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A new promising early maturing groundnut (*Arachis hypogaea* L.) accession (KCGN -1) suitable for dry and intermediate zone of Sri Lanka

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Abstract

A considerable number of farmers in northern region in Sri Lanka still prefer to cultivate the groundnut land race Mullaithivu local because of its taste and ability to maintain in poor management condition under rain fed farming. Five lines were developed and purified from stocks of this cultivar collected from Mullaitivu (MU) and Muthaiyankattu (MUK). These lines were selected based on the pod shape, peak at the distal end of the legumes, and the presence of two seeds per pod. Selected lines were tested in Preliminary Yield Trial (PYT) and in National Coordinated Variety Testing trials (NCVT), with the recommended varieties Indi and Tikiri as controls. Farmer field performances at the latest stages were compared with that of farmer's preferred recommended variety Tissa. Recommended package of practices and standard plot size (1.8 x 3 m) were adopted in all experiments in all locations. KCGN-012-1 has given the highest yield with overall rank of 2 and 1 during NCVT trials in 2014/15 *Maha* and 2015/16 *Maha* respectively. It also has given rank 1 and highest average yield (3.9 t/ha) under Variety Adaptability Trial (VAT) conducted in five locations. It also showed preferred nutritional quality and acceptable taste as a table variety. Thus a short duration high yielding table purpose variety KCGN-01 (KCGN-012-1) was developed at Kilinochchi and it is suitable for cultivation in dry and intermediate zones of Sri Lanka.

Key words: Adaptability, Groundnut, Early maturity

Introduction

Groundnut (*Arachis hypogaea* L.) is a major oil seed as well as a food legume crop in Sri Lanka. It is also a valuable cash crop cultivated by small and large scale farmers in several countries. In Sri Lanka groundnut is being cultivated in 19,975 hectares with total production of 24,200 mt/year, even though, 3095 mt groundnut imported to fill gap between production and consumption (Agstat, 2017). As there is a demand for confectionary groundnut at present, development of varieties acceptable for local conditions is a timely need. Northern and Eastern provinces have potential areas for groundnut cultivation such as districts of Mullaitivu, Kilinochchi, Jaffna and Trincomalee under rain fed in *Maha* season and *Yala*, where in few pockets having adequate water availability.

There are five varieties of groundnut recommended by the Department of Agriculture. *viz*; Tissa (3 months), Indi (3.5 - 4.0 months), Walawe (4.0 - 4.5 months), Tikiri (3.5 months) and ANKG1 (3 months). Among them, Indi, Walawe and ANKG1 produce relatively higher yields (2.47 – 2.96 t/ha) than that of Tissa and Tikiri (0.8-1.0 t/ha) under farmer field conditions (Dharmasena, 2013).Variety Tissa is being cultivated in northern region as it requires less number of days for maturity than other recommended varieties. A considerable number of farmers still prefer to cultivate a locally popular land race namely Mullaitivu local. Though it yields poorly, farmers prefer this cultivar mainly because of preferable taste and adaptability for poor management condition during rain fed farming. A sequential selection method was proposed to minimize genotype by environment interactions (Branch *et al*., 1991). Historically, the first step in the development of high yielding cultivars is the selection of pure lines from a population represented in a landrace. Therefore, selection breeding is a simple way of realizing the genetic potential available within the landraces (Massawe *et al*., 2003). Pure line selection in indigenous cultivars or varieties from countries of comparable latitude and climate offers the greatest chance of success when starting a selection program for groundnut (Horst, 2004). Therefore, a selection program was initiated from a stock of locally collected seeds of groundnut landrace Mullaitivu local to have better yields, high consumer preference and early maturity which could fit better to the cropping system of groundnut cultivation in the region. This paper stems from a series of experiment conducted at Regional Agriculture

Research and Development Centre (RARDC), Kilinochchi for the selection of promising breeding line with accepted agronomic performances.

