LR-4202
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RESEARCH ARTICLE Legume Research - An International Journal, Volume 42 Issue : (2019)

Evaluation of Groundnut (*Arachis hypogea*) Cultivars for Destabilized Ecosystem of North Eastern Hill Region

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ABSTRACT

Performance of 27 improved groundnut cultivars were assessed of the two maturity groups for agronomic and physiological traits associated to improve the high productivity for four consecutive years (2013-2016) in degraded acid soils under rainfed hilly ecosystem. The cultivar ICGS- 76 and ICGV-86590 produced significantly ($p<0.05$) higher pod yield with more than 39% improvement over the check JL-24. The study also identified five more promising cultivars viz. ICGS-5, TKG-19 A, TG-37-A, GG-11 and GG-21 with 19-38% higher yield over the check. The low productivity of cereals in the acidic and moisture stressed Jhum degraded upland soils of rainfed hilly ecosystem of Eastern Himalayan Region is a major concern for socio-economic improvement of resource poor farmers. Adoption of these cultivars is expected to increase the net income to a tune of 93.2% without incurring any additional costs to the prevailing production system.

Key words: Rainfed groundnut, Production efficiency, Agronomic traits, Production economics.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.), an essential food and important oilseed crop is mostly grown by small and marginal farmers in diverse agro-climatic environments of Asia and Africa (FAOSTAT, 2014). Globally, groundnut is grown in 25.0 m ha area with an average productivity of 1.7 t ha^{-1}, amounting to a total production of 42.0 MT (Singh *et al*., 2018). India is the second largest producer of groundnut, only next to China in the world. In the Eastern Himalayan Region (EHR) of India, groundnut is gaining popularity as an important food crop in the acidic upland hilly soils, which were once under the cultivation of low productive traditional cereals (rice/maize) (Singh *et al*., 2006).

The fragile hilly ecosystem of Eastern Himalaya is vulnerable to climate change with extremely degraded upland soils due to shifting cultivation (Jhum) has led to burning of vegetation and deforestation, acidity and severe water erosion. Despite receiving 8-10 times more rainfall than the consumptive water use, high runoff loss in the Jhum degraded uplands and low utilization efficiency (<30%) often causes intermittent to terminal soil moisture stresses (Choudhury *et al.,* 2013). Extensive use of local low yielding cultivars susceptible to abiotic stresses by the predominant marginal tribal farmers further reduced the productivity to sub-optimal level (<1.0 t/ha) (Singh *et al*., 2003; Datta *et al*., 2016; Ansari *et al*., 2017). To sustain the food requirement of burgeoning population in the fragile hilly rainfed uplands, improvement in agricultural productivity through adoption of improved crop cultivars suitable to targeted environments is the need of the hour (Singh *et al*., 2008; 2014). Diversification of cropping pattern by inclusion of oilseed crops like groundnut in the existing cropping pattern (rice/maize) in the degraded slopy uplands assures better nutritional security by providing vegetable proteins and edible oils (Singh *et al*., 2006; Das *et al*., 2016). Groundnut crop also fixes atmospheric nitrogen (N_2) in soil, reduces soil susceptibility to erosion, conserve soil moisture by smothering weed growth and thus, improves the overall soil quality (Singh *et al*., 2004; Konlan *et al*., 2013). The by-products from groundnut also can be used as feed and fodder for livestock.

The potential of groundnut cultivation in the Jhum degraded acid soils of hilly ecosystem of Eastern Himalaya cannot be explored fully without adequate information on suitable cultivars with adaptive traits. In the present study an attempt was made to identify cultivars with such adaptive agronomic and physiological traits associated with high

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How to cite this article: Ansari, M.A., Choudhary, B.U., Roy, S.S., Sharma, S.K., Saraswat, P.K., Mishra, R.K., Singh, I.M., Singh, A.L., Lal, B. and Prakash, N., Evaluation of Groundnut (*Arachis hypogea*) Cultivars for Destabilized Ecosystem of North Eastern Hill Region, Legume Research.

Submitted: 24-07-2019 **Accepted**: 06-11-2019 **Published**:

production efficiency suitable to degraded soils of rainfed hilly ecosystem of Eastern Himalaya.

