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Growth, yield and quality of Kharif groundnut (*Arachis hypogaea* L.) as affected by different levels of nitrogen, potassium and zinc in lateritic soils of Konkan

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Abstract

The present investigation entitled “Growth, Yield and Quality of Kharif Groundnut (*Arachis hypogaea* L.) as affected by different levels of nitrogen, potassium and zinc in lateritic soils of Konkan” was conducted at Irrigation Scheme, Pangari Block of CES, Wakawali during *Kharif* season of 2012 and 2013. The field experiment was laid out in split-split plot design comprising of 27 treatment combinations replicated in thrice. Main plots consisting of three levels of nitrogen (12.5, 25 and 50 kg N ha^{-1}). In sub plot, treatment comprised of three levels of potassium (15, 30 and 45 kg K_2O ha^{-1}) and sub-sub plot treatment comprised of three levels of zinc application (2.5, 5.0 and 7.5 kg Zn ha^{-1}). The application of nitrogen, potassium and zinc at various levels showed significant influence on growth and yield attributing characters *viz.*, height of plant, shelling percentage and test weight in groundnut. The pod and haulm yield of groundnut as well as quality parameters like protein, oil methionine in kernel were recorded higher by the treatment N_3 (50 kg N ha^{-1}), K_3 (45 kg K_2O ha^{-1}) and Zn_3 (7.5 kg Zn ha^{-1}) treatment respectively.

Keywords: Nitrogen, potassium, zinc, groundnut, yield, protein

Introduction

India is one of the largest producers of oilseeds in the world and occupies an important position in the Indian agricultural economy. Among the oil seed crops, groundnut (*Arachis hypogaea* L.) is an important crop both for oil and food. Groundnut is called as the ‘King’ of oilseeds. It is one of the most important food and cash crops of our country. In India, groundnut is known as poor man’s almond. In India, groundnut is grown on 4.56 million hectare and production of 6.77 million tonnes with an average productivity of 1486 kg ha^{-1} (DAC and FW, 2016) [3]. Nitrogen is the major nutrient that enhances the metabolic processes that lead to increase in vegetative, reproductive growth and yield of the crop. Furthermore, N fertilizer application affects dry matter production as well as N accumulation and partitioning into various parts of crop plants for the growth, development and other processes (Khaliq and Cheema, 2005) [9]. Potassium has long been sidelined in the crop nutrition especially in the leguminous crop where biological N-fixation is shown to be improved with potassium application. Potassium, the most abundant elements in soil is particularly important in crop physiology as it is involved in the transport of assimilates, activation of many enzymes, in the water economy of the plants and in photosynthesis. However, recent findings revealed the strong linkage (positive interaction) between N and K which suggests the possible synergistic role of K in N-nutrition of crop (Singh and Singh, 2013) [16]. The role of zinc in increasing the crop yields has been well established. Since, zinc is an important micronutrient reported deficient in Indian soils. As a part of balance nutrition an adequate supply of micronutrient especially of Zn is of paramount importance. Zinc deficiency in crop plants is a wide spread nutritional disorder in a variety of soils. Zinc plays significant role in various enzymatic and physiological activities of the plant (Jeetarwal, 2015) [8]. So keeping in view the above facts, the present’s investigation has been planned to evaluate the comparative performance of groundnut under exiting climatic condition and also to study their response of various levels of N, K and Zn.

Materials and Methods

A field experiment was conducted for two Kharif seasons of 2012-13 to 2013-14 at Pangari Block, Central Experiment Station, Wakawali, of Dr. B.S.K.K.V., Dapoli with groundnut

(Var. *Konkan Gaurav*) as test crop in a permanent layout at a fixed location. The treatments were three nitrogen levels (12.5, 25 and 50 kg N ha^{-1}), three levels of potassium (15, 30 and 45 kg ha^{-1}) and three levels of zinc (2.5, 5 and 7.5 kg ha^{-1}). There were total 81 plots in an experimental unit and 27 plots in each replication. In main plot comprised three levels of nitrogen. However, sub plot consisted of three levels of potassium and sub-sub plot consisted three levels of zinc. The plots of 3.9 x 2.4 m were prepared and demarked manually.

