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Yield maximization of winter groundnut (*Arachis hypogaea* L.) through integrated input management under polythene mulch in the Konkan region of Maharashtra

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SUMMARY

The field experiment was conducted at Agronomy Department Farm, College of Agriculture, Dapoli, MS on the lateritic soil to study the role of different components of production technology of groundnut (*Arachis hypogaea* L.) under polythene mulch. The factors considered were *viz*., improved varieties, seed beds, nutrition levels and plant growth regulator. Results revealed that the groundnut genotypes TG 26 and JL 24 equally proved better for yield and quality of groundnut in lateritic soils of Konkan. TG 26 and JL 24 recorded 51 q ha^{-1} and 53 q ha^{-1} dry pod yields, respectively. JL 24 also showed good promise for higher haulm yield in addition to yield and quality. The values of yield and yield attributing characters *viz*., dry pods, kernels, oil and haulm yield, mean number of mature pods per hill, mean weight of pods per hill, 100-pod weight, 100-kernel weight and harvest index and nutrient content and uptake were considerably higher due to application of 50:100:70 kg N, P_2O_5 and Ca /ha (N_3) and 75:150:105 kg N, P_2O_5 and Ca /ha (N_4) than the other treatments under study. Polythene mulched *Rabi* groundnut gave equal pod and haulm yield on both the seed beds *viz*., flat bed and broad bed furrow (BBF). Mean dry pod yield of 51.5 and 52.8 q ha^{-1}, dry haulm yield of 57.9 and 56.7 q ha^{-1}, kernel yield of 38.3 and 39.2 q ha^{-1} and oil yield of 18.7 and 19.2 q ha^{-1} was recorded under FB and BBF, respectively. A foliar application of growth regulator *i.e.* paclobutrazol @ 60 ppm at 25 days after initiation of first flower roughly 52 to 58 days after sowing during *Rabi* season proved better in reducing excessive vegetative growth ultimately reflecting in increased the yield of groundnut. The dry pod, kernel and oil yield was increased significantly due to application of paclobutrazol.

Key words : Groundnut, Polythene mulch, Genotypes, Nutrients, Seed beds, Paclobutrazol

Groundnut is one of the world's staple oil, food and industrial crops and it is grown in about 23.77 million ha in the world extending from tropical to temperate zones in about 100 countries. India is the third largest edible oil producing country in the world after the U.S. and China. The impact of groundnut crop in the oilseed scenario of India and its reflection on the country's economy has been highly significant. Groundnut is dominating other oilseeds of the country by sharing 35 to 45 % of the total area under oilseeds and 45 to 55 % of the total oilseeds production.

Groundnut is grown in the post rainy (*Rabi* / summer) season in about 1.5 million ha with assured moisture with an average yield of 1.5 to 2.0 t ha^{-1}.

Konkan region has the potential for non-traditional area, where groundnut can be grown in both the rainy and the post rainy seasons with the productivity range of 2.0 to 3.0 t ha^{-1}. (Bandopadhhyay and Desai, 2000)

On the global basis, major abiotic stresses, drought, temperature extremes, mineral nutrient deficiencies are most important (Johansen and Nageswara Rao, 1996).

Among the environmental factors, temperature is the most important factor for proper development of crop. Low temperature <18^{0}C in the *Rabi*-hot season at the time of sowing affects germination, whereas higher temperature affects pod development at a later stage. Use of mulches especially polythene mulch is useful for the temperature stress management. The use of polythene mulch to boost the productivity of groundnut was introduced from Japan into China in 1978. Trials with polythene mulched groundnut (PMG) were conducted at Shandong Peanut Research Institute in 1979, resulting in significant increase in pod yield.

Intensification of food grain production resulted in excessive removal of plant nutrients from the soil and hence corrective measures are necessary for sustainability. Groundnut needs large amount of N P K and Ca and various micronutrients. Amount of N fixed by root nodules, N content of the soil and cost: benefit ratio of N application determines rate of nitrogen application. A balanced application of P and N Fertilizers in a ratio of 1:1.5 has observed to be better than single application. When available potassium in the soil is < 128 kg ha^{-1}, then there is a response to potassium. K:Ca:Mg ratio is important than total K, 4:4:2 K:Ca:Mg ratio is observed to be a best ratio for higher yields.

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In India, the trials conducted at different locations under AICRP G'nut resulted in 30 to 50 per cent increase in the dry pod yield ha^{-1} over normal planting. Keeping above-mentioned points in view, the present study was undertaken to develop agro-techniques under polythene mulch. The factors considered for the studies were *viz*., improved varieties, seed beds, nutrition levels and plant growth regulator

MATERIALS AND METHODS

The field experiment was conducted at Agronomy Department Farm, College of Agriculture, Dapoli, dist. Ratnagiri, MS on the lateritic soil. Dapoli is located at 17.4^0 N latitude, 73.1^0E longitude and 250 m above mean sea level. The climate is subtropical with mean annual precipitation of 3500 mm which is generally received from June to October in about 95 to 100 days.

