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Research Article

IMPACT OF DIFFERENT MICROBIAL CULTURES ON NUTRIENT UPTAKE AND QUALITY OF GROUNDNUT

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Abstract- Field experiment was conducted during summer season of 2014-15 on farmers field to study the effect of different microbial cultures on nutrient uptake and quality of groundnut. The results emerged out indicated that significant increase in nutrient content and uptake after harvest of crop was found highest with RDF + *Rhizobium* + *Pseudomonas striata*. However, P content was recorded highest with RDF + *Rhizobium* + *Bacillus megaterium*. Quality parameters such as test weight, protein and oil content were also improved with the inoculation of RDF + Rhizobium + *Pseudomonas striata* over only RDF + Rhizobium.

Keywords- Nutrient uptake, Groundnut, Microbial inoculants, Quality parameters

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Introduction

Groundnut is a good source of dietary proteins, minerals and vitamins. It is also known as poor man's almond. Its calorific value is 349 per hundred grams of seed. The residual oil cake contains 7 to 8 per cent of N, 1.5 per cent of P_2O_5 and 1.20 per cent of K_2O and hence it is used as a fertilizer. The cake is also used for making of reconstituted food because of its high protein content. Being a legume crop, it can fix atmospheric nitrogen and thereby improves soil fertility [15]. Microbial inoculants are cost effective, eco-friendly and renewable sources of plant nutrients. Rhizobium and PSB assume a great importance on account of their vital role in N_2-fixation and P-solubilization, the introduction of efficient strains of P-solubilizing species such as *Bacillus megaterium, Biovar phosphaticum, Bacillus polymyxa, Pseudomonas striata, Aspergillus awamori* and *Penicillium digitatum* in the rhizosphere of crops and soils has been reported to help in increasing phosphorus availability in the soil. Macro-nutrients such as nitrogen, phosphorus and potassium play a crucial role in plant growth and yield. In soil, both macro and micronutrients undergo a complex dynamic equilibrium of solubilization and insolubilization that is greatly influenced by the soil pH and microflora and that ultimately affects their accessibility to plant roots for absorption. At the same time, some of these organisms play a positive role in providing nitrogen, phosphorous, sulphur and other macro and micronutrients through their metabolic activities due to that the agriculturally important crops are benefited.

Therefore, present study was carried out considering the importance of microbial cultures in nutrient uptake and improving the quality of groundnut.

Material and Methods

The present investigation was carried out to study the effect of different microbial cultures on nutrient uptake and quality of Groundnut during summer season of 2014-15. The experiment was conducted at farmer's field in Kehal village, Tq. Jintoor, Dist. Parbhani. Total eight treatments of bioinoculants were replicated three times in RBD. The experiment consists of 8 treatments of laboratory tested P and Zn solubilizers T_1 RDF+ *Rhizobium*; T_2 RDF + *Rhizobium* + *Bacillus megaterium*; T_3 RDF + *Rhizobium* + *Burkholderia cepacia*; T_4 RDF + *Rhizobium* + *Burkholderia cenocepacia*; T_5 RDF + *Rhizobium* + *Pseudomonas fluorescens;* T_6 RDF + *Rhizobium* + *Pseudomonas striata;* T_7 RDF + *Rhizobium* + *Trichoderma viride;* T_8 RDF + *Rhizobium* + *Trichoderma* harzianum. Seed treatment was done before sowing with liquid bioinoculants each @ 100 ml 10 kg^{-1} seed. The crop was raised following recommended agronomic practices. The recommended dose of chemical fertilizers were applied @ 25:50:00 NPK kg ha^{-1} at the time of sowing. Intercultural operations like thinning, weeding, spraying of insecticides, fertilizer application and schedule of irrigation for groundnut crop was carefully followed. The crop variety used was TG 37A. Plant samples were collected after harvest for determination of nutrients concentration and uptake in groundnut. The nitrogen content in dry matter and grain was determined by Micro Kjeldhal's method [1]. Whereas, phosphorus was estimated spectrophotometrically by vanadomolybdate phosphoric acid yellow colour method [9]. Potassium content was determined from the diacid extract on flame photometer [10]. Sulphur was estimated by turbidimetric method from diacid extract as described by Tabatabai and Bremner [22]. The turbidity was measured on Spectrophotometer. Quality parameters such as test weight, protein content, protein yield, oil content and oil yield in groundnut was determined as per standard procedures. Statistical analysis done as per method obtained by Panse and Sukhatme [14].

