RESPONSE OF SEED SIZE AND BIO-FERTILIZER ON YIELD, QUALITY, NUTRIENT CONTENT AND UPTAKE OF GROUNDNUT CROP UNDER RAINFED CONDITION

ABSTRACT

A field experiment was conducted during *kharif* season 2021 to study the effect of seed size and bio-fertilizers on yield, quality, nutrient content and uptake by the crop and available nutrients in soil after harvest of crop. The treatments include different categories of seed size viz., mixed (S_1), bold (S_2) and small seed size (S_3) and bio-fertilizer viz., control (B_1), *Rhizobium* + PSB + KMB (B_2) and *Trichoderma harzianum* + *Aspergillus niger* (B_3). Seed yield and haulm yield of groundnut were significantly increased by the treatments of seed size and biofertilizers. The crops sown with large seed size (1184 kg ha^{-1}) and bio-fertilizer with the treatment *Rhizobium* + PSB + KMB produced significantly higher seed yield (1227 kg ha^{-1}). Similarly, significantly higher haulm yield was also found in the treatment large seed (2442 kg ha^{-1}) and *Rhizobium* + PSB + KMB (2427 kg ha^{-1}). However, oil content and oil yield were found non-significant by seed size and bio-fertilizer. Significantly higher nutrient uptake by seed and haulm of crop obtained with the treatment bold seed and *Rhizobium* + PSB + KMB.

Key words: Groundnut, seed size, bio-fertilizer, yield, nutrient content and uptake.

INTRODUCTION

Groundnut [A*rachis hypogea* (L.)], of the family fabaceae is one of the most valuable legume crops grown as an annual whose remarkable characteristic is underground seed production. The use of high-quality seeds is essential for a successful crop production and food security. Crop yield and resource use efficiency depend on the successful plant establishment in the field, and seed vigour is what defines the ability to germinate and establish seedlings rapidly, uniformly and robustly, across diverse environmental conditions. Seed size is an important physical indicator of seed quality that affects the emergence, plant growth and performance of the crop in the field. Indeed, the sowing of mixed seeds of a species may result in a non-uniform stand establishment, what may lead to heterogeneity in the plant vigour and size. Bio-fertilizers can play an important role in meeting the nutrient

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requirement of crops through biological nitrogen fixation (BNF), solubilization of insoluble phosphorus sources (PSB), extend the nutrient absorption to zones not accessible to plant roots (VAM). Therefore, introduction of efficient strain of *Rhizobium* in the soil which is poor in nitrogen may be helpful in boosting up production and consequently more nitrogen fixation. Several bacteria belonging to genera pseudomonas and bacillus have the ability to solubilize inorganic phosphorus insoluble sources. Inoculation of seed with phosphate solubilizing bacteria (PSB) increases crop growth, nutrient availability, uptake and crop yield. In groundnut, seed cost constitutes nearly 30% of total cost of production and bio-fertilizer play important role in providing crop nutrient and better crop production. Hence, the present study was taken up to see the effect of seed size and bio-fertilizer used for sowing on growth and yield of *kharif* groundnut.

MATERIALS AND METHODS

The field experiment was conducted at the College Farm, Navsari Agricultural University, campus Bharuch (South Gujarat Agro Climatic Zone - I) in the Plot No. 12 during the kharif season of 2021. The soil is clayey in texture and slightly alkaline in reaction. The soil was low in available N (242.5 kg ha^{-1}), low in available P_2O_5 (26.2 kg ha^{-1}) and high in available K_2O (330.21 kg ha^{-1}).