The initial experimental soil status was soil pH 6.35, O. C. 0.76 %, available N 235 kg ha^{-1}, available P 8.20 kg ha^{-1} and available K 154 kg ha^{-1}. The experiment was carried out in Split-split Plot Design with three replications. There were 32 treatment combinations comprising two factors *viz*., JL 24 and TG 26 genotypes and flat beds and BBF seed beds as main plot treatments, four levels of nutrients *viz*., N_1 : 25:50 kg N:P_2O_5 ha^{-1}, N_2: 37.5:75:35 kg N: P_2O_5: Ca ha^{-1} N_3 : 50:100:70 kg N: P_2O_5: Ca ha^{-1} N_4: 75:150:105 kg N: P_2O_5: Ca ha^{-1} as sub plot treatments and two levels of plant growth regulator P_1: control P_2 : paclobutrazol @ 60 ppm at 25 days after emergence of first flower as sub-sub plots .

Well decomposed mixture of FYM and poultry manure @ 5 t ha^{-1} was uniformly applied at the time of land preparation and mixed thoroughly in to the soil. Chemical fertilizers were applied as per the treatments. Nitrogen and phosphorus were applied through diammonium phosphate (DAP 18 % N and 46 % P_2O_5) and remaining quantity of N was applied through urea (46 % N), while calcium was adjusted through gypsum (22.5 % Ca), respectively. The chemical fertilizers were applied as basal dose and mixed in to the soil before spreading the plastic film. Seedbeds *viz*., FB and BBF were prepared. Flat beds of plot size (3.6 x 4.0 m) were prepared and for the BBF four beds of the size 0. 90 m width at bottom, 0.60 m width at the top, 4 m long and 8 to 10 cm height were prepared in each.

Two seeds were dibbled per hill at 30 cm x 10 cm spacing in flat beds and 20 cm x 10 cm on broad bed furrows, however, plant population was kept equal by adjusting number of rows. The entire experimental area was covered by polythene mulch (PM) by spreading it before sowing (MPBS). The polythene film used for mulching had 900-mm width, 0.007 mm (7 microns) thickness, more than 70 % light transmittance, 100 % elasticity and white colour.

The dry matter samples of crop plant taken at harvest were analysed for total N, P and K by using standard methods. The protein content in kernel was calculated by multiplying total nitrogen content in groundnut kernels by 6.25. Oil content in groundnut kernel was estimated as described by Mehra (1955) by using Soxhlet apparatus.

The five representative plants from each net plot were selected randomly for biometric observations *viz*., plant population, height of plant (cm), number of leaves per plant, number of branches per plant, spread of the plant (cm), dry matter per plant.

Plant protection measures against the pests spodoptera, and aphids etc. were undertaken by spraying of endosulphan @ 0.05% and the diseases like leaf spots and rust were controlled by spraying of carbendazim and Dithane M-45.

The statistical data of the factors variables obtained during the course of investigation were analysed by analysis of variance method as per the procedure (Split-split Plot Design) described by Gomez and Gomez (1983) and Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The results obtained from the present investigation are presented below:

Effect of genotypes on crop growth and development:

The plant height, spread, no. of primary branches and dry matter weight at harvest was influenced significantly due to genotype during both the years. JL 24 recorded significantly higher plant height over TG 26. The maximum mean plant spread of 53.54 cm was observed in JL-24 as compared to TG-26 (34.84 cm). Mean number of primary branches 11.82 and 8.60 were noted in TG-26 and JL-24, respectively. Both the genotypes recorded equal number of leaves per hill at harvest during both the years. JL 24 recorded 37.10 and 28.50 % higher dry matter weight at harvest over TG 26 during both the years.

Effect of seed beds on crop growth and development:

The plant height, plant spread, number of leaves per hill, number of branches per plant and dry matter weight were identical under flat beds and broad bed furrows at harvest during both the years

Effect of nutrition levels on crop growth and development:

Application of nutrients showed a great impact on growth of groundnut. It influenced the plant height significantly during both the years. Higher dose of nutrients *viz*., 75:150:105 (N_4) kg N, P_2O_5 and Ca /ha, registered significantly higher plant height over rest of the treatments, except application of 50:100:70 (N_3) kg N, P_2O_5 and Ca / ha.