MATERIALS AND METHODS

Experimental site

The experiment was conducted for four consecutive years (2013-2016) in the upland (Jhum degraded) at Langol farm of ICAR Research Complex for NEH Region, Manipur Centre, Imphal, India (24^{0}49' N latitude, 93^{0}55' E longitude and 786 m above MSL altitude) (Fig 1). Experimental site falls under humid sub-tropical climate. The mean monthly minimum and maximum temperatures during the study period (2013-2016) varied widely from 18.6 ^{0}C to 32.8 ^{0}C while mean annual rainfall (May to October) varied from 818.7 mm (in 2013) to 1852 mm (in 2016) (Fig 2). Monthly sunshine hours varied from 2.6 to 5.8 hrs while average relative humidity varied from 62 to 93%. The soils of the experimental site was sandy clay loam (sand 52.2 %, silt 14.6 % and clay 33.2 %) in texture, acidic in reaction (pH 4.9), high in organic carbon (Walkley and Black, 1.51 %), low in available nitrogen (alkaline permanganate N, 185.5 kg ha^{-1}), available phosphorus (Bray I P, 8.1 kg ha^{-1}) and available K (neutral normal ammonium acetate K, 115.5 kg ha^{-1}) contents.

Experimental design and treatment details

Experiment was laid out in randomized block design with twenty six improved groundnut cultivars with one additional popular cultivar JL-24 as check and replicated thrice. These twenty six cultivars belonged to two major groups *viz.* 9 early maturing cultivars, 17 medium to late maturing cultivars. Uniform plant population density (3.33 ×10^5 plants ha^{-1}) was maintained and the performance of these cultivars was evaluated for four consecutive years (2013 to 2016) during *Kharif* season. The crop was sown to a depth of about 5 cm during first week of May and harvested during September to mid October. The experiment was well managed and kept weeds, diseases and insect pests' free by following the recommended package of practices from planting till harvest. The recommended doses of fertilizers were applied as 20-40-40 (N, P, K) kg ha^{-1} in the form of nitrogen from urea,

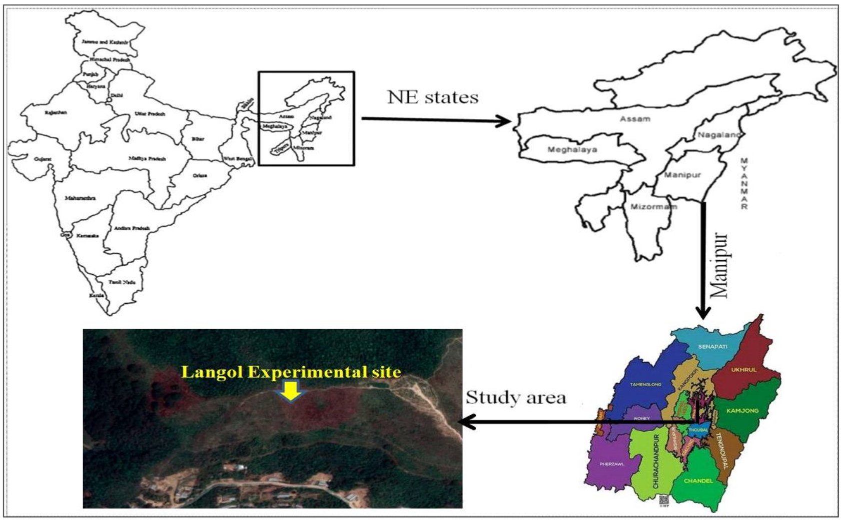

Fig 1: Spatial location of the study area.

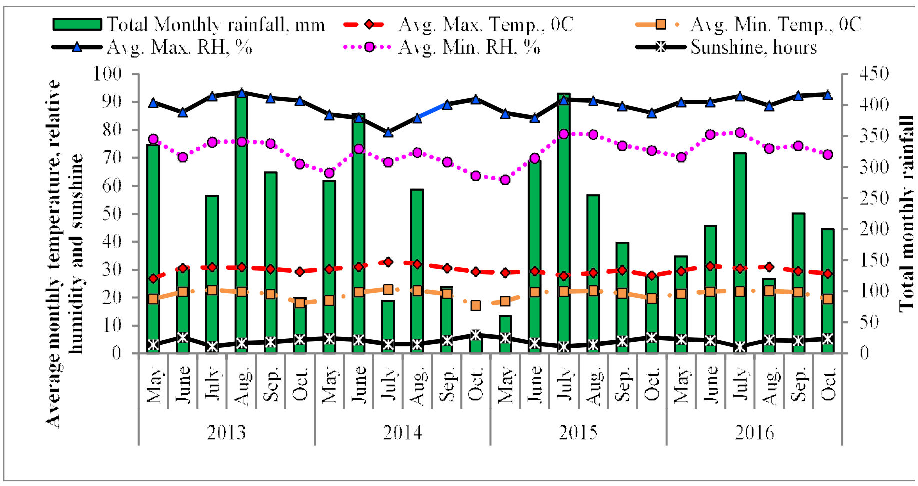

Fig 2: Monthly weather observations (rainfall, maximum and minimum temperature, sunshine hour and Relative humidity) at study area during the experimental period of 2013 to 2016.