Results and Discussion

Nutrient content and uptake of major nutrients

The content and uptake of major nutrients by groundnut was found to be enhanced with the different microbial inoculants [Table-1 and 2]. Highest N content and uptake in the kernel and haulm was found with RDF + *Rhizobium* + *Pseudomonas striata* over other treatments. But, as regards to N content in the kernel, treatment RDF + *Rhizobium* + *Trichoderma viride,* RDF + *Rhizobium* + *Pseudomonas fluorescens* and RDF + *Rhizobium* + *Trichoderma harzianum* were found to be statistically at par with RDF + *Rhizobium* + *Pseudomonas striata*. Whereas, total uptake of N was found maximum in treatment RDF + *Rhizobium* +

Pseudomonas striata which was found to be at par with RDF + *Rhizobium* + *Trichoderma viride* (191.83 kg ha^{-1}). The lowest value of N uptake by groundnut was recorded in RDF + *Rhizobium* only, which might be due to lower yields as compared to other treatment combinations. Our results are corresponding with the findings [11] who reported that highest N content and uptake due to seed inoculation with the native *Rhizobium* isolates in groundnut. However, Tanwar [23] revealed highest N content in grain and straw in the dual inoculation of *Bradyrhizobium* + PSB treatment in blackgram. Whereas, Singh and Pareek [19] noted that seed inoculation with *Rhizobium* + PSB had maximum content of N and found superior over control. The content and uptake of P by the groundnut crop was increased significantly with inoculation of *Rhizobium* + *Bacillus megaterium* along with recommended dose of fertilizer. But treatment RDF+ *Rhizobium* + *Pseudomonas striata* was found to be at par with it. It might due to the P solubilization effect of *Bacillus megaterium, which* is generally used as PSB in all the crops. Similar results were also reported by Mohapatra [12] reported that the combined application of inorganic fertilizer with FYM, *Rhizobium* stimulate the uptake of nutrient due to enhanced microbial and *Rhizobium* activity, the better root growth under congenial soil physical condition created by FYM. Further, Shiva Kumar [18] revealed that the increasing levels of P and seed inoculation with *Rhizobium* and PSB significantly increased P uptake in grain, stover and total in chickpea. Significant increase in content and uptake of K by groundnut with different microbial cultures. Highest K content and uptake was found with the inoculation of RDF + *Rhizobium* + *Pseudomonas striata*. The acid secretions by the microbial cultures might have acted on unavailable K in soil and made it more available for growing crops. Similar results were observed by Gupta [8] who found that seed inoculation with *Rhizobium* and PSB have higher N, P and K content in plant and seed in pigeon pea. Moreover, Bhunia [4] found that application of P @ 40 kg P_2O_5 ha^{-1} and seed inoculation with *Rhizobium* increased N, P and K uptake in fenugreek. Significant increase in content and uptake of S by groundnut with the inoculation of different microbial isolates. The highest values were noticed in RDF + *Rhizobium* + *Pseudomonas striata* whereas, RDF + *Rhizobium* + *Burkholderia cenocepacia* and RDF + *Rhizobium* + *Trichoderma harzianum* were found to be at par. The supply of S through SSP might be one of the reasons in increasing S uptake by the crop. Further, at the time of solubilization of P by microbes, the S might have oxidized and utilized by the groundnut crop. Similar finding were also reported by Singh [21] also found that the application of presumed @ 5 t ha^{-1} along with Rhizobium and PSB increased S content. The highest total uptake of S by groundnut was found with treatment, receiving 100% RDF + *Rhizobium* + *PSB, which* might be due to higher availability of the plant nutrients from the soil reservoir and additional quantity of the nutrients made available through bio-fertilizers.