During both the years there was no significant difference in the plant spread due to application of nutrition levels. Application of 50:100:70 (N_3) kg N, P_2O_5 and Ca /ha recorded significantly higher number of branches over RDF (N_1), but the treatments $N_{3,}$ and N_4 as well as N_1 and N_2 behaved significantly with each other. Numbers of leaves per hill were not influenced significantly due to different nutrition levels at harvest.

The treatment N_4 and N_3 produced significantly higher dry matter per hill over N_2 and $N_{1,}$ while the difference between former two treatments was of similar magnitude, but latter two behaved independently. Similar trend was observed during both the years of experimentation. Patra *et al*. (1995) reported significantly higher dry matter due to foliar application of nutrients.

Effect of growth regulator on crop growth and development:

Application of paclobutrazol at 25 days after initiation of first flower significantly reduced the plant height, plant spread and number of leaves at harvest, but the number of branches per hill was not influenced significantly due to application of growth regulator. The rate of dry matter accumulation was significantly increased over control.

Effect of genotypes on yield and yield attributes:

TG 26 recorded significantly higher mean number of mature pods per hill over JL 24 during both the years. Mean number of mature pods per hill was 30.40 and 29.20 in TG 26 and 28.30 and 27.2 in JL 24 during 1999-2000 and 2000-2001, respectively. Mean number of immature pods per hill was significantly lower in JL 24 as compared to TG 26. JL 24 and TG 26 recorded identical mean weight of pods per hill, but numerically higher values were observed in TG 26 during both the years. TG 26 recorded significantly higher harvest index (0.59) over JL 24 (0.45). There was no significant difference in the dry pod, kernel and oil yield in both the genotypes *i.e*. JL 24 and TG 26,

Table 1 : Growth attributing characters at harvest as influenced by various treatments

Treatments	Plant height (cm)		Plant spread (cm)		No. of branches per plant		No. of leaves per plant		Dry matter weight (g plant^{-1})	
	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	1999-2000	1999-2000	2000-2001	1999-2000	2000-2001
Genotypes										
G_1: JL 24	32.12	31.80	53.54	51.23	8.60	9.05	100.31	95.13	77.71	74.19
$G_{2:}$ TG 26	24.55	20.65	34.84	31.30	11.82	11.07	94.36	92.48	56.68	57.73
S.E. ±	0.24	0.18	1.14	1.54	0.61	0.61	6.11	5.99	1.14	0.80
C.D. (P=0.05)	0.87	0.64	4.14	5.60	1.77	1.79	NS	NS	3.50	3.18
Seed beds										
S_1: Flat beds	28.35	25.84	43.80	41.13	10.82	9.96	96.53	94.92	66.30	65.79
S_2: BBF	28.33	26.81	44.58	42.60	10.81	10.17	98.15	96.18	68.09	66.18
S.E. ±	0.24	0.18	1.14	1.54	0.61	0.61	6.11	5.99	1.14	0.87
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nutritional levels										
N_1	26.44	24.86	42.10	40.29	9.99	9.29	94.02	92.14	63.47	58.77
N_2	28.36	25.71	44.53	42.62	10.48	9.84	97.61	95.30	66.07	66.04
N_3	28.89	26.97	44.70	42.74	11.12	10.49	98.31	96.35	68.84	69.51
N_4	28.67	27.36	43.37	43.52	11.27	10.64	99.48	97.43	69.39	69.61
S.E. ±	0.47	0.15	2.27	2.17	0.32	0.33	2.64	2.59	0.85	0.78
C.D. (P=0.05)	1.36	0.43	NS	NS	0.93	0.95	NS	NS	2.47	2.29
Growth regulator										
P_o:	29.94	27.41	45.87	43.82	10.75	10.11	99.45	97.46	65.79	65.11
P_1:	26.73	25.05	42.51	40.66	10.67	10.02	95.23	93.15	68.60	66.27
S.E.±	0.19	0.16	0.98	0.82	0.05	0.05	0.75	0.74	0.26	0.28
C.D. (P=0.05)	0.57	0.46	2.85	2.34	NS	NS	2.20	2.16	0.75	0.83

N_1 : 25:50 kg N:P_2O_5 ha^{-1}, N_2 : 37.5:75:35 kg N: P_2O_5: Ca ha^{-1} N_3 : 50:100:70 kg N: P_2O_5: Ca ha^{-1} N_4 : 75:150:105 kg N: P_2O_5: Ca ha^{-1}
P_1:Control P_2:Paclobutrazol @ 60 ppm. N.S.-Non significant

however JL 24 recorded significantly higher haulm yield during both the years.

Effect of Seed beds on yield and yield attributes:

There were no significant differences in the mean number of mature pods per hill, mean number of immature pods per hill, 100 pod weight, 100-kernel weight and harvest index due to different seed beds during both the years (Table 2).