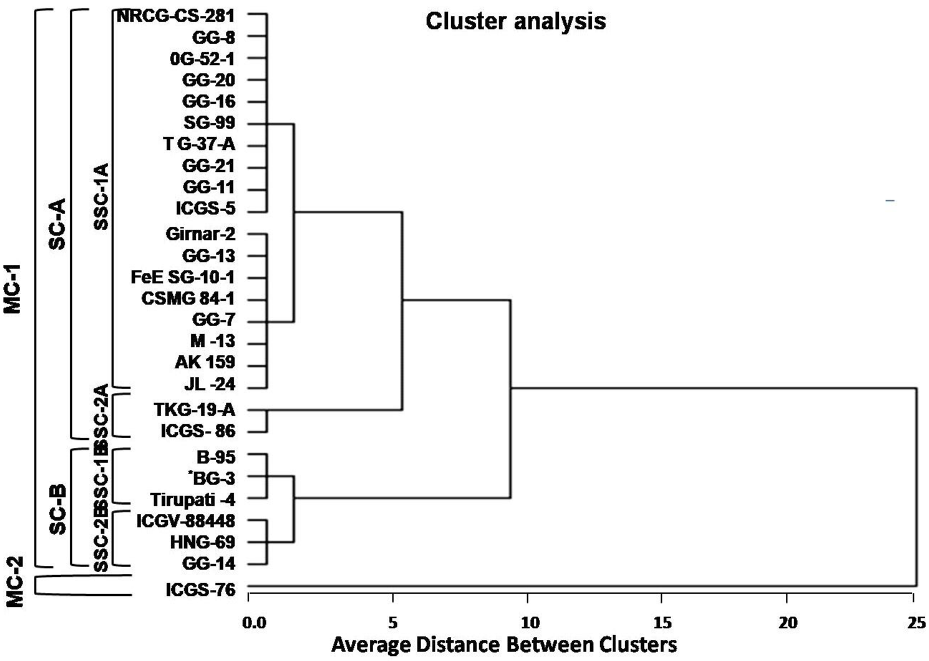

Fig 3: Dendrogram representing clustering of 27 groundnut cultivars based on Squared Euchlidean distance matrix for dry pod yield.

phosphorus (P_2O_5) from single super phosphate and potassium (K_2O) from murate of potash, respectively (Singh *et al*., 2006).

Five plants from each plot were tagged at randomly from the sampling row and height of these plants was recorded from the base to the tip of the last fully opened leaf of the plant at maturity stage. Nodule plant^{-1} was observed at 50 days after sowing. Five random plants from each plot were dug out by breaking the rhizospheric soils around the plants up to a depth of 50 cm with a hand hoe. Care was taken so that the root system was not disturbed during the process. The plants were then pulled out gently and put in polyethylene bags. In the laboratory, samples were kept in sieves (mesh size 0.25 mm) and washed with water to remove the soil particles. The nodules on the roots were separated and those that broke off during the course of washing were also picked up for final count.

Observations on number of pegs plant^{-1}, effective pods plant^{-1}, pod weight plant^{-1} and kernel (seewd) weight plant^{-1} were recorded at maturity stage from 5 randomly selected plants in each plot. Grain weight of each genotype was harvested separately and further shelled groundnut, 100 seeds weight (g) of each cultivar from each replication was measured. The harvests from 1 m^2 area for each genotype were threshed separately. The production efficiency was estimated using the following equation.

Production efficiency (kg ha^{-1} day^{-1}) =Grain yield (kg ha^{-1})/ crop duration (days)...(1)

Shelling percent was calculated by the following formula
Shelling (%) = (kernel dry weight/pod dry weight) X 100.......(2)

Economics analysis

The gross return was calculated by multiplying the dry pod yield (economic yield) of groundnut with their minimum support price (MSP, 2016) fixed by Government of the India. The net return was worked out by subtracting the cost of cultivation from the gross return. The benefit: cost ratio (B: C ratio) was computed from the ratio of gross return and cost of cultivation.

Net returns (US $ ha^{-1}) = Gross returns - cost of cultivation.. (3)

B: C ratio = Gross returns/ cost of cultivation................ (4)

Statistical analysis

The agronomical data were analysed of randomized block design (RBD) in SPSS v.20 software. Statistical significance was set at an alpha level of 0.05. Means were compared by the least significant difference (LSD) test if the f-value was significant. The clustering of the 27 cultivars was done based on average linkage between the groups and the proximity matrix using squared Euchlidean distance (SPSS v.20 software).

