Research Article

NARC-2019; A High Yielding Medium Duration Groundnut Variety Suitable for Commercial Cultivation in Pakistan

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Abstract | A high yielding medium duration Virginia semi spreading decumbent-2 groundnut line PG-1090 (BARD-479xICGV-87387) was developed at Oilseed Research Program, National Agricultural Research Center (NARC), Islamabad. The line was evaluated along with six other promising lines and checked across the country. Selection following pedigree method was continued up to F_5 generation. The generations, F_2 to F_5 were raised for consecutive selection as single plant progeny rows along with parents. PG-1090 being medium duration showed overall higher mean yield (4912 kg ha^{-1}) in preliminary, advance, national uniform yield and on-farms trials compared to other lines and check cultivars BARD-479 and Golden. Its attributes include 70% shelling, 100-kernel weight 66g, 20-pods length 58 cm, oil content 53% and protein content 28%. It was also evaluated under natural field condition to check its potential and tolerance against fungal disease and insects. The subject line is rated as moderately resistant to fungal attack. At the same time, it is 10 to 15 days earlier than check varieties i.e. BARD-479 and Golden. PG-1090 has been approved by concerned authorities as a new variety with the name NARC-2019 for cultivation in rain-fed as well as irrigated areas of Pakistan.

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Introduction

Groundnut (*Arachis hypogaea* L.) is cultivated in over 100 countries with an estimated area of 26 million hectares (mha) with a total of 44 million metric (M) tons world production. Its average yield is approximately 1,655 $kgha^{-1}$ (FAOSTAT, 2017). Two continents (Asia and Africa) produce almost 58.3% and 31.6%, respectively, comprising about 90% of the world's total production. China is the highest producer with 16.6 M tons while India and Nigeria produce 6.6 M tons and 3.4 M tons, respectively (FAOSTAT, 2017). In Pakistan, it is grown on an area of 91.1 thousand hectares with annual production of 74.8

thousand tons and average per hectare dry pods yield of 821.1 kg ha^{-1} (GoP, 2017). It is given great priority all over the world because of its beneficial characters. It is considered as a dense nutritious food in Ghana with high capability to generate income for producers and healthier life for consumers. The crop recorded high scores for nourishment, quality, affordability, acceptability, integrity, along with business/investment interest (Anim-Somuah et al., 2013). Ground nut is given pinnacle as a crop in Malawi and Tanzania for broadening the horizons of the country's economy and has been incorporated in the national investment plan and national agricultural development strategy (Anonymous, 2014). It is also used directly because of its rich nutritional characteristics and higher percentages of oil content (46.70%), protein (22.0%), carbohydrate (10.0%) and minerals (3.0%) (Patra *et al.*, 2011). The haulms of groundnut are important source of animal feed and high in crude protein as reported by Tolera (2008) and Yami *et al.* (2008) that crude protein values of 11.4% for groundnut haulm as compared to 5.6% of sorghum stover and can serves as supplements. Positive live weight gains were observed in sheep when supplemented with groundnut haulm (Abdou *et al.*, 2011).

Besides, groundnut being a leguminous crop, fixes atmospheric nitrogen and maintains soil fertility as it adds significant amounts of symbiotic nitrogen to fields and cropping-system (Mokgehle *et al.*, 2014). Groundnut is considered as cash crop and is regularly traded locally, and globally which funds significantly to rural communities cash income and national economy as well. It is a drought tolerant crop and appropriate for crop rotation in semi-arid areas. The average yield of ground nut is far away from its potential yield and more than 70% of potential yield has not been achieved yet (Hatam and Abbasi, 1994). Development of new varieties in field crops has significant role to enhance their yields (Khan *et al.*, 2016). Improved varieties play a vital role and yield of groundnut crop can be increased from 30% to 89% with high yielding varieties (Reddy *et al.*, 1993). There is, always a need to develop and promote improved varieties producing high yield with good quality characteristics (Naeem-ud-Din *et al.*, 2012; Raut *et al.*, 2010). The groundnut crop is self-pollinated crop in general but a bit out crossing occurs in it. The natural out crossing measured in groundnut is 0.27% and 0.99% reported during 1969 and 1970 respectively (Sneath *et al.*, 1973). Though hybridization is main procedure in plant breeding to create genetic variability but in case of groundnut, things are not so simple. The major purpose of the study was to develop a high yielding, early maturing variety with good food nutrients for ground growing farmers of Pakistan.

In the present study, the results of evaluation trials of medium duration groundnut entries over years has been presented leading to the identification of high yielding Virginia decumbent-2 growth habit groundnut variety NARC-2019 (PG-1090) suitable for commercial cultivation in Pakistan.