The dry pod, haulm, kernel and oil yield did not differ significantly due to seed beds *viz*., FB and BBF during both the years (Table 3). Mean dry pod yield of 51.0 and 52.0 q ha^{-1}, dry haulm yield of 60.2 and 55.8q ha^{-1}, kernel yield of 38.8 and 38.3 q ha^{-1} and oil yield of 18.6 and 18.7 q ha^{-1} was recorded under FB and BBF, respectively. In general, slightly higher values of dry pod, kernel and oil yield were observed under BBF, while haulm yield was more in FB. The significant response of groundnut to seed beds may not be due to lateritic soils and application of polythene mulch and optimum irrigation as crop was grown in the winter.

Effect of nutrition levels on yield and yield attributes:

Application of 50:100:70 (N_3) kg N, P_2O_5 and Ca / ha recorded significantly higher number of mature pods per hill over N_2 and N_1, while it was at par with N_4. Application of 37.5:75:35 (N_2) kg N, P_2O_5 and Ca /ha registered significantly higher number of mature pods per hill over N_1.

Application of nutrients reduced the mean number of immature pods per hill as compared to RDF (N_1). The lowest number of immature pods were observed due to application of 75:150:105 (N_4) kg N, P_2O_5 and Ca /ha followed by N_3. Application of 37.5:75:35 (N_2) kg N, P_2O_5 and Ca/ha noted significantly lower number of immature pods per hill over N_1.

Application of 50:100:70 (N_3) and 75:150:105 (N_4) kg N, P_2O_5 and Ca /ha recorded significantly higher mean weight of pods per hill, 100-pod weight, 100-kernel weight over N_2 and N_1, but the difference between former two treatments was of the similar magnitude. Ravikumar and Raghavulu (1995) reported that significantly higher weight of pods, 100-pod weight and 100-kernel weight were observed due to application of gypsum @ 500 kg/ha.

Table 2 : Yield attributing characters at harvest as influenced by various treatments

Treatments	No. of mature pods (No. plant^{-1})		No. of immature pods (No. plant^{-1})		100 pod weight (g)		100 kernel weight (g)		Harvest index	
	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001
Genotypes										
G_1: JL 24	28.28	27.15	6.17	4.01	132.3	133.8	44.58	48.36	0.42	0.45
G_2: TG 26	30.40	29.19	8.01	7.74	125.4	132.5	43.71	47.03	0.52	0.59
S.E. ±	0.45	0.43	0.51	0.21	2.72	1.84	0.27	0.23	0.004	0.01
C.D. (P=0.05)	1.63	1.56	1.84	0.75	NS	NS	NS	0.86	0.14	0.02
Seed beds										
S_1: Flat beds	29.26	28.09	7.19	6.13	128.4	133.1	44.16	47.37	0.46	0.51
S_2: BBF	29.42	28.45	7.01	5.70	129.0	133.3	44.12	48.02	0.47	0.53
S.E. ±	0.45	0.43	0.50	0.21	2.72	1.84	0.27	0.23	0.004	0.01
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.02
Nutritional levels										
N_1	25.29	24.92	8.73	9.49	123.7	128.6	42.41	45.18	0.45	0.50
N_2	29.00	27.84	7.04	5.94	128.1	132.3	43.85	46.15	0.47	0.51
N_3	31.45	30.18	6.67	4.76	131.1	135.2	45.80	48.63	0.48	0.53
N_4	30.96	29.72	5.92	3.76	132.5	136.6	45.50	50.28	0.47	0.53
S.E. ±	0.31	0.30	0.41	0.46	1.47	1.13	0.16	0.18	0.005	0.01
C.D. (P=0.05)	0.90	0.87	1.08	1.06	3.87	3.30	0.46	0.51	0.01	0.02
Growth regulator										
P_o:	28.54	27.08	9.16	7.06	125.3	129.2	43.50	46.49	0.45	0.50
P_1:	30.14	29.25	5.09	4.70	132.5	137.2	44.80	48.90	0.48	0.54
S.E. ±	0.11	0.10	0.21	0.13	0.77	0.53	0.20	0.12	0.002	0.002
C.D. (P=0.05)	0.32	0.30	0.61	0.37	2.25	1.55	0.59	0.36	0.004	0.006

N_1 : 25:50 kg N:P_2O_5 ha^{-1}, N_2 : 37.5:75:35 kg N: P_2O_5: Ca ha^{-1} N_3 : 50:100:70 kg N: P_2O_5: Ca ha^{-1} N_4 : 75:150:105 kg N: P_2O_5: Ca ha^{-1}
P_1:Control P_2:Paclobutrazol @ 60 ppm. N.S.-Non-significant

Table 3 : Pod, haulm, kernel and oil yield of groundnut as influenced by various treatments