RESULTS AND DISCUSSION

Genotypic variation in agronomical attributes

The plant height at maturity varied widely across the improved cultivars with the mean values ranging from 32.2 cm (GG-21) to 55.8 cm (OG-52-1) (Table 1). The height of the check cultivar (JL-24) was also comparable (41.4 cm) with the improved cultivars. The variation of groundnut cultivars had a significant (p<0.05) influence on all yield attributes *viz*., pegs plant^{-1}, effective pods plant^{-1}, pod and grain weight per plant exhibiting among the cultivars (Table 1). The production of number of pegs per plant and effective pods per peg were maximum in ICGS-76 (24.3) followed by ICGV-86590 (23.3) and GG-21 (20.0). Of the

27 cultivars evaluated, only few cultivars could able to produce more than >75% of total pods filled with grains while many others had only 63-65% filled pods. Highest pod weight was recorded in ICGS-76 and ICGV-86590 compared to the local check JL 24. ICGS -76 and ICGV-86590 cultivars registered a significant improvement of 61.09 % and 39.36 % over the local check JL 24. The grain weight per unit area and 100 seed weight is the major yield attributing characters also exhibited high variation among the cultivars. Few improved cultivars such as ICGS-76 and ICGS-86 produced significantly (p<0.05) higher amount of grain per unit area compared to the remaining cultivars. ICGS-76 and ICGS-86 were the best cultivars the recorded an improvement of 87.67 % and 63.47 % respectively for grain weight per unit area over the local check JL-24.

Significant positive correlation (r= 0.90-0.98*, p<0.005) among these three yield attributes (effective pods per plant, pod and grain weight) with dry pod yield also affirmed it. Phakamas *et al*. (2008) also reported the significant effect of major yield attributing traits of groundnut on yield. Crop yield is an integrated result of various processes, including canopy photosynthesis, conversion of assimilates to biomass and partitioning of assimilates to grain and higher yield attributing traits (Datta *et al*., 2016; Frimpong *et al*., 2017; Singh *et al*., 2018). However, the efficiency of conversion of assimilates into pod or grain; vary with diverse genetic make-up of the cultivars coupled with its suitability of the cultivars to the growing environment (Nautiyal *et al*., 2012, Singh *et al*., 2014; Singh *et al*., 2018).

Table 1: Variation in agronomical attributes of groundnut cultivars tested in Manipur (averaged of 4 years).

Cultivars	Plant height at maturity (cm)	Nodules (No.)	Pegs plant^{-1} (No.)	Effective pods plant^{-1} (No.)	Pod weight (g plant^{-1})	Kernel weight (g plant^{-1})	100 kernel weight (g)
Early maturing genotype							
GG-7	50.5	24.3	17.5	12.0	6.71	4.31	66.3
GG-8	46.1	24.9	18.5	14.1	7.03	4.63	47.8
AK -159	42.7	20.3	16.5	11.9	6.12	3.72	94.7
SG-99	35.3	10.9	16.7	13.7	7.13	4.73	53.0
0G-52-1	55.8	19.1	19.2	13.2	7.03	4.66	26.0
ICGV-86590	34.2	26.8	23.3	18.0	8.81	6.41	49.0
FeE SG-10-1	48.1	14.7	17.9	12.8	6.30	3.90	41.1
ICGS-5	47.7	15.5	19.1	15.8	7.73	5.33	62.2
TG-37-A	36.6	12.5	18.4	14.7	7.53	5.13	47.6
Group average	44.1	18.8	18.6	14.0	7.2	4.8	54.2
Medium to late maturing genotype							
BG-3	44.5	10.3	15.9	10.1	4.57	2.17	51.9
Tirupati -4	48.3	16.6	14.9	10.0	4.90	2.82	54.3
GG-11	47.3	26.4	17.2	11.5	6.93	4.53	81.4
GG-14	50.1	12.1	14.4	11.3	5.64	3.06	72.9
GG-16	47.7	24.0	17.4	14.3	7.59	5.19	78.8
ICGS-76	47.6	34.3	24.3	19.5	10.17	7.35	65.4
GG-13	40.6	15.9	16.1	13.4	6.56	4.16	47.4
GG-20	36.0	14.8	19.5	15.5	6.93	4.53	50.1
M -13	41.2	12.8	19.5	14.2	6.66	4.34	56.5
B-95	41.8	16.2	13.6	9.5	4.32	2.47	77.7
ICGV-88448	43.3	20.9	16.1	10.9	5.21	2.81	74.9
HNG-69	36.7	11.2	15.6	10.8	5.13	2.73	59.8
CSMG 84-1	36.7	22.9	15.4	10.9	6.55	4.15	72.3
GG-21	32.2	17.0	20.0	16.1	7.45	5.05	62.9
TKG-19-A	52.3	17.0	18.0	14.8	8.18	5.78	81.3
NRCG-CS-281	42.5	14.4	17.7	14.0	7.19	4.79	96.9
Girnar-2	35.8	25.7	15.1	11.6	6.56	3.47	74.9
Group average	42.6	18.4	17.1	12.8	6.5	4.1	68.2
JL -24 (Check)	41.4	15.2	16.2	12.6	6.32	3.92	88.8
Mean	43.1	18.4	17.6	13.2	6.71	4.30	64.3
LSD (P=0.05)	4.7	8.1	2.1	1.8	0.47	0.57	3.2
CV (%)	14.3	28.08	14.0	18.4	19.0	27.9	26.7