The nine treatments were selected with four replicates and each consisted of a Mixed seed + control (T_1), Mixed seed + *Rhizobium* + PSB + KMB (T_2), Mixed seed + *Trichoderma harzianum* + *Aspergillus niger* (T_3) , Bold seed + Control (T_4), Bold seed + *Rhizobium* + PSB + KMB (T_5) Bold seed + *Trichoderma harzianum* + *Aspergillus niger* (T_6), Small seed + Control (T_7), Small seed + *Rhizobium* + PSB + KMB (T_8) and Small seed + *Trichoderma harzianum* + *Aspergillus niger* (T_9) with groundnut (GJG -22) crop having a plot size 4.5 x 3.6 m. The experiment was laid out in FRBD with 9 treatment combinations with four replications. After thorough field preparation initial soil samples were taken to analyze the initial soil properties. The initial soil sample was analyzed for available major nutrients; nitrogen (N), phosphorous (P), potassium (K) and sulphur (S), pH and EC of soil. The pH of the experimental field was 7.96, EC 0.29 dSm^{-1} and organic carbon was 0.26%. The N status of the experimental field was medium (242.5 kg ha^{-1}), medium in available P (26.20 kg ha^{-1}) and low in S (7.92 kg ha^{-1}) while available K status was in higher range (330.21 kg ha^{-1}). The entire dose of fertilizer was 12.5-25-00 N: P_2O_5: K_2O kg ha^{-1}. Groundnut variety GJG-22 was sown by line sowing at a distance of 45 x 10 cm. At harvest, seed and haulm yields were recorded. Plant samples were collected for chemical analysis of nitrogen, phosphorus, potassium and sulphur in seed and haulm samples. The nitrogen content in groundnut seed was estimated by micro alkaline permanganate oxidation method as described by Subbiah and Asija (1956). The oil content was determined by Soxhlet extraction method as per procedure. Chemical studies about nitrogen, phosphorus, potassium content and their uptake by seed and stover and available nitrogen, phosphorus, potassium status in the soil after harvest of the crop were determined as per different methods viz., Modified alkaline permanganate oxidation method (for N), Spectro photometric (for P) and Flame photometric method (for K). The data were analyzed statistically by adopting the standard procedures described by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Effect of seed size

Yield: It revealed that seed yield and haulm yield of groundnut was significantly influenced due to sowing with different seed sizes (Table 1). The crops sown with large seed size (1184 kg ha^{-1}) proved significantly higher yield which was at par with mixed seed size (1098 kg ha^{-1}). All the yield contributing characters showed their superiority over that of small seed size which finally resulted in increased pod yield of groundnut which in turn increased seed yield.

From the data it shows that significantly higher haulm yield was found in large seed (2442 kg ha^{-1}) which was at par with mixed seed size (2335 kg ha^{-1}). Similar results obtained by Sulochanamma and Reddy (2007).

Quality parameters: The data (Table 1) revealed that different size of seed failed to attain the level of significance for oil content in seeds. However, oil yield was influenced by seed size. The data regarding to the oil yield stated that oil yield is significantly higher with bold seed (595.73 kg ha^{-1}) which was at par with mixed seed size (546.28 kg ha^{-1}). Similar result was observed by Hossain *et al*. (2001).

Nutrient content and uptake: An appraisal of data given in Table 2 revealed that no significant difference was observed in nitrogen, phosphorus, potassium and sulphur content in seed and haulm due to different seed size. However, significantly higher nitrogen, phosphorus, potassium and sulphur uptake by seed and stover was obtained with the large seed followed by mixed seed (Table 3). Significantly more nitrogen (41.70 kg ha^{-1}), phosphorus (6.42 kg ha^{-1}), potassium (6.99 kg ha^{-1}) and sulphur (3.32 kg ha^{-1}) was obtained with large seed. Similarly, Table 3 indicated that large seed removed significantly higher N, P, K and S by haulm (38.82, 6.29, 15.67 and 8.69 kg ha^{-1}) which was at par with mixed seed size (36.85, 6.05, 14.3 and 8.10 kg ha^{-1} respectively). Similar result was recorded by Kang and Ofeimu (1993).

Available nutrient in soil after harvest: From the data (Table 4) it cleared that available N, P_2O_5, K_2O and S in soil was not significantly influenced by seed size. However, higher available N (266 kg ha^{-1}), P_2O_5 (26.63 kg ha^{-1}), K_2O (315 kg ha^{-1}) and S (7.94 kg ha^{-1}) in soil was estimated under large seed.