Treatments	Yield (Q ha^{-1})							
	Dry pod		Dry haulm		Kernel		Oil	
	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001	1999-2000	2000-2001
Genotypes								
G_1: JL 24	50.3	52.4	69.7	66.9	37.8	39.0	18.4	18.8
G_2: TG 26	53.2	52.9	50.0	43.0	40.2	39.1	19.7	19.0
S.E. ±	1.0	0.5	1.0	1.3	0.9	0.4	0.5	0.2
C.D. (P=0.05)	NS	NS	3.6	4.6	NS	NS	NS	NS
Seed beds								
S_1: Flat beds	51.0	52.0	60.2	55.8	38.5	38.3	18.8	18.7
S_2: BBF	52.5	53.2	59.4	54.1	39.4	39.0	19.3	19.1
S.E. ±	1.0	0.5	1.0	1.3	0.9	0.4	0.5	0.2
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Nutritional levels								
N_1	46.9	47.6	57.5	53.1	34.6	34.1	16.6	16.2
N_2	52.0	52.2	59.4	54.3	39.5	38.0	19.2	18.5
N_3	54.6	55.6	60.7	55.5	41.5	41.2	20.5	20.5
N_4	53.5	55.0	61.6	56.9	40.3	41.1	20.0	20.3
S.E. ±	0.8	0.4	0.4	0.5	0.6	0.3	0.4	0.2
C.D. (P=0.05)	2.4	1.2	1.2	0.16	1.8	0.9	1.3	0.4
Growth regulator								
P_o:	49.5	50.0	61.4	57.0	37.0	36.9	18.1	18.0
P_1:	54.0	55.2	58.2	53.0	40.0	40.0	20.1	19.5
S.E. ±	0.3	0.2	0.3	0.2	0.2	0.2	0.1	0.1
C.D. (P=0.05)	0.9	0.7	0.9	0.6	0.6	0.5	0.3	0.3

N_1 : 25:50 kg N:P_2O_5 ha^{-1}, N_2 : 37.5:75:35 kg N: P_2O_5: Ca ha^{-1} N_3 : 50:100:70 kg N: P_2O_5: Ca ha^{-1} N_4 : 75:150:105 kg N: P_2O_5: Ca ha^{-1}
P_1:Control P_2:Paclobutrazol @ 60 ppm. N.S.-Non-significant

Application of 50:100:70 (N_3) kg N, P_2O_5 and Ca / ha recorded significantly higher dry pod, kernel and oil yield over N_1 and N_2, respectively. The difference between N_3 and N_4 was of similar magnitude.

Application of 75:150:105 (N_4) kg N, P_2O_5 and Ca / ha recorded significantly higher dry haulm yield over N_2 and N_1. Various scientists reported the dose of nitrogen, phosphorous and potassium to groundnut, Angadi and Patil (1988) reported 60:80:40, Mishra and Vyas (1992) 20:80:20, Kumar and Solaimalai (2000) 34:17:50 kg ha^{-1} N:P_2O_5:K_2O, respectively as an optimum requirement.

Effect of growth regulator on yield and yield attributes:

Application of paclobutrazol significantly reduced the number of immature pods per hill over control. The proportion of immature pods to total number of pods was 19 % and 14% in the treated plot and 24% and 20% in the control plots during 1999-2000 and 2000-2001, respectively and it resulted into significant increase in number of mature pods per hill over control. Increase in the number of mature pods and decrease in immature pods per hill reflected in the significant increase in the mean weight of pods per hill due to application of growth regulator. The application of paclobutrazol significantly increased the 100-pod weight, 100-kernel weight and harvest index over control. There was 5.75 % and 6.15 % increase in the 100-pod weight, 2.98 % and 3.27 % increase in 100-kernel weight and 6 % and 8 % increase in harvest index over control during 1999-2000 and 2000-2001, respectively. Jeyakumar and Thangaraj (1996) and Giridhar and Giri (1999) reported that spraying of 500 to 1000 ppm Cycocel [chlormequat] suppressed the LAI and dry matter weight at 60 DAS, however, at harvest CCC sprayed plots produced more LAI and dry matter weight, increased the number of flowers, pegs and pods $plant^{-1}$, peg: flower ratio, pod: peg ratio and 1000-seed weight and pod yield. The magnitude of increase of pod yield was from 7.6 % to 15.9 %.

The paclobutrazol application resulted in reduction in vegetative growth and prohibited the production of late ineffective flowers, which resulted in the less number of immature pods and increased the developed and mature pods. This has ultimately reflected in increased yield. The dry pod, kernel and oil yield was increased significantly due to application of paclobutrazol. There was 9.1 % and 10.4% increase in dry pod, 10.5 % and 8.4 % increase in kernel 11 % and 9.4 % increase in oil yield over control during 1999-2000 and 2000-2001, respectively. But, there was significant reduction in the dry haulm yield (5.21

and 7.02 %) due to application of paclobutrazol over control during 1999-2000 and 2000-2001, respectively. Significant increase in the yield of groundnut due to application of growth regulators were reported by the Kothale *et al*. (1993) and Singh *et al*. (1994).

