (T₉) registered significantly higher haulm yield (4274 kg/ha) over all other treatments (Table 2), but it was found at par with treatment T₄ (3761kg/ha), T₅ (3620kg/ha), T₆ (3914kg/ha) and T₇ (4050kg/ha). The treatments T₉,T₇,T₆,T₅and T₄ gave 41.66, 34.23, 29.73, 19.98 and 24.85 per cent higher haulm yield, respectively as compared to treatmentT₁₀.

Better growth environment created by microorganisms might be one of the most probable reasons for significantly higher haulm yield under treatment T₉,T₇,T₆,T₅and T₄. Kulkarni *et al.*,(2018) found similar results in groundnut.

The higher haulm yield in groundnut crop was attributed to the beneficial effect of readily available forms of nutrients to the crop which were supplied through foliar spray. These nutrients were directly absorbed by plant either through cuticle or stomata and might have participated in photosynthesis activity in leaves of plant leading to increased haulm yield.

Foliar spray of nutrients to the crop resulted in timely supply of optimum quantity of nutrients to the plant and their subsequent absorption by groundnut leaves resulting in better assimilation and translocation of nutrients (Mekki, 2015). Different treatments did not exert any significant effect on the harvest index.

Shelling percentage

The maximum shelling percentage of groundnut was noted under the treatment of 15 kg K₂O+KSB in conjunction with RDF(T₅) which was at par with the treatment T₁, T₂, T₃, T₄, T₆ andT₇. Further, noticeable effect KSB on shelling percentage might be due to its

ability to solubilize potassium as well as other hormones, enzymes and siderophores which might have helped in better potassium uptake, optimum growth and higher shelling percentage. These results are in accordance with the findings of Hemeid *et al.*, (2015).

Table.1 Growth and yield attributes of groundnut at harvest as influenced by different treatments

Treatments		Plant population	Plant height (cm)	Number of pod per plant
T ₁	: RDF (25 : 50 : 00 kg/ha)	161	50.0	24.0
T ₂	: RDF + KSB	159	52.0	24.3
T ₃	: RDF + 20 kg K ₂ O	162	54.3	25.0
T ₄	: RDF + 40 kg K ₂ O	160	54.3	26.0
T ₅	: RDF + 15 kg K ₂ O + KSB	163	54.7	25.7
T ₆	: RDF + 30 kg K ₂ O + KSB	161	53.7	27.0
T ₇	: 75 % RDF + NPK consortium	164	57.0	28.3
T ₈	: NPK consortium	159	49.7	23.7
T ₉	: RDF + NPK consortium	165	58.3	29.3
T ₁₀	: Absolute control	160	42.7	22.7
S.Em. ±		3.70	2.77	1.09
C.D. at 5 %		NS	8.24	3.25
C.V. %		3.97	9.13	7.4

Table.2 Pod yield, haulm yield, harvest index, kernel oil content and shelling percentage of groundnut as influenced by different treatments

Treatments		Pod yield (kg/ha)	Haulm yield (kg/ha)	Harvest index (%)	Shelling (%)
T ₁	: RDF (25:50:00 kg/ha)	2215	3384	39.38	67.07
T ₂	: RDF + KSB	2236	3414	39.60	67.20
T ₃	: RDF + 20 kg K ₂ O	2284	3501	39.63	68.67
T ₄	: RDF + 40 kg K ₂ O	2369	3761	38.73	68.03
T ₅	: RDF + 15 kg K ₂ O + KSB	2337	3620	39.34	69.23
T ₆	: RDF + 30 kg K ₂ O + KSB	2435	3914	38.52	68.23
T ₇	: 75 % RDF + NPK consortium	2529	4050	38.58	69.10
T ₈	: NPK consortium	2128	3271	39.61	63.17
T ₉	: RDF + NPK consortium	2872	4274	40.28	68.80
T ₁₀	: Absolute control	1904	3017	38.62	59.30
S.Em. ±		163.56	243.10	2.57	2.03
C.D. at 5 %		485.95	722.30	NS	6.04
C.V. %		12.15	11.63	11.36	5.27