Active nodule (pink or red in colour) count in roots varied widely among the cultivars and it ranged from 10.9 in SG-99 to 33.3 per plant in ICGS-76 at 50 DAS (Table 1). The highest nodulating improved genotype ICGS-76 recorded 2.2-fold increase in nodulation over local check (JL-24: 15.2 plant^{-1}). High amount of variation is observed in nodule formation among groundnut cultivars. This variation is primarily due to differences in emergence of auxiliary root hairs on lateral roots (Tajima *et al*., 2008) and similar observation has been made in this present study also.

Genotypic variation in production and economics

The wide variability among the 27 cultivars was studied across seasons from 2013 to 2016 (Table 2). Wide variation was observed among the cultivars for dry pod yield per hectare. ICGS-76 and ICGV-86590 produced more than 39% higher pod yield and ICGS-5, TKG-19 A, TG-37-A, GG-11 and GG-21 gave 19-38% significantly ($p<0.05$) higher pod yield over the check JL 24 across years. Similarly, mean shelling percentage of the pods among the cultivars ranged from 45.1 (BG-3) to 72.6% (ICGS-86). Only two cultivars viz., ICGS-76 and ICGV-86590 could register a mean improvement of more than 15% over the check JL-24 for shelling percentage across years. Mean Production efficiency (PE), an estimated parameter from the productivity

Table 2: Effect of genotypic variation on dry pod yield and shelling percentage.