Effect of genotypes on the quality parameters :

JL 24 recorded significantly higher sound mature kernel percentage over TG 26 during both the years. Both the genotypes behaved significantly with each other in oil content during both the years. Mean oil content 48.73 % and 48.89 % were recorded in JL 24 and TG 26, respectively. Mean protein content in the groundnut kernels was significantly higher in JL 24 (21.24 %) as compared to TG 26 (20.66%). Nalawade (1999) reported the superiority of JL 24 in producing higher dry pod yield.

Effect of seed beds on the quality parameters :

Shelling percent, sound mature kernel percentage (SMK), oil content and protein content were of equal magnitude due to different seed beds during both the years. Mean shelling per cent 75.04 % and 74.82 %, mean sound mature kernel percentage 95.45 % and 95.40 %, mean oil content 48.77 % and 48.84 % and mean protein content 20.93 % and 20.97 % were recorded under FB and BBF, respectively.

Effect of nutrition levels on the quality parameters:

Quality attributes *viz.*, shelling percent, sound mature kernel percentage, oil content and protein content in groundnut were also influenced significantly due to application of nutritional levels. During both the years, application of 75:150:105 (N_4) kg N, P_2O_5 and Ca /ha registered significantly higher shelling percent, sound mature kernel percentage, oil content and protein content in groundnut compared to N_2 and N_1, while N_3 and N_4 treatments behaved similarly with each other. Application of 37.5:75:35 (N_2) kg N, P_2O_5 and Ca /ha significantly increased the quality attributes over N_1. Application of calcium might have helped in increasing the shelling per cent and sound mature kernel percentage. Geethalakshmi and Lourduraj (1998) and Lourduraj *et al*. (1998) observed significant increase in the growth, yield and quality attributes and yield of groundnut due to combine application of N, P_2O_5, K_2O and Ca application than individual elements

Table 4 : Quality parameters of groundnut as influenced by various treatments

Treatments	Shelling (%)		SMK (%)		Oil (%)		Protein (%)	
	1999-2000	2000-01	1999-2000	2000-01	1999-2000	2000-01	1999-2000	2000-01
Genotypes								
G_1: JL 24	75.6	74.5	96.5	96.6	48.8	48.8	21.7	20.8
G_2: TG 26	75.4	74.0	93.8	94.7	48.8	48.9	21.1	20.2
S.E. ±	0.26	0.23	0.24	0.44	0.15	0.11	0.04	0.04
C.D. (P=0.05)	NS	NS	0.78	1.60	NS	NS	0.15	0.14
Seed beds								
S_1: Flat beds	75.5	74.3	95.2	95.7	48.8	48.8	21.4	20.5
S_2: BBF	75.5	74.2	95.1	95.7	48.8	48.9	21.4	20.5
S.E. ±	0.29	0.23	0.24	0.44	0.15	0.11	0.04	0.04
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Nutritional levels								
N_1	74.0	72.1	93.8	94.1	47.3	47.7	20.3	19.4
N_2	75.6	73.8	95.1	95.5	48.5	48.6	21.1	20.2
N_3	76.1	75.7	95.6	96.9	49.3	49.3	22.2	21.2
N_4	76.2	76.3	96.1	96.7	49.5	49.6	22.1	21.2
S.E. ±	0.18	0.17	0.18	0.15	0.09	0.08	0.03	0.03
C.D. (P=0.05)	0.54	0.50	0.53	0.45	0.30	0.26	0.09	0.09
Growth regulator								
P_o:	74.8	73.5	94.9	95.3	48.7	48.7	21.3	20.4
P_1:	76.2	74.9	95.5	96.0	48.9	48.9	21.5	20.6
S.E. ±	0.1	0.08	0.04	0.05	0.03	0.03	0.04	0.04
C.D. (P=0.05)	0.3	0.25	0.10	0.16	0.09	0.09	0.12	0.11

N_1 : 25:50 kg N:P_2O_5 ha^{-1}, N_2 : 37.5:75:35 kg N: P_2O_5: Ca ha^{-1} N_3 : 50:100:70 kg N: P_2O_5: Ca ha^{-1} N_4 : 75:150:105 kg N: P_2O_5: Ca ha^{-1}
P_1:Control P_2:Paclobutrazol @ 60 ppm. N.S.-Non significant

Table 5: N and P content in pod and haulm of groundnut as influenced by various treatments