Table-1 *Effect of different microbial cultures on nutrient content in Groundnut*

Treatment	Content (%)							
	N		P		K		S	
	Kernel	Haulm	Kernel	Haulm	Kernel	Haulm	Kernel	Haulm
T_1:RDF+*Rhizobium*	5.32	0.67	0.31	0.21	1.23	0.70	0.28	0.121
T_2:T1+*Bacillus megaterium*	5.32	0.72	0.58	0.48	1.18	0.74	0.30	0.123
T_3:T1+*Burkholderia cepacia*	5.36	0.74	0.36	0.30	1.32	0.76	0.30	0.125
T_4:T1+*Burkholderia cenocepacia*	5.42	0.85	0.45	0.39	1.46	0.76	0.32	0.138
T_5:T1+*Pseudomonas fluorescens*	5.53	0.74	0.52	0.32	1.40	0.69	0.28	0.132
T_6:T1+*Pseudomonas striata*	5.73	0.92	0.53	0.40	1.55	0.80	0.35	0.167
T_7:T1+*Trichoderma viride*	5.66	0.78	0.51	0.39	1.35	0.77	0.30	0.142
T_8:T1+*Trichoderma harzianum*	5.64	0.79	0.52	0.39	1.33	0.73	0.32	0.134
S.E.±	0.08	0.01	0.01	0.01	0.03	0.01	0.009	0.002
C.D. at 5 %	0.24	0.03	0.03	0.04	0.10	0.04	0.029	0.005
C.V. %	2.54	2.48	4.13	6.68	4.39	2.49	5.28	2.18

Table-2 *Effect of different microbial cultures on major nutrient uptake in Groundnut*

Treatment	Uptake (kg ha^{-1})											
	N			P			K			S		
	Kernel	Haulm	Total	Kernel	Haulm	Total	Kernel	Haulm	Total	Kernel	Haulm	Total
T_1:RDF+*Rhizobium*	119.72	21.52	141.24	7.37	6.44	13.81	25.93	21.63	47.56	2.85	3.73	6.58
T_2:T1+*Bacillus megaterium*	131.01	23.17	154.18	16.78	17.45	34.23	29.44	23.70	53.14	3.06	3.95	7.01
T_3:T1+*Burkholderia cepacia*	137.43	24.32	161.76	8.90	9.64	18.54	28.59	24.97	53.56	3.20	4.11	7.31
T_4:T1+*Burkholderia cenocepacia*	144.63	28.70	173.33	11.53	10.63	22.16	31.10	25.64	56.74	3.69	4.69	8.38
T_5:T1+*Pseudomonas fluorescens*	157.40	26.28	183.68	14.69	14.02	28.71	34.71	24.49	59.20	3.75	4.70	8.44
T_6:T1+*Pseudomonas striata*	164.73	33.42	198.15	15.17	14.34	31.51	36.62	28.95	65.43	4.87	6.08	10.95
T_7:T1+*Trichoderma viride*	163.78	28.06	191.83	13.67	13.22	26.89	35.48	27.46	64.08	4.07	5.10	9.17
T_8:T1+*Trichoderma harzianum*	157.05	27.69	184.74	14.59	13.65	28.24	36.49	25.58	62.52	3.72	4.69	8.41
S.E.±	3.24	0.59	3.74	0.46	0.46	0.46	0.83	0.50	1.23	0.09	0.10	0.20
C.D. at 5 %	9.84	1.82	11.35	1.95	1.40	2.01	2.54	1.52	3.75	0.30	0.32	0.62
C.V. %	3.82	3.89	3.73	6.26	6.42	4.54	4.46	3.44	3.71	4.67	3.95	4.26