After the preparation of plots, FYM was added @ 5 t ha^{-1} as common to all treatments. Nitrogen was applied in two splits *viz.*, first dose of 50 per cent N at the time of sowing and second dose of 50 per cent at flowering stage in the pertinent treatments. Phosphorus @ 50 kg ha^{-1}, potassium and zinc were applied in a single dose at the time of sowing in the pertinent treatments. Inoculation of groundnut seeds with biofertilizers (*Rhizobium*+PSB) was done before sowing and after drying in shed, sowing was done. The groundnut variety 'Konkan Gaurav' was sown manually in rows at 4-5 cm depth using 150 kg seed rate with 30 x 15 cm spacing, when the soil was in *vapsa* condition. Various growth and yield attributing characters of the crop were measured at peg initiation, pod formation and after harvest of crop and studied during the course of investigations. Other management practices were followed as recommended. The data recorded on each character were analyzed by the ANOVA technique as described by Panse and Sukhatme (1967) [11].

Results and Discussion

The results obtained from the present investigation are summarized below:

Effect of different levels of N

Plant height showed significant differences among the different graded levels of nitrogen at peg initiation stage and at harvest are presented in Table 1 during the couple of year. The treatment N_3 (50 kg N ha^{-1}) observed significantly highest plant height at pod formation and after harvest stage in of both year. The application of graded levels of nitrogen showed non-significant results, with respect to the number of branches in both year. While in the year 2013, application of 50 kg N ha^{-1} (N_3) recorded highest number of branches per plant (9.27) which was significantly superior over rest of all the nitrogen treatments. The application of different levels of nitrogen increased the plant height may due to nitrogen at higher level might have accelerated photosynthetic activity by increasing the source size (plant height and branches), thereby providing the developing bud with more photosynthates, which might have resulted in increased in cell division and cell expansion and increased height of crop. The results are in conformity with those obtained by Thakare *et al.* (2003) [18], Chandra *et al.* (2006) [2] and Elayaraja and Singaravel (2012) [5] in groundnut.

From the data (Table 2) it was revealed that treatment (N_2) was recorded highest shelling percentage i.e. 79.89% and 82.14% during the year 2012 and 2013, respectively and found to be statistically superior over rest of all treatments. The treatment N_3 (50 kg N ha^{-1}) and N_2 (25 kg N ha^{-1}) were recorded highest 100 kernel weight of groundnut in the year of 2012 and 2013 respectively. The basic fact that the nitrogen being a major constituents of cell division and cell elongation which might have ultimately increased plat growth (Patel *et al*., 2014) [12]. The perusal of results showed that the significantly highest haulm and pod yield of groundnut were recorded during the year 2012 and 2013, respectively with the treatment N_3 receiving 50 kg N ha^{-1} and which was found significantly superior over rest of all the treatments.

Among the various treatments, nitrogen application @ 50 kg N ha^{-1} (N_3) were recorded significantly highest all quality parameters in kernel during the year 2012 and 2013, respectively and which were found significantly superior over rest of all the treatments (Table 3). Increased protein content may be due to increased transfer of N from haulm to kernel due to application of K. This may due to the under high N supply, a large proportion of photosynthesis may have diverted to protein formation leaving a potential deficiency of carbohydrate to be degraded to 'acetyl co-enzyme A' for the synthesis of fatty acids. Further fact that synthesis of fatty acids in plants occurs through conversion of 'acetyl co-enzyme A' to 'malonyl coenzyme A' in presence of ATP and phosphate (Kumawat *et al.*, 2014) [10].