Effect of bio-fertilizer

Yield: The data covered in Table 1 revealed that seed yield of groundnut was significantly influenced due to various bio-fertilizer treatments. Application of *Rhizobium* + PSB + KMB produced significantly higher seed yield (1227 kg ha^{-1}) which was at par with the treatment *Trichoderma harzianum + Aspergillus niger* (1146 kg ha^{-1}). The overall improvement in all the growth and yield attributing components may be due to adequate supply of nutrients with easy availability to plant at most critical growth period resulted into better growth and yield attributing characters. The better growth of crop ultimately diverted more energy under sink source relationship which helped in providing more yield. This result corroborated with the findings of Jain and Trivedi (2005), Jaga and Sharma (2015) and Rajput and Pandey (2004). The effect of bio-fertilizer on the haulm yield shows significantly higher in the treatment *Rhizobium* + PSB + KMB (2427 kg ha^{-1}) which was at par with the treatment *Trichoderma harzianum* + *Aspergillus niger* (2346 kg ha^{-1}). Similar result recorded by Donga and Mathukia (2021), Bhutadiya *et al.* (2019) and Ruksar *et al.* (2017).

Quality parameters: The data (Table 1) revealed that oil content of groundnut did not respond significantly by bio-fertilizer treatments. However, oil yield of groundnut shows significant effect. Application of *Rhizobium* + PSB + KMB shows significantly higher oil yield (619.27 kg ha^{-1}) which was at par with the treatment *Trichoderma harzianum* + *Aspergillus niger* (571.22 kg ha^{-1}). Similar results were also reported by Jain and Trivedi (2005), Zalate and Padmani (2009) and Sheela *et al.* (2011)

Nutrient content and uptake: Data presented in Table 2 indicated that N, P, K and S content in seed and haulm was not influenced significantly by bio-fertilizer. Maximum N, P, K and S content (3.512, 0.542, 0.593 and 0.278 %, respectively) in seed and N, P, K and S content (1.606, 0.261, 0.649 and 0.354%, respectively) in haulm estimated with *Rhizobium* + PSB + KMB. The application of *Rhizobium* + PSB + KMB recorded significantly highest uptake of nitrogen (43.32 kg ha^{-1}), phosphorous (6.71 kg ha^{-1}), potassium (7.28 kg ha^{-1}) and sulphur (3.49 kg ha^{-1}) followed by the treatment *Trichoderma harzianum* + *Aspergillus niger* (Table 3). Similar result of nutrient uptake was reported by Patil *et al*. (2004), Sheela *et al*. (2011), Jaga and Sharma (2015), Kamdi *et al*. (2011) and Ipsita and Singh (2014).

Available nutrient in soil after harvest: The data furnished in Table 4 inferred that available N, P_2O_5, K_2O and S in soil was not significantly influenced by biofertilizer. However, highest available N (267 kg ha^{-1}), P_2O_5 (26.52 kg ha^{-1}), K_2O (318 kg ha^{-1}) and S (7.96 kg ha^{-1}) in soil was estimated under found in the treatment *Rhizobium* + PSB + KMB.

CONCLUSION

From the results, it is concluded that large seed size significantly increased the seed yield compared to other sizes. So, grading seed was economically becomes important operation getting higher yield and net profit of groundnut cultivar GJG-22. Whereas, the application of *Rhizobium* + PSB + KMB also play important role to increase the yield of groundnut and also reduce the cost of cultivation.

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Table 1: Effect seed size and bio-fertilizer on yield and quality of groundnut

Treatments	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})
(A) Seed size (S)				
S_1- Mixed	1098	2335	49.65	546.28
S_2- Bold seed	1184	2442	50.24	595.73
S_3- Small seed	1058	2174	49.06	521.38
S.Em. ±	32.89	69.00	0.64	18.55
CD at 5%	96.00	201.38	NS	54.14
(B) Bio-fertilizer (B)				
B_1 - Control	968	2177	48.78	472.89
B_2 - *Rhizobium* + PSB + KMB	1227	2427	50.38	619.27
B_3 - *Trichoderma harzianum* + *Aspergillus niger*	1146	2346	49.79	571.22
S.Em. ±	32.89	69.00	0.64	18.55
CD at 5 %	96.00	201.38	NS	54.14
Interaction (S x B)				
S.Em. ±	56.98	119.52	1.10	32.13
CD at 5 %	NS	NS	NS	NS