Table.3 Kernel oil content and protein content of groundnut as influenced by different treatments

Treatments			Kernel oil (%)	Protein content (%)
T ₁	:	RDF (25:50:00 kg/ha)	47.30	21.63
T ₂	:	RDF + KSB	47.39	21.73
T ₃	:	RDF + 20 kg K ₂ O	48.23	22.19
T ₄	:	RDF + 40 kg K ₂ O	48.18	23.00
T ₅	:	RDF + 15 kg K ₂ O + KSB	48.25	22.63
T ₆	:	RDF + 30 kg K ₂ O + KSB	48.17	23.06
T ₇	:	75 % RDF + NPK consortium	48.31	23.13
T ₈	:	NPK consortium	46.41	21.13
T ₉	:	RDF + NPK consortium	48.35	23.23
T ₁₀	:	Absolute control	45.42	20.25
S.Em. ±			0.60	0.608
C.D. at 5 %			1.77	1.82
C.V. %			2.17	4.74

Table.4 Fatty acid profile (%) of groundnut as influenced by different treatments

Treatments	Fatty acid profile								
	Palmitic	Steric	Oleic	Linoleic	Linolenic	Arochidic	Gadoleic	Behenic	Lignoceric
T ₁ :RDF (25 : 50 : 00 kg/ha)	13.14	3.40	41.16	34.87	1.33	0.78	2.56	1.13	0.46
T ₂ :RDF + KSB	13.27	3.34	41.42	35.46	1.25	0.74	2.56	1.10	0.38
T ₃ :RDF + 20 kg K ₂ O	12.79	3.53	41.42	35.92	1.33	0.81	2.34	1.14	0.41
T ₄ :RDF + 40 kg K ₂ O	13.45	3.22	41.46	36.57	1.36	0.73	2.39	1.19	0.43
T ₅ :RDF + 15 kg K ₂ O + KSB	13.36	3.24	40.96	35.41	1.34	0.76	2.32	1.14	0.46
T ₆ :RDF + 30 kg K ₂ O + KSB	13.60	3.48	41.48	36.22	1.42	0.76	2.65	1.14	0.45
T ₇ :75 % RDF + NPK consortium	13.26	3.82	41.69	34.43	1.45	0.76	2.59	1.12	0.43
T ₈ :NPK consortium	13.54	3.23	41.68	36.83	1.14	0.74	2.11	1.15	0.43
T ₉ :RDF + NPK consortium	13.47	3.15	41.57	36.71	1.16	0.72	2.24	1.24	0.47
T ₁₀ :Absolute control	12.77	3.13	40.74	36.78	1.35	0.70	2.59	1.08	0.46
S.Em.±	0.33	0.17	0.83	0.93	0.07	0.03	0.12	0.04	0.02
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	4.31	8.72	3.46	4.50	9.66	7.07	8.66	5.62	7.34

Fig.1 Geographical location of Dantiwada in Gujarat (India)