Materials and Methods

Locally collected groundnut seed materials from Mullaitivu Muthaiyankattu farmer fields were planted at the Regional Agriculture Research and Development Center (RARDC), Kilinochchi during *Maha* 2011/12. Since the stocks had a mixture of pods with single seeded, double seeded and triple seeded pods. Lines were selected based on the pod shape, peak at the distal seed of the legume, and the presence of only two seeds per pod. In addition a purified stock of collected Mullaitivu (MU) and Muthaiyankattu (MUK) have also tested initially in an observational trial. The experimental site was low land, which comes under Agro ecological region DL3 and having Red yellow latasols with well-drained soil. Of these selections seven more or less distinguishable lines *viz*; KCGN 012-1,KCGN – 012-2, KCGN – 012-3, KCGN – 012-4, KCGN – 012-5, MU and MUK were identified and compared with already recommended varieties Indi, Tikiri and Tissa Or Indi and Tikiri for their agronomic performances in early stages at the research station. Six advance breeding lines were selected and tested in the Preliminary Yield Trial (PYT) and the Major Yield Trial (MYT) during *Maha* 2013/14 and *Yala* 2014, respectively. Five better performing lines (KCGN – 012-1, KCGN – 012-2, KCGN – 012-3, KCGN – 012-5, MUK) were tested in National Coordinated Variety Testing (NCVT) trials at Kilinochchi, Angunakolapalasa, Aranaganwila, Thirunelvely and Mahailluppallama during *Maha* 2014/15 and *Yala* 2015. Selected lines (KCGN – 012-1, KCGN – 012-3, MUK) were tested in farmer fields in multi-location adaptability trials during *Maha* 2016/17. Lines tested in PYT and NCVT were compared with already recommended high yielding varieties Indi and Tikiri. Farmer field performances at the latest stages (Brelihela, Lunama, Kalthota, Ranjanganaya left bank and Galgamuwa) were compared with farmer's preferred recommended variety Tissa. Pod quantity and Qualities' characters of three testing lines were compared with the standard variety Tissa. Department of Agriculture recommended package of practices were adopted in all experiments in all locations with standard plot size with spacing of 45 x 15 cm. Pod yield data were analyzed using the ANOVA procedure in Statistical Analysis Software 9.1 (SAS) and means were compared using least significant difference (DMRT). Stability

of the lines in multi-location trials was assessed using the adaptability ranking method proposed by Abeysiriwardena *et al*. (1991). Nutritional quality analysis was done at Food Research Unit Gannoruwa using standard procedures. A tasting panel comprising 22 panelists had examined the taste of these tested lines and percentage preferences were recorded to compare the taste for this table purpose lines.

Results and Discussion

Table 1. Mean pod yield (mt/ha) of seven breeding lines and three recommended groundnut varieties tested at RARDC, Kilinochchi in *Maha* 2013/14 and *Yala* 2014

Entries	*Maha* 2013/14 (mt/ha)	*Yala* 2014 (mt/ha)
KCGN – 012-1	1.93a	2.14a
KCGN – 012-2	0.78 c	1.28 c
KCGN – 012-3	1.24bc	1.63 bc
KCGN – 012-4	1.30 abc	1.32 bc
KCGN – 012-5	0.95 bc	1.77 abc
MU	1.05 bc	1.36 bc
MUK	1.56 ab	1.81 ab
INDI	0.94 bc	1.35 bc
TISSA	1.40 abc	1.80 ab
TIKIRI	0.78 c	1.54bc
LSD	0.63	0.50
CV %	28.69	18.40

Note- Means followed by the same letter are not significantly different at p=0.05

Performances of selected breeding lines in PYT and MYT were evaluated at RARDC, Kilinochchi is given in table 01 and table 02. Out of seven selected lines KCGN-012-1 was performed with significantly higher yield (1.93 mt/ha) than that of other lines in 2013/14 *Maha* and 2014 *Yala* seasons (Table 1).