Table 1: Effect of different levels of N, K and Zn on height and branches of groundnut at different growth stages

Treatment	Height of groundnut (cm)				Number of branches per plant			
	PI		AH		PI		AH	
	2012	2013	2012	2013	2012	2013	2012	2013
Nitrogen Levels								
N_1:12.5 kg ha^{-1}	38.62	31.83	55.62	51.60	8.73	6.73	11.05	10.45
N_2:25.0 kg ha^{-1}	41.10	32.57	61.48	52.67	8.44	8.49	11.28	10.58
N_3:50.0 kg ha^{-1}	41.16	33.31	63.89	55.74	7.74	9.27	11.90	11.30
S.E±	0.44	0.23	0.93	0.72	0.29	0.17	0.31	0.30
C.D. at 5%	1.74	0.92	3.66	2.84	N.S	0.69	N.S	N.S
Potassium Levels								
K_1:15 kg ha^{-1}	39.00	32.05	58.56	53.11	8.03	7.59	11.63	10.62
K_2:30 kg ha^{-1}	41.05	32.73	60.29	52.02	8.18	8.41	11.23	10.84
K_3:45 kg ha^{-1}	40.83	32.93	62.14	54.89	8.70	8.49	11.37	10.86
S.E±	0.34	0.20	0.81	0.39	0.16	0.17	0.30	0.32
C.D. at 5%	1.05	0.62	2.51	1.20	0.51	0.54	N.S	N.S
Zinc Levels								
Zn_1:2.5 kg ha^{-1}	39.31	32.32	60.42	54.05	8.03	7.72	11.30	10.49
Zn_2:5.0 kg ha^{-1}	39.84	32.60	60.15	53.49	8.40	8.21	11.48	10.85
Zn_3:7.5 kg ha^{-1}	41.73	32.78	60.43	52.48	8.49	8.57	11.46	10.98
S.E±	0.37	0.31	0.58	0.90	0.12	0.14	0.31	0.32
C.D. at 5%	1.05	N.S	N.S	N.S	0.33	0.40	N.S	N.S

Table 2: Effect of different levels of N, K and Zn on yield and yield attributes of groundnut

Treatment	Yield attributing characters							
	Shelling (%)		100 seed weight (g)		Yield (q ha^{-1})			
					Haulm (q ha^{-1})		Pod (q ha^{-1})	
	2012	2013	2012	2013	2012	2013	2012	2013
Nitrogen Levels								
N_1:12.5 kg ha^{-1}	78.54	80.75	46.63	47.69	41.04	32.87	18.42	19.67
N_2:25.0 kg ha^{-1}	79.89	82.14	47.46	48.94	42.52	38.20	22.77	25.11
N_3:50.0 kg ha^{-1}	78.12	80.32	48.12	48.76	44.54	39.63	23.76	28.18
S.E$\pm$	0.29	0.29	0.21	0.15	0.62	0.26	0.17	0.39
C.D. at 5%	1.14	1.16	0.81	0.61	2.45	1.03	0.68	1.54
Potassium Levels								
K_1:15 kg ha^{-1}	78.21	80.42	46.86	48.02	40.68	35.90	21.08	22.77
K_2:30 kg ha^{-1}	79.51	81.75	47.64	48.81	43.54	36.16	22.49	24.88
K_3:45 kg ha^{-1}	78.82	81.04	47.71	48.56	43.88	38.65	21.38	25.32
S.E$\pm$	0.27	0.28	0.19	0.21	0.58	0.40	0.19	0.27
C.D. at 5%	0.83	0.86	0.58	0.63	1.79	1.24	0.58	0.82
Zinc Levels								
Zn_1:2.5 kg ha^{-1}	78.27	80.48	46.43	47.70	41.92	35.80	21.60	24.05
Zn_2:5.0 kg ha^{-1}	78.88	81.11	47.74	48.91	42.56	37.27	21.65	23.93
Zn_3:7.5 kg ha^{-1}	79.39	81.62	48.03	48.77	43.62	37.64	21.69	24.98
S.E$\pm$	0.31	0.31	0.30	0.23	0.38	0.21	0.25	0.20
C.D. at 5%	0.86	0.90	0.86	0.65	1.08	0.62	0.72	0.59

Table 3: Effect of different levels of N, K and Zn on quality parameters of groundnut