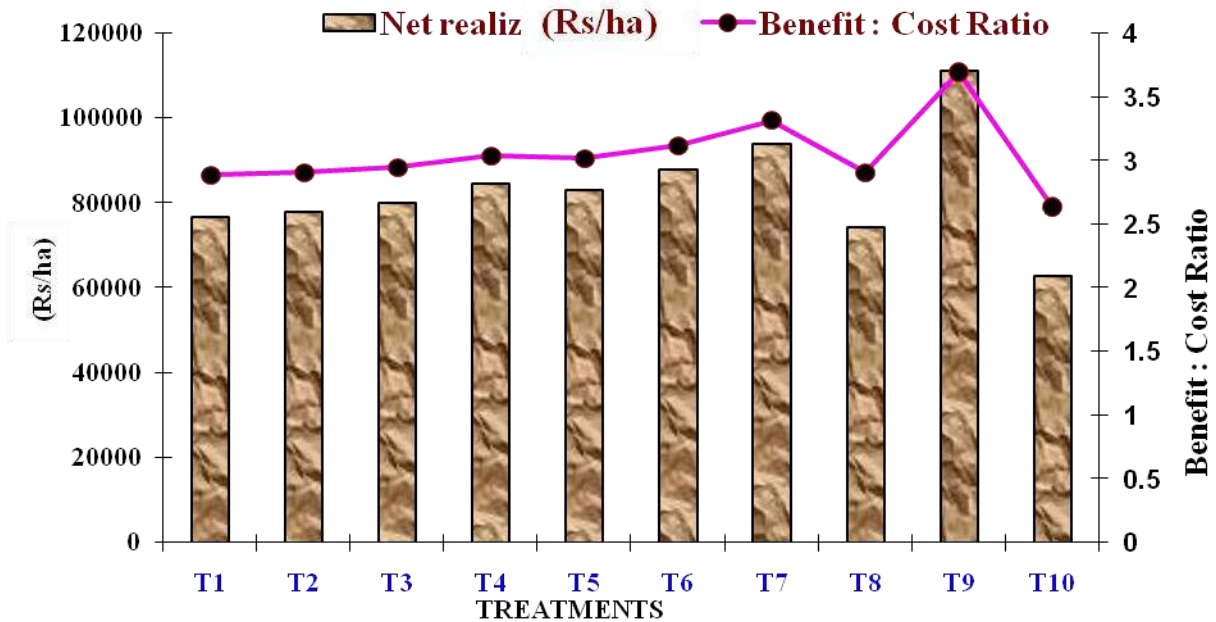
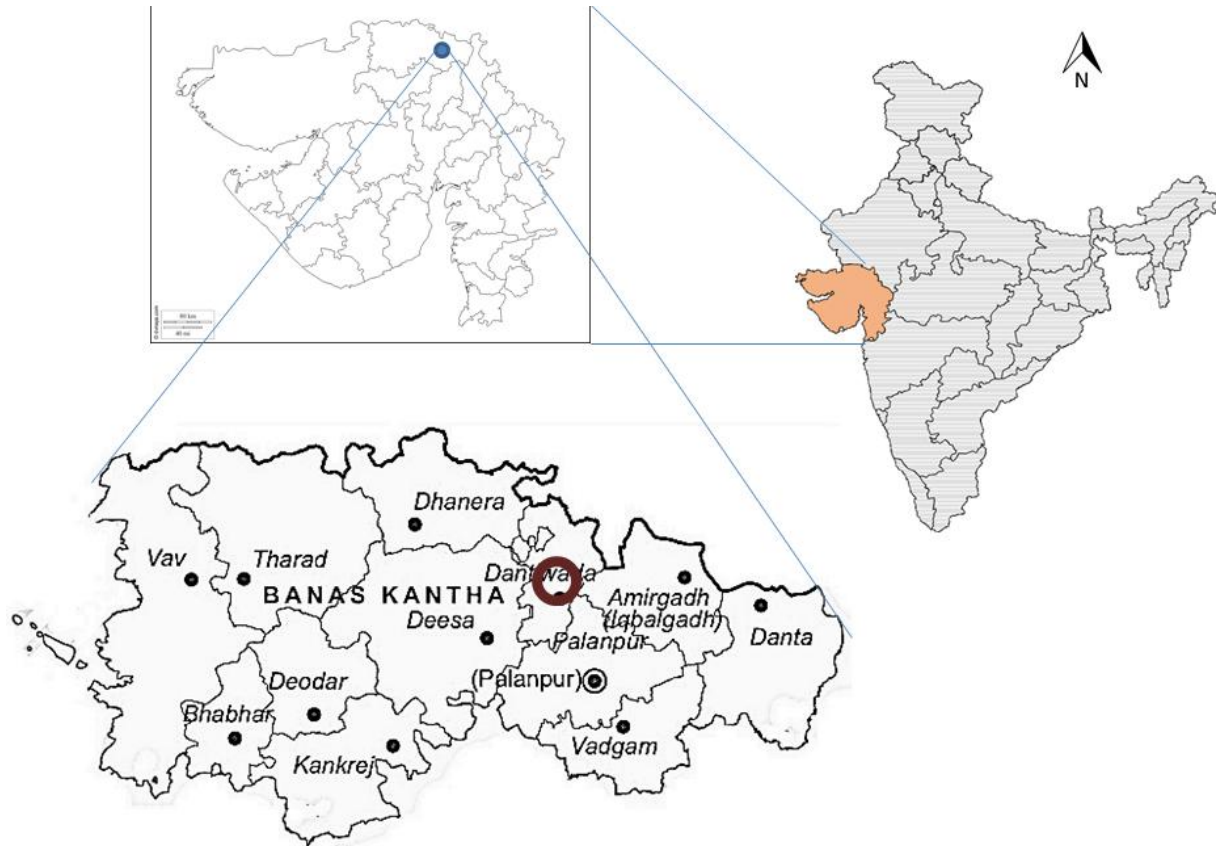