Among them, five high yield performing lines were nominated to NCVT *viz*; KCGN – 012-1, KCGN – 012-2, KCGN – 012-3, KCGN – 012-5 and MUK. Number of days to 50% flowering was same among selected lines but significantly lower (55)

than other recommended varieties Indi and Tikiri. Among these lines KCGN-012-1 had shown significantly early maturity in 102 days than others. This is a farmer preferable plant character compared with recommended varieties Indi (108 days) and Tikiri (108 days) which show more number of days for maturity. Significant different were shown in number of mature pods per plant (72) and number of seeds per plant (122) in Indi than selected lines (Table 2).

All selected lines and recommended varieties showed more or less same value for 100 seeds weight (Table 2). NCVT results are given in Table 3 and 4. There was no significant yield difference between KCGN-012-1 and other recommended varieties Indi and Tikiri at all three tested locations in *Maha* 2014/15. KCGN-012-1 had significantly higher yield (2.13 mt/ha) than that of other recommended varieties at Aranaganvila in *Maha* 2015/16. However there was no significant yield difference recorded among selected lines which were out yielded than the recommended varieties.

Table 2. Number of days to 50% flowering (days), Days to Maturity, No. of nodules per plant (number) and some important yield components of tested groundnut lines at RARDC, Kilinochchi in 2014/15 *Maha*

Accession	Number of days to 50% flowering (days)	Number of days to maturity	No. of nodules per plant	Number of mature pods per plant	Number of seeds per plant	Number of seeds per pod	100 Seeds weight (g)	Yield (t/ha)
KCGN-012-1	55bc	102e	316 a	52 b	89 b	2a	50.83 a	2.12 ab
KCGN-012-2	55 bc	105 c	317 a	53 b	88 b	2a	49.76 a	1.97 ab
KCGN-012-3	55 bc	104 d	297 a	63 ab	100 ab	2a	46.86 a	2.10 ab
KCGN -012-5	55 bc	106 b	283 a	57 ab	101 ab	2a	45.27 a	1.72 ab
MUK	56 ab	104 cd	252 a	57 ab	84b	2a	45.13 a	1.48 b
Indi	57 a	108 a	288 a	72 a	122 a	2a	45.13 a	2.37 a
Tikiri	57 a	108 a	315 a	64 ab	111 ab	2a	47.13 a	2.00 ab
LSD	1.26	0.89	85.67	16.32	33.6	0.00	9.09	0.75
CV %	1.27	0.47	16.26	15.31	19.05	0.00	11.1	21.45

Note- Means followed by the same letter are not significantly different at p=0.05

Table 3. Pod yield (mt/ha) and overall adaptability ranks of tested lines in NCVT 2014/15 *Maha*

Line/ Variety	Kilinochchi (t/ha)	score	Angunakolapalassa (t/ha)	score	MI (kg/ha)	score	Total score	Overall rank
KCGN – 012-1	0.79abc	6	0.89 a	7	2.76 ab	6.5	6.5	2
KCGN – 012-2	0.60 c	5	0.77 a	7	2.66 ab	6.5	6.125	4
KCGN – 012-3	0.65 bc	5.5	0.94 a	7	2.76 ab	6.5	6.5	2
KCGN – 012-4	0.89 abc	6	0.88 a	7	2.73 ab	6.5	6.5	2
MUK	0.79 abc	6	0.95 a	7	1.96 b	6	6.375	3
Indi (Check)	1.07 ab	6.5	0.98 a	7	2.83 a	7	6.75	1
Tikiri (Check)	1.20 a	7	0.85 a	7	2.53 ab	6.5	6.75	1
CV %	28.6		13.4		17			
LSD	0.44		0.002		0.80			

Note- Means followed by the same letter are not significantly different at p=0.05

Table 4. Pod yield (mt/ha) and overall rank of tested lines in NCVT 2015/16 *Maha*