Cultivars	Dry pod yield (t ha^{-1})					Shelling percentage					Mean PE	Mean Economics	
	2013	2014	2015	2016	Mean	2013	2014	2015	2016	Mean	(kg ha^{-1} day^{-1})	NR ($ ha^{-1})	BCR
Early maturing genotype													
GG-7	2.21	2.21	2.22	2.15	2.20	62.7	63.8	66.0	63.7	64.1	19.1	874	3.0
GG-8	2.47	2.52	2.21	2.14	2.34	62.6	68.2	64.3	68.3	65.9	19.4	965	3.2
AK 159	2.00	2.06	2.03	2.04	2.03	60.2	61.2	61.2	61.1	60.9	16.8	782	2.7
SG-99	2.43	2.42	2.39	2.29	2.39	64.9	67.0	65.4	67.0	66.1	19.1	985	3.2
0G-52-1	2.59	2.53	2.22	2.12	2.36	62.1	68.5	63.8	68.3	65.7	20.1	964	3.2
ICGV- 86590	3.03	3.04	2.81	2.71	2.90	70.4	73.8	72.4	73.9	72.6	22.4	1295	3.9
FeE SG-10-1	2.29	2.27	1.99	1.97	2.13	57.4	64.9	59.9	64.9	61.8	16.6	821	2.8
ICGS-5	2.53	2.50	2.66	2.56	2.56	68.6	68.0	70.4	68.0	68.8	20.4	1087	3.5
GG-11	2.50	2.54	2.52	2.46	2.51	67.4	61.0	69.5	61.0	64.7	17.5	919	3.1
Group average	2.45	2.45	2.34	2.27	2.38	64.0	66.3	65.9	66.2	65.6	19.0	965.8	3.2
Medium to late maturing genotype													
BG-3	1.26	1.24	1.85	1.75	1.52	54.1	35.1	56.1	35.2	45.1	12.1	465	2.0
Tirupati -4	1.59	1.67	1.62	1.52	1.60	61.7	55.7	57.1	55.7	57.6	13.4	525	2.2
GG-16	2.09	2.06	2.62	2.48	2.31	67.7	68.6	68.8	68.5	68.4	19.8	1081	3.4
ICGS-76	3.37	3.40	3.30	3.32	3.35	71.6	72.7	71.8	72.8	72.2	27.0	1569	4.5
GG-13	2.26	2.34	2.03	2.03	2.16	60.5	65.9	59.4	65.9	62.9	17.2	865	3.0
GG-20	2.46	2.47	2.22	2.12	2.32	62.2	67.5	63.8	67.6	65.3	18.3	947	3.1
M -13	2.16	2.18	2.31	2.21	2.22	62.7	65.0	65.4	65.0	64.5	18.3	887	3.0
B-95	1.41	1.44	1.51	1.49	1.46	56.0	57.9	58.9	57.9	57.7	12.9	437	2.0
ICGV-88448	1.77	1.77	1.77	1.71	1.75	52.9	54.9	53.9	54.9	54.2	14.0	607	2.4
T G-37-A	2.45	2.52	2.48	2.49	2.49	67.7	68.5	67.1	68.5	68.0	19.5	1058	3.4
HNG-69	1.58	1.66	1.75	1.76	1.69	54.5	51.6	53.8	51.7	52.9	13.0	579	2.3
CSMG 84-1	1.90	1.87	2.53	2.41	2.18	66.7	57.1	68.2	57.1	62.3	16.8	858	2.9
GG-21	2.60	2.59	2.43	2.33	2.49	65.3	69.2	66.0	69.2	67.4	19.4	1045	3.3
TKG-19-A	2.55	2.54	2.98	2.83	2.72	71.6	68.5	72.8	68.5	70.4	21.8	1189	3.7
NRCG-CS-281	2.53	2.47	2.24	2.14	2.34	62.3	67.6	67.6	67.6	66.3	18.7	953	3.1
GG-14	1.92	1.86	1.84	1.74	1.84	49.7	51.6	61.5	51.7	53.6	14.3	652	2.5
Girnar-2	2.25	2.22	1.77	2.36	2.15	51.0	51.4	59.4	51.4	53.3	17.2	839	2.9
Group average	2.13	2.14	2.19	2.16	2.15	61.1	60.5	63.0	60.5	61.3	17.3	856.2	2.9
JL -24	2.23	2.21	2.02	1.89	2.09	59.2	63.8	61.2	63.8	62.0	17.5	812	2.8
Mean	2.24	2.24	2.23	2.19	2.23	62.0	62.6	63.9	62.6	62.8	17.9	891.1	3.0
LSD (P=0.05)	0.25	0.27	0.25	0.23	0.18	7.7	7.3	5.6	7.3	5.6	1.3	98	0.2
CV (%)	20.9	20.7	19.1	18.8	18.9	9.9	13.5	8.6	13.5	10.5	18.4	28.3	18.8

PE, NR and BCR represent Production efficiency, net returns and benefit cost ratio, respectively.

(grain) per unit area and crop duration also varied widely among the cultivars. The medium duration genotype ICGS-76 with maximum pod yield obviously recorded the highest PE followed by early duration ICGV-86590 with second highest pod yield. The genotype TKG-19-A also produced significantly higher yield with better shelling percentage and PE than other cultivars as compared to the local check JL-24. Differential maturity groups (early and medium to late) among the cultivars marginally influenced the pod yield as evident from group average values in early (2.38 t ha^{-1}) groups as against the medium to late maturing group (2.15 t ha^{-1}). Even with shorter crop growth period in majority of the early duration cultivars, production efficiency (PE) did not increase since low pod yield produced by these cultivars offset the gain in early crop duration. Differences in pod yield among the cultivars are the major factor causing variation in net return (437- 1569 \$ ha^{-1}) and benefit: cost ratio (2.0 - 4.5) among the cultivars (Table 2). Though 12 cultivars ICGS-76, ICGV-86590, ICGS-5, TG 37 A, GG21, GG 11, TKG 19 A, GG 8, SG 99, OG 52-1, GG-16 and GG-20 showed significantly higher yield than JL-24 as the check cultivar. The higher dry pod yield in ICGS-76, ICGV-86590 and TKG-19-A and net return as estimated from the gross return after deducting cost of cultivation and benefit : cost ratio were significantly (p<0.05) higher than the other improved cultivars. Among the 27 test cultivars, ICGS-76 and ICGS-86590 were superior for yield attributing traits recording significant improvement over the check JL-24.