Fig. 2 : Economic of groundnut as influenced by different treatments

Oil and Protein content

Oil and protein contents of groundnut were significantly influenced by different potassium treatments (Table 3). Significantly higher oil content (48.35%) of groundnut was recorded under the treatment RDF + NPK consortium (T₉) over control (T₁₀) but it remained at par with the rest of the treatments except NPK consortium (T₈). The increase in oil content in groundnut kernels might be due to the enhanced activity of malic dehydrogenase enzyme which helps in the synthesis of fatty acids such as malate and oxaloacetate in groundnut, resulting in the enhanced oil content. These results are in accordance with the findings of Sanadi *et al.*, (2018).

Data presented in Table 3 revealed that different treatments highest protein content was found in treatment T₉ which was at par with all the treatments except treatment T₈ and T₁₀. Addition of nutrients through chemical fertilizer increased the protein content in groundnut kernel and was attributed to the role of potassium in facilitating the uptake as well as assimilation of nitrogen into simple amino acids and amides which enhanced the peptide synthesis and led to protein synthesis (Umar and Moinuddin, 2002).

Fatty acid profile

Under the present study, different treatments failed to exert significant response on fatty acid profile per cent in oil (Table 4). The main saturated fatty acids present in groundnut oil were palmitic acid 13.26 per cent and steric acid 3.35 per cent. The groundnut contained 41.36 per cent of oleic acid, which was monounsaturated fatty acid, 35.92 per cent linoleic acid and 1.31 per cent linolenic acid which were key polyunsaturated fatty acids of groundnut oil. The increase in oil content in groundnut kernels might be due to the enhanced activity of malic dehydrogenase

enzyme, which helps in the synthesis of fatty acids such as malate and oxaloacetate in groundnut kernels thus, resulting in the enhanced oil content. These results are in accordance with the findings of Dwivedi *et al.*, (1993) and Sanadi *et al.*, (2018).

Economics

Under the present study, the higher net realization of Rs 111063/ha was accrued with the treatment T₉ (RDF + NPK consortium), it was followed by treatment T₇ (Rs 94043/ha). The lowest net realization (Rs 62872/ha) was noticed under the treatment T₁₀ (Absolute control). Higher benefit: cost ratio of 3.70 was observed with treatment T₉ (RDF + NPK consortium) and followed by treatment T₇ (3.32). The lowest benefit: cost ratio of 2.64 was noted with the treatment T₁₀ (Absolute control) (Fig 2). This could be attributed to higher pod and haulm yield received in these treatments.

Therefore it can be inferred that from the foregoing results and discussion that significant increase in yield, oil content and protein content due to potassium application either in form of chemical fertilizer or potassium solubilizing bacteria. Considering benefit cost ratio, it seems that recommended dose of fertilizer along with microbial consortium (NPK) may be a better combination for sustainable groundnut production.

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