Nutrient content and uptake of micronutrients

Micronutrient content and uptake of plant was also significantly improved with the inoculation of different microbial strains [Table-2]. The content and uptake of Fe, Zn, Mn and Cu by groundnut was also found to be significantly highest with the inoculation of RDF + *Rhizobium* + *Pseudomonas striata*. The microbes at the time of P solubilization also act on micronutrient cations and reduce them to their available form such as converting ferric iron to ferrous form, which might have made more Fe available to the crop leading to more content and uptake. Similar results were also reported by Daft [6] and Sadd [16] found that Fe in plant increased by mycorrhizae inoculation. Further, Chand and Somani [5] revealed that effective use of FYM, bio-fertilizers along with chemical fertilizers improved Fe and Zn content in mustard. These results are supported by the finding of Sharma [17]. Micronutrient uptake was significantly improved with the inoculation of different microbial strains such as Trichoderma viride, Bacillus megaterium over the control treatment. These results corroborate with Amalraj [2] studied nutrient solubilization efficiency, plant growth promoting traits and antagonistic effects of *Bacillus megaterium* and revealed that it also improved zinc (184 mg/100g dry mass), iron (743 mg/100g dry mass) and manganese (138 mg/100g dry mass) in the plant.

Grain quality attributes in groundnut

The data pertaining the quality attributes of groundnut are presented in [Table-3]. The results revealed that the significant effect of different microbial strains on test weight, oil content, oil yield, protein content and protein yield was observed. Treatment RDF+ *Rhizobium* + *Pseudomonas striata* was found to be significantly superior over other treatments in increasing test weight, oil content, oil yield,

protein content and protein yield. But in test weight, oil content, and oil yield treatment RDF+ *Rhizobium* + *Pseudomonas citrate* were found to be at par with RDF + *Rhizobium* + *Pseudomonas fluorescens* and RDF + *Rhizobium* + *Trichoderma harzianum.* Whereas, in protein content treatment RDF+ *Rhizobium* + *Pseudomonas striata* was found to be at par with treatment receiving RDF+ *Rhizobium* + *Trichoderma viride*. The microbial cultures acts as PGPR and make nutrients more available to the crops in a sustainable manner influencing more yields and improvement in quality attributes. Similar results were obtained by Singh and Pareek [19] who noted that inoculation of *Rhizobium* + PSB significantly increased protein content in mungbean. Further, Dhage [7] found that application of RDF + *Rhizobium* + PSB + foliar spray of 2% urea at various stages increased protein yield in chickpea. Whereas, Basu [3] revealed that the levels of cobalt and inoculation with *Rhizobium* significantly increased oil content in groundnut. Further, Zalate and Padmini [24] noted that seed inoculation with *Rhizobium* + PSM increased oil content in groundnut. Further, Singh and Sinsinwar [20] noted that increasing farmyard manure and N levels with biofertilizer increased the oil content positively and hence resulted in increasing trend in oil yield of mustard. Pandey and Khuswaha [13] noted that co-inoculation of *Rhizobium* + PSB along with 100% RDF recorded maximum 100 seed weight in pigeon pea.

Table-3 *Effect of different microbial cultures on micronutrient content in Groundnut*

Treatment	Content (mg/kg)							
	Fe		Zn		Mn		Cu	
	Kernel	Haulm	Kernel	Haulm	Kernel	Haulm	Kernel	Haulm
T_1:RDF+*Rhizobium*	188.00	125.00	48.33	26.40	73.10	32.60	28.97	15.73
T_2:T1+*Bacillus megaterium*	214.67	136.33	50.53	26.97	73.83	33.63	29.60	16.70
T_3:T1+*Burkholderia cepacia*	240.00	152.00	51.63	28.37	75.70	34.67	30.90	17.70
T_4:T1+*Burkholderia cenocepacia*	264.67	184.00	51.67	29.37	81.30	36.63	32.63	18.97
T_5:T1+*Pseudomonas fluorescens*	246.00	166.00	51.23	29.40	76.93	34.80	34.03	18.10
T_6:T1+*Pseudomonas striata*	286.33	215.00	56.87	34.57	84.93	42.17	38.63	22.47
T_7:T1+*Trichoderma viride*	270.33	178.00	54.57	32.80	81.10	40.0	37.43	21.80
T_8:T1+*Trichoderma harzianum*	272.67	181.67	53.90	28.77	80.17	34.30	31.83	19.10
S.E.±	4.0	5.16	0.69	0.42	1.24	0.47	0.44	0.15
C.D. at 5 %	12.14	15.68	2.09	1.28	3.78	1.44	1.30	0.47
C.V. %	2.84	5.35	2.31	2.48	2.76	2.31	2.33	1.47