Table 2: Nutrient content of seed and haulm of groundnut as influenced by seed size and bio-fertilizer

Treatments	Nutrient content of seed and haulm (%)							
	Seed				**Haulm**			
	N	**P_2O_5**	**K_2O**	**S**	**N**	**P_2O_5**	**K_2O**	**S**
(A) Seed size (S)								
S_1- Mixed	3.493	0.535	0.590	0.275	1.579	0.258	0.634	0.349
S_2- Bold seed	3.512	0.542	0.593	0.278	1.590	0.259	0.643	0.354
S_3- Small seed	3.397	0.528	0.556	0.274	1.566	0.247	0.623	0.336
S.Em. ±	0.041	0.008	0.011	0.006	0.020	0.005	0.008	0.006
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
(B) Bio-fertilizer (B)								
B_1 - Control	3.382	0.517	0.556	0.265	1.538	0.244	0.618	0.333
B_2 - *Rhizobium* + PSB + KMB	3.528	0.546	0.594	0.285	1.606	0.261	0.649	0.354
B_3 - *Trichoderma harzianum* + *Aspergillus niger*	3.492	0.541	0.588	0.277	1.591	0.259	0.633	0.352
S.Em. ±	0.041	0.008	0.011	0.006	0.020	0.005	0.008	0.006
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (S x B)								
S.Em. ±	0.071	0.015	0.020	0.010	0.034	0.009	0.015	0.011
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Nutrient uptake by seed and haulm of groundnut as influenced by seed size and bio-fertilizer

Nutrient uptake by seed and haulm (kg ha^{-1})								
Treatments	**Seed**				**Haulm**			
	N	**P_2O_5**	**K_2O**	**S**	**N**	**P_2O_5**	**K_2O**	**S**
(A) Seed size (S)								
S_1- Mixed	38.54	5.90	6.53	3.01	36.85	6.05	14.83	8.10
S_2- Bold seed	41.70	6.42	6.99	3.32	38.82	6.29	15.67	8.69
S_3- Small seed	35.95	5.56	5.87	2.90	34.08	5.35	13.54	7.30
S.Em. ±	1.23	0.20	0.19	0.11	1.08	0.19	0.43	0.22
CD at 5%	3.60	0.61	0.57	0.32	3.17	0.56	1.28	0.64
(B) Bio-fertilizer (B)								
B_1 - Control	32.80	4.98	5.37	2.56	33.42	5.35	13.46	7.25
B_2 - *Rhizobium* + PSB + KMB	43.32	6.71	7.28	3.49	39.01	6.35	15.78	8.61
B_3 - *Trichoderma harzianum* + *Aspergillus niger*	40.06	6.19	6.73	3.17	37.33	5.99	14.81	8.24
S.Em. ±	1.23	0.20	0.19	0.11	1.08	0.19	0.43	0.22
CD at 5 %	3.60	0.61	0.57	0.32	3.17	0.56	1.28	0.64
Interaction (S x B)								
S.Em. ±	2.13	0.36	0.34	0.19	1.88	0.33	0.76	0.38
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS

Table 4: Available nutrient status of soil by groundnut as influenced by seed size and bio-fertilizer

Available nutrient status of soil by groundnut (kg ha^{-1})				
Treatments	**N**	**P_2O_5**	**K_2O**	**S**
(A) Seed size (S)				
S_1- Mixed	265	26.20	312	7.77
S_2- Bold seed	266	26.63	315	7.94
S_3- Small seed	264	25.85	311	7.72
S.Em. ±	3.242	0.389	3.198	0.132
CD at 5%	NS	NS	NS	NS
(B) Bio-fertilizer (B)				
B_1 - Control	264	25.91	307	7.58
B_2 - *Rhizobium* + PSB + KMB	267	26.52	318	7.96
B_3 - *Trichoderma harzianum* + *Aspergillus niger*	265	26.24	312	7.89
S.Em. ±	3.242	0.389	3.198	0.132
CD at 5 %	NS	NS	NS	NS
Interaction (S x B)				
S.Em. ±	5.616	0.674	5.540	0.228
CD at 5 %	NS	NS	NS	NS