Treatments	N (%)				P (%)			
	Pod		Haulm		Pod		Haulm	
	1999-2000	2000-01	1999-2000	2000-01	1999-2000	2000-01	1999-2000	2000-01
Genotypes								
G_1: JL 24	2.80	2.68	1.77	1.74	0.59	0.61	0.33	0.32
G_2: TG 26	2.75	2.64	1.82	1.80	0.58	0.61	0.33	0.33
S.E. $\pm$	0.01	0.008	0.01	0.01	0.004	0.004	0.004	0.005
C.D. (P=0.05)	0.03	0.02	0.04	0.04	0.012	NS	NS	NS
Seed beds								
S_1: Flat beds	2.78	2.66	1.79	1.77	0.59	0.61	0.33	0.32
S_2: BBF	2.78	2.66	1.80	1.77	0.58	0.61	0.34	0.32
S.E. $\pm$	0.01	0.008	0.01	0.01	0.004	0.004	0.004	0.005
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Nutritional levels								
N_1	2.62	2.50	1.64	1.62	0.41	0.44	0.30	0.29
N_2	2.73	2.62	1.71	1.69	0.58	0.60	0.33	0.32
N_3	2.87	2.76	1.87	1.84	0.66	0.66	0.34	0.33
N_4	2.88	2.77	1.95	1.92	0.67	0.67	0.36	0.35
S.E. $\pm$	0.005	0.006	0.01	0.01	0.004	0.003	0.003	0.004
C.D. (P=0.05)	0.016	0.019	0.03	0.03	0.012	0.01	0.01	0.01
Growth regulator								
P_o:	2.76	2.65	1.78	1.76	0.58	0.60	0.33	0.32
P_1:	2.74	2.67	1.81	1.77	0.59	0.62	0.34	0.33
S.E. $\pm$	0.01	0.01	0.01	0.009	0.002	0.002	0.002	0.003
C.D. (P=0.05)	NS	NS	NS	NS	0.004	0.004	NS	NS

N.S.-Non significant N.S.-Non significant

Effect of growth regulator on the quality parameters:

Application of paclobutrazol also significantly increased shelling percent, sound mature kernel percentage, oil content and protein content over control during both the years. The results are in conformity with the results reported by Chen *et al.* (1995).

Effect of genotypes on the NPK concentration and uptake:

Nitrogen content in the groundnut pod and haulm was significantly influenced due to genotypes during both the years. JL 24 recorded significantly higher nitrogen content in the pods over TG 26, while TG 26 showed its superiority in respect of N content in the haulm as compared to the JL 24. Mean phosphorus, potassium and calcium content in groundnut pods and haulms were not influenced significantly due to genotypes (Table 5 and 6).

Genotypes did not influence the mean nitrogen, phosphorus, potassium and calcium uptake by the groundnut pods, but mean nitrogen, phosphorus, potassium and calcium uptake by haulm and total uptake was influenced significantly due to genotypes (Table 7). JL 24 recorded significantly higher mean nitrogen, phosphorus, potassium and calcium uptake by haulms and total nitrogen uptake over TG 26. This may be due to excess vegetative growth of JL 24. These results are in conformity with results reported by Vananja *et al*. (2000).

Effect of seed beds on the NPK concentration and uptake:

Both the Seed beds behaved similarly with each other in case of mean nitrogen, phosphorus, potassium and calcium content in the pods and haulm and mean nitrogen, phosphorus, potassium and calcium uptake during both the years.

Effect of nutrition levels on the NPK concentration and uptake:

During the years, mean nitrogen, phosphorus, potassium and calcium content in the groundnut pods and haulms were significantly influenced due to application of nutritional levels. Application of 75:150:105 (N_4) kg N, P_2O_5 and Ca /ha registered significantly higher nitrogen, phosphorus, potassium and calcium content in the pods and haulms over rest of the treatments, except N_3 (Table 5 and 6).

Application of nutrition levels significantly increased the mean uptake of nitrogen, phosphorus, potassium and

Table 6 : K and Ca content in pod and haulm of groundnut as influenced by various treatments