Table-4 *Effect of different microbial cultures on micronutrient uptake in Groundnut*

Treatment	Uptake (g ha^{-1})											
	Fe			Zn			Mn			Cu		
	Kernel	Haulm	Total	Kernel	Haulm	Total	Kernel	Haulm	Total	Kernel	Haulm	Total
T_1:RDF+*Rhizobium*	442.43	383.53	825.96	113.59	81.12	194.71	17.18	10.02	27.20	6.82	4.83	11.65
T_2:T1+*Bacillus megaterium*	536.01	438.62	974.63	126.10	86.79	212.90	18.43	10.83	29.26	7.39	5.37	12.76
T_3:T1+*Burkholderia cepacia*	615.05	498.47	1113.53	132.32	93.20	225.52	19.40	11.39	30.79	7.92	5.82	13.73
T_4:T1+*Burkholderia cenocepacia*	704.90	623.43	1328.33	137.81	99.57	237.38	21.68	12.42	34.10	8.70	6.43	15.13
T_5:T1+*Pseudomonas fluorescens*	699.70	592.25	1291.96	145.71	104.86	250.57	21.84	12.41	34.25	9.68	6.46	16.14
T_6:T1+*Pseudomonas striata*	833.46	782.06	1615.53	165.50	125.60	291.10	24.72	15.32	40.04	10.99	8.16	19.12
T_7:T1+*Trichoderma viride*	730.52	638.04	1368.56	153.35	118.54	275.89	22.35	13.24	37.59	10.29	6.74	18.73
T_8:T1+*Trichoderma harzianum*	717.35	636.06	1353.41	144.45	100.87	245.32	22.32	12.03	34.35	8.86	6.70	15.56
S.E.±	19.67	18.04	29.34	3.44	2.10	5.52	0.58	0.32	0.86	0.25	0.13	0.36
C.D. at 5 %	59.68	54.74	89.03	10.45	6.37	16.75	1.79	0.98	2.63	0.78	0.40	1.12
C.V. %	5.16	5.45	4.12	4.28	3.60	3.97	4.86	4.59	4.53	4.98	3.66	4.20

Table=5 *Effect of different microbial cultures on grain quality attributes of Groundnut*

Treatment	Test wt. (g/100 seed)	Oil content (%)	Oil yield (kg ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})
T_1:RDF+*Rhizobium*	32.20	39.70	931.98	26.57	624.57
T_2:T1+*Bacillus megaterium*	33.42	40.67	1014.44	28.57	712.90
T_3:T1+*Burkholderia cepacia*	32.31	42.27	1081.63	27.63	708.22
T_4:T1+*Burkholderia cenocepacia*	32.61	42.37	1131.29	27.86	742.85
T_5:T1+*Pseudomonas fluorescens*	33.42	42.53	1209.13	28.41	807.83
T_6:T1+*Pseudomonas striata*	34.10	44.77	1279.73	29.42	851.42
T_7:T1+*Trichoderma viride*	34.03	43.33	1262.0	29.26	841.35
T_8:T1+*Trichoderma harzianum*	33.15	42.23	1174.99	28.13	783.10
S.E.±	0.47	1.27	39.47	0.20	17.47
C.D. at 5 %	1.44	3.86	119.7	0.61	53.00
C.V. %	2.49	5.23	6.02	1.23	3.99

Conclusion

From this field experiment, it can be concluded that, inoculation of microbial cultures has improved the nutrient content, nutrient uptake and quality of summer groundnut.

Conflict of Interest: None declared

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