Shelling percentage is mostly influenced by the pod size, volume, kernel weight of cultivars as well as availability of calcium (Ca) in the soil (Misra *et al*., 2000; Misra, 2004; Singh *et al*., 2018). In (strong acidic) soils, exchangeable Ca^{2++} availability was 1.5 meq 100^{-1} g soil, which was just above the critical threshold limits (Ca1.0 meq 100^{-1} g soil) for the acid soils of the region (Patiram, 2007). Therefore, the wide variability in shelling percentage among the cultivars was mostly contributed by the differences among the cultivars for pod characters including grain yield per pod. The two high yielding cultivars ICGS-76 and ICGV-86590 recorded significantly better pod characters (higher number of effective pod, pod and grain per pod etc.) over others include local check. A strong positive correlation of these pod attributes with shelling percentage (r= 0.738 - 0.921*, p<0.0005) and higher shelling percentage of more than 72% in these two cultivars further affirmed our assumption was in confirmation with the earlier reports (Jnr *et al*., 2017). Variation in production efficiency was highly influenced by the dry pod yield (per ha) produced by the respective cultivars and was evident from a strong positive correlation (r=0.94, p<0.0005) of production efficiency (PE) with dry pod yield. Since all the cultivars were grown under similar management practices including variable cost (cost of human labour, seed and sowing, crop management, seed material and fertilizers), the variation in the estimated net return as well as benefit cost ratio was predominantly due to the pod yield/ha of the respective cultivars. It was also evident from the strong positive correlation of dry pod yield with net returns (r= 0.96*, p<0.0005) and benefit cost ratio (r= 0.97*, p<0.0005). As a result, higher dry pod yield producing cultivars namely ICGS-76 and ICGV-86590 is expected to improve the net income to a tune of 59-93% over local check (JL-24) while increasing the benefit: cost ratio by 39-60%. Similar observations of higher net return on adoption of improved cultivars of groundnut were reported by other workers (Singh *et al*., 2006; Datta *et al*., 2016).

Cluster analysis

The clustering based on average linkage between the groups and dissimilarity matrix using squared euchlidean distance for dry pod yield ha^{-1}, grouped the 27 cultivars in two main clusters (MC-1 and MC-2). The MC-2 cluster comprised of only one genotype, that is, ICGS-76 which out-yielded (3.35 t ha^{-1}) other cultivars. The remaining 26 cultivars in MC-1 cluster were grouped under two distinct sub-clusters (SC-A with 20 cultivars and SC-B with 6 cultivars). The SC-A was again represented by two sub-sub-clusters (SSC-1A with 18 cultivars and SSC-2A with 2 cultivars). The SSC-2A comprised of two high yielding cultivars *viz*., TKG-19-A (2.72 t ha^{-1}) and ICGV-86590 (2.90 t ha^{-1}); while 18 cultivars in SSC-1A represented the medium yielding group with dry pod yield ranging from 2.03 to 2.56 t ha^{-1}. The SC-B comprised of six low yielding cultivars represented in two sub-sub-clusters *viz*. SSC-1B (B-95, G-3 and Tirupati-4) and SSC-2B (ICGV-88448, HNG-69 and GG-14). Among the cultivars, maximum dissimilarity matrix of 3.572 was recorded between B-95 and ICGS-76, followed by BG-3 and ICGS-76 (3.349). These cultivars from divergent clusters would serve as appropriate parental lines for attaining highest genetic advance in respect of dry pod yield in groundnut.

CONCLUSION

From this study, it can be concluded that high yielding genotype such as ICGS-76, ICGV-86590, TKG-19-A, ICGS-5, TG 37 A, GG-21 and GG-11 have greater adaptability in the degraded strong acid soils of hilly ecosystem of Eastern Himalaya. Better yield attributing traits of these cultivars helped them to withstand multi-ferrous abiotic stresses (soil degradation from Jhuming, acidity) and thus, they could produce up to 60.3% higher mean dry pod yield over local check under similar agro-ecosystem management. Adoption of these cultivars will assures better productivity and profitability with higher net return without any extra cost to the existing production system. This may also offer a viable alternative to the existing low profit cereal based cropping systems (rice/maize-fallow) in the region thereby improving sub-optimal cropping intensity (<150%) and area diversification in the Jhum degraded acidic soils of rainfed hilly ecosystem.

ACKNOWLEDGEMENT

The authors are thankful to the Director, ICAR RC for NEH Region, Meghalaya, India for funding assistance. The authors express their sincere gratitude to Director, Directorate of Groundnut Research, Junagadh, Gujarat for providing the germplasm for current study.

REFERENCES

Ansari, M.A., Choudhary B.U., Prakash N. and Rajkhowa D.J. (2017). Comparative performance of maize (*Zea mays* L.) cultivars on productivity, quality, root dynamics and profitability in North Eastern Himalayan Region of India. Bangladesh J. Bot. 46(1):195-202.