Line/ Variety	Thirn alveli (t/ha)	score	Anguna palasa (t/ha)	score	Arala ganwila (t/ha)	score	Adaptability			Variance component method				
							Mean	Variance	Overall rank	Average yield over 3 locations (t/ha)	No of+ve deviatons out of 3	Adaptability parameters		Adaptability rank
												Mean deviations over locations	Interaction variance	
KCGN – 012-1	0.84ab	6.50	0.73a	7.00	2.13a	7.0	6.8	0.1	1	1.24	1	0.14	0.18s	1
KCGN – 012-2	0.77ab	6.50	0.86a	7.00	1.79ab	6.5	6.7	0.1	2	1.15	2	0.04	0.01ns	1
KCGN – 012-3	0.91a	7.00	0.57a	7.00	1.12c	5.0	6.3	1.3	4	0.87	1	-0.22	0.36s	4
KCGN – 012-4	0.69b	6.00	0.88a	7.00	1.82ab	6.5	6.5	0.3	3	1.13	1	0.03	0.04ns	2
MUK	0.78ab	6.50	0.68a	7.00	1.79ab	6.5	6.7	0.1	2	1.09	1	-0.01	0.02ns	3
INDI (Check)	0.82ab	6.50	0.81a	7.00	1.66b	6	6.5	0.3	3	1.10	1	0.00	0.01ns	2
Tikiri (Check)	0.77ab	6.50	0.93a	7.00	1.67b	6	6.5	0.3	3	1.13	1	0.03	0.03ns	2
CV %	12.7		25.1		13.1									

Note- Means followed by the same letter are not significantly different at p=0.05

All selected lines and recommended varieties showed more or less same value for 100 seeds weight (Table 2). NCVT results are given in Table 3 and 4. There was no significant yield difference between KCGN-012-1 and other recommended varieties Indi and Tikiri at all three tested locations in *Maha* 2014/15. KCGN-012-1 had significantly higher yield (2.13 mt/ha) than that of other recommended varieties at Aranaganvila in *Maha* 2015/16. However there was no significant yield difference recorded among selected lines which were out yielded than the recommended varieties.

Table 5. Pod yield (mt/ha) of three testing lines with comparison to the standard variety tested over five locations in 2016/17 *Maha*

Place	Average yield (mt/ha)			
	Muk	**KCGN – 012-1**	**KCGN – 012-3**	**Tissa**
Brelihela	4.4	4.6	3.8	4.1
Lunama	1.5	1.6	2	1.8
Kalthota	3.3	2.9	3.6	3.1
Rajanganaya left bank	2.5	2.2	2.4	2.4
Galgamuwa	4	2.6	2.9	2.4

Table 6. Adaptability rank of three testing lines with comparison to the standard variety tested over five locations in 2016/17 *Maha*

Line/ Variety	Distance from maximum response		Ave. yield (mt/ha)	Adaptability rank
	Mean	**Variance**		
KCGN – 012-1	0.9033	1.914	3.9	1
KCGN – 012-3	1.2258	6.412	3.6	2
Muk	1.3833	18.314	3.5	3
Tissa (check)	1.7962	19.254	3.1	4

Table 7. Pod quantity and qualities' characters of three testing lines with comparison to the standard variety Tissa

Line/Variety	Pod weight (g)	Pod circumference (cm)	Pod length (cm)	TSS/ Brix	pH	Acidity	Antioxidant activity (mg/100 ml)	Tasting panel preference (%)
KCGN–012-1	1	5	7	1.2	6.9	0.03	12	29
KCGN–012-3	0.9	5.5	6.6	1.3	6.9	0.03	14	23
MUK	1	4.3	7.2	1.4	6.6	0.03	7	27
Tissa	0.9	4.6	6.4	1.5	7.1	0.03	11	21

Performance of three lines compared with Tissa showed that KCGN-012-1 had highest yield adaptability in farmer field condition. Except Lunama, results obtained at all other five locations proved that, all three selected lines had higher yield than that of recommended variety Tissa and this results were proved that KCGN-012-1 was recorded highest yield of 4.6 mt/ha at Brelihela and also has high stability than that of other cheeked varieties.