Treatment	Protein (%)		Protein yield (kg ha^{-1})		Oil (%)		Oil yield (kg ha^{-1})		Methionine content (%)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Nitrogen Levels										
N_1:12.5 kg ha^{-1}	21.38	22.57	309.8	359.2	40.82	40.20	591.1	639.7	0.348	0.337
N_2:25.0 kg ha^{-1}	24.67	25.80	449.4	533.6	43.84	41.69	798.9	863.6	0.358	0.354
N_3:50.0 kg ha^{-1}	29.34	30.75	544.0	696.7	48.30	49.78	894.0	1131.2	0.368	0.389
S.E$\pm$	0.09	0.13	3.2	9.4	0.75	1.26	17.6	37.3	0.001	0.006
C.D. at 5%	0.35	0.53	12.7	36.7	2.93	4.95	68.9	146.4	0.004	0.024
Potassium Levels										
K_1:15 kg ha^{-1}	23.98	25.18	401.9	470.0	42.23	41.48	700.7	769.2	0.354	0.356
K_2:30 kg ha^{-1}	25.22	26.41	457.6	546.8	44.62	44.01	803.1	906.1	0.358	0.357
K_3:45 kg ha^{-1}	26.20	27.53	443.8	572.8	46.12	46.18	780.2	959.2	0.362	0.368
S.E$\pm$	0.10	0.09	2.7	5.3	0.58	0.67	10.5	16.5	0.002	0.004
C.D. at 5%	0.30	0.29	8.2	16.5	1.79	2.06	32.4	50.9	N.S	N.S
Zinc Levels										
Zn_1:2.5 kg ha^{-1}	25.01	26.25	428.2	517.2	43.58	39.31	740.6	768.6	0.346	0.321
Zn_2:5.0 kg ha^{-1}	25.13	26.37	435.2	522.3	43.76	44.37	751.6	873.6	0.359	0.366
Zn_3:7.5 kg ha^{-1}	25.25	26.50	439.8	550.0	45.63	47.98	791.9	992.3	0.369	0.394
S.E$\pm$	0.10	0.11	6.4	5.6	0.53	0.77	13.5	18.9	0.002	0.007
C.D. at 5%	N.S	N.S	N.S	N.S	1.51	2.20	38.7	54.3	0.006	0.019

Effect of different levels of K

In the year 2012 and 2013 the maximum plant height at peg initiation stage were noted with treatment K_2 and treatment K_3 respectively (Table 1). While at harvest stage, it was observed that the maximum plant height were recorded in treatment K_3 i.e. (45 kg K_2O ha^{-1}) in of both year. The data shows that the different levels of K did not show any significant effect on number of branches at harvest stage only at peg initiation stage the highest number of branches per plant were observed in the treatment K_3 (45 kg K_2O ha^{-1}) and which found significantly superior over rest of the treatments in both year. Significant increase in plant height could be attributed to the fact that potassium enhances plant vigour and strengthens the stalk, further it has synergistic effect with nitrogen and phosphorous resulted in better plant growth and more number of branches per plant (Goud *et al.*, 2014) [6].

The shelling percentage and test weight were significantly influenced due to application of potassium @ 30 kg ha^{-1} and recorded highest in treatment K_2 in couple of year (Table 2). Potassium is involved in physiological and biochemical function of plant growth i.e. enzyme activation and synthesis which causes the increase in kernel size which directly increases kernel weight (Salve *et al.*, 2010) [14]. A glance look on data showed that the haulm and pod yield of groundnut as influenced by various treatments of potassium. The application of potassium @ 45 kg K_2O ha^{-1} (K_3) were recorded significant higher haulm yield (43.88 q ha^{-1}) and (38.65 q ha^{-1}) as compare to other treatments during the year 2012 and 2013, respectively. The highest pod yield (22.49 q ha^{-1}) was recorded in treatment K_2 (30 kg K_2O ha^{-1}) and which was significantly superior over the rest of treatment in year 2012. Whereas, in the year of 2013 application of 45 kg K_2O ha^{-1} (K_3) recorded higher pod yield (25.32 q ha^{-1}) and it was on par with treatment (K_2) receiving K_2O @ 30 kg ha^{-1}. This increase in yield is in accordance with essential requirement for K in plant biochemistry and physiology, in processes including photosynthesis, water relationships, protein synthesis and the requirement for K in at least 60 different enzyme systems within the plant. Similar results showing the benefit of K on crop yield have also been reported by Trivedi *et al.* (2013) [19].