Choudhury, B.U., Mohapatra, K.P., Das, A., Das P.T., Nongkhlaw, L., Fiyaz, A.R., Ngachan, S.V., Hazarika, S., Rajkhowa D.J. and Munda, G.C. (2013). Spatial variability in distribution of organic carbon stocks in the soils of North East India. Curr. Sci. 104:604-614.

Das, A., S. Babu, G.S. Yadav, M.A. Ansari, R. Singh, L.K. Baishya, D.J. Rajkhowa, S.V. Ngachan. (2016). Status and strategies for pulses production for food and nutritional security in North-Eastern region of India. Indian. J. Agron. 61 (Special issue):43-57.

Datta, M., Yadav, G.S. and Chakraborty S. (2016). Performances of groundnut varieties under sub-tropical climate of North East Hilly Agro-Ecological Region of India. Legume Res. 39(2):297-300.

FAOSTAT. (2014). Food and Agricultural Organization of the United Nations Statistics Division. Available online from http://www.fao.org /faostat/en/#data/QC. Accessed 23 Jan 2017.

Frimpong, R.O., Konlan S.P. and Ninju D.N. (2017). Evaluation of selected groundnut (*Arachis hypogaea* L.) lines for yield and haulm nutritive quality traits. Int. J. Agron. https://doi.org/10.1155/2017/7479309.

Jnr, E.Z., Amade M., Amane M.I.V., Brandenburg R.L. and Mondjana A.M. (2017). Effect of harvesting time on groundnut yield and yield components in Northern Mozambique. J. Post harv. Techol. 5(2):55-63.

Konlan, S., Sarkodie-addo, J., Asare, E. And Kombiok, M.J. (2013). Groundnut (*Arachis hypogaea* L.) varietal response to spacing in the Guinea savanna agro-ecological zone of Ghana: Growth and yield. Afr. J. Agric. Res. 8(22):2769-2777.

Misra, J.B. (2004). A mathematical approach to comprehensive evaluation of quality in groundnut. J. Food Compost. Anal. 17:69-79.

Misra, J.B., Ghosh P.K., Dayal D. and Mathur R.S. (2000). Agronomic, nutritional and physical characteristics of some Indian groundnut cultivars. Indian J. Agr. Sci. 70:741-746.

Nautiyal, P.C., Ravindra V., Rathnakumar A.L., Ajay B.C. and Zala P.V. (2012). Genetic variations in photosynthetic rate, pod yield and yield components in Spanish groundnut cultivars during three cropping seasons. Field Crops Res. 125: 83-91.

Patiram. (2007). Management and future research strategies for enhancing productivity of crops on the acid soils. J. Indian. Soc. Soil Sci. 55(4):411-420.

Phakamas, N., Patanothai A., Pannangpetch K., Jogloy S. and Hoogenboom G. (2008). Dynamic patterns of components of genotype environment interaction for pod yield of peanut over multiple years: A simulation approach. Field Crop. Res. 106:9-21.

Singh, A.L. (2004). Growth and physiology of groundnut. In: Groundnut Research in India (Eds. M.S. Basu and N.B. Singh), National Research Center for Groundnut (ICAR), Junagadh, India. pp. 178-212.

Singh, A.L., Nakar, R.N., Chaudhari, V., Chakraborty, K., Goswami, N., Kalariya, K.A., *et al* (2018). Physiological efficiencies of 186 peanut cultivars of various botanical groups. Indian J Expl Biology. 56 (12): 899-913.

Singh, A.L., Basu, M.S. and Singh, N.B. (2003). Potential of Groundnut in North-eastern States of India. National Research Center for groundnut (ICAR), Junagadh, India. 76 p.

Singh, A.L., Basu, M.S., Munda, G.C., Dutta, M., Singh, N.P., Patel, D.P. and Raychaudhuri, M. (2006). Groundnut Cultivation Technologies for North Eastern Hills of India. National Research Centre for Groundnut (ICAR), Junagadh, India. 50 p.

Singh, A.L., Hariprassana K. and Solanki R.M. (2008). Screening and selection of groundnut cultivars for tolerance of soil salinity. Aus. J. Crop Sci. 1:69-77.

Singh, P., Nedumaran S., Ntare B.R., Boote K.J., Singh N.P., Srinivas K. and Bantilan M.C.S. (2014). Potential benefits of drought and heat tolerance in groundnut for adaptation to climate change in India and West Africa. Mitig. Adapt. Strat. Gl. 19 (5): 509-529. http://oar.icrisat.org/6449/.

Tajima, R., Abe J., Lee O.N., Morita S. and Lux A. (2008). Developmental changes in peanut root structure during root growth and root-structure modification by nodulation. Ann. Bot. 101:491-499. doi:10.1093/aob/mcm322.