KCGN-012-1 was a promising confectionary type groundnut line, when considering yield performance under NCVT and VAT. It has also given the highest yield overall rank of 2 and 1 during NCVT trials 2014/15 *Maha* and 2015/16 *Maha*, respectively (Table 3 and 4). It also has given first rank and highest average yield (3.9 mt/ha) under VAT trials conducted in five locations than that of other lines and recommended variety Tissa. Earlier findings at RARDC, Kilinochchi has also revealed that, KCGN-012-1 line can cultivated with two plants per hill gypsum application and earthning-up practice in order to obtain higher pod yield and better filling percentage with attractive kernels of ground nut seeds (Arasakesary *et al*., 2017).

The results of Food Research Unit, Gannoruwa proved that, KCGN-012-1 has highest average pod length (7 cm), pod circumference (5 cm), pod weight (1 g), Antioxidant activity (12 mg/100 ml) and taste preference than Tissa and it had acceptable acidity (0.03) with low pH (6.9) (Table 7). A tasting panel was conducted with 22 staff at RARDC, Kilinochchi. The results showed that, KCGN-012-1 was highest (29%)

preferred nuts when it is roasted and fried. Detail of grain quality and descriptors of this variety is given in appendex-01 and appendex-02 respectively.

Conclusion

This study concluded that, KCGN-012-1 a selected line of Mullaitivu was performing in PYT, NCVT and VAT and it had average yield of 2.13 mt/ha with early maturity. It also showed preferably preferred nutritional quality and acceptable taste as a table variety. Thus KCGN-012-1 was recommended for dry and intermediate zone cultivation in 2018 by Varietal Releasing Committee of the Department of Agriculture conditionally.

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Appendix- 01 Quality test report of groundnut (Food Research unit Gannoruwa)

Sample	Seed colour	Seed coat colour	Shell colour	Pod weight (g)	Pod circumferance (cm)	Pod length (cm)	Tss/ Brix	PH	Acidity	Antioxidant activity (mg/100ml)
K1	Greyed Orange Gp 164-D	Greyed Orange Gp 164-D	Greyed Orange Gp 164-D	1	5	7	1.2	6.9	0.03	12
Tissa	Greyed Orange Gp 164-D	Greyed Orange Gp 164-D	Greyed Orange Gp 164-D	0.9	4.6	6.4	1.5	7.1	0.03	11
K3	Greyed Orange Gp 164-D	Greyed Orange Gp 164-D	Greyed Orange Gp 164-D	0.9	5.5	6.6	1.3	6.9	0.03	14
MU	Greyed Orange Gp 164-D	Greyed Orange Gp 164-D	Greyed Orange Gp 164-D	0.9	4.4	6.9	1.3	6.9	0.03	16
MUK	Greyed Orange Gp 164-D	Greyed Orange Gp 164-D	Greyed Orange Gp 164-D	1	4.3	7.2	1.4	6.6	0.03	7

Appendix-02 Descriptor

Accession	Day length	Pod beak	Pod constriction	Pod colour	Seed colour	Reticulation
KCGN012 -1	Sensitive	Slight	Slight	Brownish	Variegated	Moderate
KCGN012 -3	Sensitive	Slight	Slight	Yellowish	One colour	prominent
MU	Sensitive	Slight	Moderate	light brown	One colour	prominent
MUK	Sensitive	Slight	Slight	light brown	Variegated	Sligh
TISSA	Sensitive	Slight	Deep	Brown	One colour	prominent

Accession	Growth habit	Stem branching pattern	Corolla	Stigma	seedling	stem	leaf	Leaf sheath	Plant height (cm)
KCGN012 -1	Decumbent 3	Irregular with flowers on main stem	Yellow & orange	White	light green	light green	green	Light green	46.2
KCGN012 -3	Decumbent2	Irregular with flowers on main stem	Yellow & orange	White	light green	light green	green	Light green	35.8
MU	Decumbent 3	Irregular with flowers on main stem	Yellow & orange	White	light green	light green	green	Light green	45.5
MUK	Decumbent 3	Irregular with flowers on main stem	Yellow & orange	White	light green	light green	green	Light green	37.4
TISSA	Decumbent 2	Irregular with flowers on main stem	Yellow & orange	White	light green	light green	green	Light green	33.2