Among the various treatments, application of potassium @ 45 kg K_2O ha^{-1} (K_3) was recorded significantly highest all quality parameters in kernel during the year 2012 and 2013, respectively except methionine content in groundnut showed non-significant results. The increase in the oil content might have been due to requirement of K in carbohydrate synthesis from which fat is formed. These results were in accordance with earlier results reports by Patra *et al.* (1995) [13] and Saxena *et al*. (2003) [15] in groundnut.

Effect of different levels of Zn

Increases in plant height and number of branches was observed with increasing levels of applied zinc (Table 1). In year 2012, the significantly maximum plant height (41.73 cm) was noted at peg initiation stage by application of Zn @ 7.5 kg ha^{-1} (Zn_3) and which was significantly superior over rest of all treatments. On other hand, the different levels of zinc application statistically did not affect the plant height at other growth stages. At peg initiation stage, application of zinc @ 7.5 kg ha^{-1} (Zn_3) showed highest number of branches per plant in the both of year. While at harvest stage, the application of Zn showed non-significant results with respect to the number of branches. The improvement in number of branches per plant might due to the fact that zinc is an essential component of several enzyme and plays an important role in nitrogen metabolisms and increase the uptake of nitrogen in plant, resulting in increased amino acid and protein synthesis in cell of plant, causing better growth (Singhal *et al*., 2014) [17].

The highest shelling percentage (79.39 and 81.62%), haulm yield (43.62 and 37.64 q ha^{-1}) and pod yield (21.69 and 24.98 q ha^{-1}) were recorded in treatment Zn_3 (7.5 kg Zn ha^{-1}) followed by treatment Zn_2 (5 kg Zn ha^{-1}) which was at par with each other (Table 2). The increase in yield might be due to role of zinc in biosynthesis of indole acetic acid (IAA) and especially due to its role in initiation of primordial for reproductive parts and partitioning of photosynthates towards them, which resulted in better flowering and fruiting. The findings of present investigation are supported by (Jat and Mehra, 2007) [7]. The maximum 100 kernel weight of groundnut (48.03 and 48.91 g) were noted with treatment Zn_3 (7.5 kg Zn ha^{-1}) and treatment Zn_2 (5 kg Zn ha^{-1}) in the year 2012 and 2013, respectively.

The presented results (Table 3) clearly indicated that the application of different levels of zinc did not significantly affected on the protein content and protein yield in groundnut. The treatment Zn_3 (7.5 kg Zn ha^{-1}) has recorded significantly highest oil content (45.63 and 47.98 %) and oil yield (791.9 and 992.3 kg ha^{-1}) in groundnut kernel during the year 2012 and 2013, respectively and which were recorded superior over rest of the treatments. The application of zinc increases the oil percentage in groundnut crop may due to the zinc functions in plants largely as a metal activator of enzymes like cysteine desulphydrases, dihydropeptidase, glycylgycine, dipeptidase etc. Thus, addition of zinc might have activated the enzymes responsible for the production of oil, and caused higher oil content (Dev and Khandelwal, 2009) [4]. The treatment receiving zinc @ 7.5 kg Zn ha^{-1} (Zn_3) recorded significantly highest methionine content (0.369% and 0.394%) in kernel during the year 2012 and 2013, respectively and which were found superior over rest of all the treatments. Bharti *et al.*, (2013) [1] reported that the increased efficiency of the protein synthesis is manifested in the increase in its structural components which include the amino acids such as lysine, tryptophan and methionine.

Conclusion

On the basis of foregoing results are concluded as the application of various levels N, K and Zn showed significant positive influence on growth and yield attributing characters *viz*., height of plant, shelling percentage and test weight in groundnut. The pod and haulm yield of groundnut as well as the maximum quality parameters like protein content, protein yield, oil content, oil yield and methionine in kernel were recorded higher by the treatment N_3 (50 kg N ha^{-1}), treatment K_3 (45 kg K_2O ha^{-1}) and treatment Zn_3 (7.5 kg Zn ha^{-1}) in both of years.

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