	K (%)				Ca (%)			
	Pod		Haulm		Pod		Haulm	
	1999-2000	2000-01	1999-2000	2000-01	1999-2000	2000-01	1999-2000	2000-01
Genotypes								
G_1: JL 24	0.98	1.0	0.99	1.01	0.34	0.34	1.68	1.80
G_2: TG 26	0.98	1.1	0.99	1.00	0.34	0.34	1.68	1.80
S.E. ±	0.005	0.003	0.004	0.002	0.005	0.006	0.009	0.008
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Seed beds								
S_1: Flat beds	0.98	0.99	0.99	1.01	0.33	0.34	1.67	1.80
S_2: BBF	0.99	1.01	0.99	1.00	0.34	0.34	1.68	1.80
S.E. ±	0.005	0.003	0.004	0.002	0.005	0.006	0.009	0.008
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Nutritional levels								
N_1	0.97	0.98	0.98	0.99	0.31	0.31	1.57	1.43
N_2	0.97	0.99	0.98	0.99	0.32	0.34	1.67	1.85
N_3	0.98	1.01	0.98	1.01	0.35	0.35	1.73	1.87
N_4	0.99	1.01	0.99	1.02	0.36	0.36	1.74	1.89
S.E. ±	0.004	0.002	0.003	0.003	0.004	0.004	0.008	0.006
C.D. (P=0.05)	0.013	0.007	0.02	0.011	0.01	0.012	0.024	0.017
Growth regulator								
P_o:	0.98	1.00	0.98	1.00	0.33	0.34	1.67	1.80
P_1:	0.98	1.00	0.98	1.01	0.34	0.34	1.68	1.81
S.E. ±	0.003	0.001	0.001	0.002	0.004	0.002	0.005	0.004
C.D. (P=0.05)	NS	NS	NS	NS	0.01	0.06	NS	NS

N.S. - Non significant N.S.-Non significant

Table 7 : N, P, K and Ca uptake by groundnut crop as influenced by various treatments

Treatments	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})		Ca uptake (kg ha^{-1})	
	1999-2000	2000-01	1999-2000	2000-01	1999-2000	2000-01	1999-2000	2000-01
Genotypes								
G_1: JL 24	264.3	259.5	53.68	54.0	119.1	120.2	134.3	138.9
G_2: TG 26	237.5	214.8	48.95	56.4	102.5	95.4	102.5	95.14
S.E. ±	5.18	2.06	1.08	0.53	2.14	1.57	2.29	2.42
C.D. (P=0.05)	15.10	7.51	3.93	1.93	7.80	5.71	8.33	8.79
Seed beds								
S_1: Flat beds	249.2	236.8	50.50	50.0	110.4	307.9	118.6	118.3
S_2: BBF	253.2	237.5	51.77	50.4	111.2	107.6	118.2	115.8
S.E. ±	5.18	2.07	1.08	0.53	2.14	1.57	2.29	2.42
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Nutritional levels								
N_1		204.3	36.52	46.5	101.3	99.3	111.6	100.5
N_2	244.6	227.6	49.58	48.3	109.9	105.6	116.2	117.00
N_3	270.7	254.7	56.52	55.2	115.9	112.6	121.8	142.1
N_4	272.4	262.1	62.02	60.8	115.7	113.7	124.0	126.2
S.E. ±	3.58	1.63	0.78	0.34	1.29	0.51	1.10	0.68
C.D. (P=0.05)	10.45	4.75	2.27	0.99	3.77	1.50	2.90	2.03
Growth regulator								
P_o:	250.0	237.9	51.09	50.0	110.9	107.7	119.6	118.5
P_1:	251.7	236.4	51.23	50.4	110.7	107.9	117.2	115.9
S.E. ±	1.30	1.07	0.25	0.18	0.48	0.35	0.68	0.45
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	1.98	NS

N.S. - Non significant N.S.-Non significant calcium total uptake over application of only RDF (N_1) during both the years. Application of 50:100:70 (N_3) kg N, P_2O_5 and Ca /ha and 75:150:105 (N_4) kg N, P_2O_5 and Ca /ha noted significantly higher mean uptake of major plant nutrients by pods, haulms and total uptake over the remaining treatments. The treatments N_3 and N_4 behaved similarly with each other (Table 7).

Effect of growth regulator on the NPK concentration and uptake:

Mean nitrogen and potassium content in the pods and haulm as well as mean phosphorus and calcium content in the haulm did not differ significantly due to application of paclobutrazol. Mean phosphorus and calcium content in the pods increased significantly over control due to application of paclobutrazol during both the years (Table 5 and 6). Mean nitrogen, phosphorus and potassium uptake by pods and haulms was influenced significantly due to application of paclobutrazol, but the total nitrogen, phosphorus and potassium uptake did not differ significantly (Table 7). There was 3.84 % and 2.75% increase in the nitrogen, 2.33 % and 3.76 % increase in the phosphorus and 4.85 % and 3.87% increase in the potassium uptake by pods due to application of paclobutrazol during the year 1999-2000 and 2000-2001, respectively, while there was 3.48 % and 5.42 % decrease in the nitrogen, 2.87 % and 4.41 % decrease in phosphorus and 4.20 % and 3.21 % decrease in the potassium uptake by haulm due to application of paclobutrazol during the year 1999-2000 and 2000-2001, respectively.

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