Materials and Methods

Advance line PG-1090 was developed from the cross of groundnut varieties BARD-479 and ICGV-87387. The cross(x) was attempted during the year 2000 at Oilseed Research Program, National Agricultural Research Center (NARC), Islamabad. Entry BARD-479 (Barani Agricultural Research and Development) is a high yielding, long duration, semi-spreading, large seeded Virginia type variety, while entry ICGV-87387 is a high yielding, medium duration, bunch type, medium seeded with compact pods. These entries were received from ICRISAT, India. Crossing of these two lines was made following hybridization pedigree method for developing a new line PG-1090. The F_1 generation was raised and consecutive selections were made up to F_5 as single plant progeny rows along with parents from 2002 to 2005. Selections were made on the basis of semi spreading, spreading and bunch type plant, leaf size, number of pods per plant, number of seeds per pod, and disease reaction under natural rain-fed conditions. In F_5 generation uniform promising lines were selected and their traits were confirmed on the basis of desired agronomic characters. Entry PG-1090 having semi-spreading nature was then evaluated in preliminary and advance yield trials during 2006 and 2007 and 2009 and 2010 respectively with row to row and plant to plant spacing of 45 cm and 10 cm. Then it was tested in National Uniform Yield Trials at six locations across the country viz., National Agricultural Research Center, Islamabad, Barani Agricultural Research Institute (BARI), Chakwal, Groundnut Research Station (GRS), Attock, Oilseed Research Institute (ORI), Faisalabad, Agricultural Research Station (ARS), Karak, Agricultural Research Institute (ARI), Mingora Swat, and Agricultural Research Institute

(ARI), Quetta during the years 2011 and 2012. It is important to mention that during 2011 one location ORI, Faisalabad was included in National Uniform Yield Trials on their request but was dropped during 2012 because of non-conducive environment for ground nut production. During 2012, ARI, Swat was included in trials because of conducive environment and also a growing area for groundnut in Pakistan. Majority of locations' soils were sandy to loam with more sand ingredients. The soil types are given in Table 14. While the weather data of all the locations during 2011 & 2012 is given in Table 12 and Table 13. For NUYT, seven entries including PG-1090 were planted in a randomized complete block design with three replications. Four rows of 4 meter length of each entry were planted keeping row-to-row and plant-to-plant spacing of 45 cm and 10 cm, respectively. A basal dose of NPK fertilizer @ 20, 80 and 50 kg ha^{-1} was applied at the time of planting. Gypsum @ 500 kg ha^{-1} was applied at flowering to get better pods development. Then PG-1090 was tested on larger plot size of 90 meters squares during the years 2013 to 2016 at different locations of Chakwal and Attock districts i.e. the promising groundnut growing areas. Agronomic studies were also conducted on sowing dates i.e., 1st and 15th April; 1st May, 15 May ;1st June, 15 June and 1st July,15 July, row and plant spacing (30cm x 10cm; 30cm x 15cm; 30cm x 20cm and 45cm x10cm; 45cm x 15cm; 45cm x 20cm and 60cm x 10cm; 60cm x 15cm; 60cm x 20cm) and NPK fertilizer trials with different doses of (0-0-0 kg ha^{-1}, 20-40-0 kg ha^{-1}, 30-60-0 kg ha^{-1}, 20-80-20 kg ha^{-1}, 20-80-50 kg ha^{-1} and 30-80-100 kg ha^{-1}) during the years 2011 and 2012. Oil content (%) was appraised at maturity by the method Nuclear Magnetic Resonance (NMR) spectro-photometer (Anonymous, 1995). For determining the protein, Bunchi Auto Kjeldahl model K-370 was used. The disease aspect data was also recorded as Tikka disease is major disease of groundnut in Pakistan. The yield data collected at harvest were analyzed statistically by using Least Significant Difference (L.S.D) test at 5% level of probability (Steel and Torrie, 1980).

Results and Discussion

Among the twenty entries evaluated in preliminary yield trials PG-1090 showed the highest mean dry pods yield of 4912 kg ha^{-1} as compared to check variety BARD-479 with mean dry pods yield of 3510 kg ha^{-1}. Table 1 depicts that per hectare yield is 40%

Table 1: *Preliminary Yield Trials conducted at NARC, Islamabad.*

S. No	Entries	2006 (yield kg ha^{-1})	2007 (yield kg ha^{-1})	Mean (kg ha^{-1})	Increase/ decrease over check (%)
1	PG-1090	5230	4593	4912	+40
2	BARD-479	4031	2989	3510	---
3	PG-1091	4068	3507	3788	+08
4	PG-1092	5294	4528	4911	+40
5	PG-1093	4223	2396	3310	-06
6	PG-1094	3617	2440	3029	-14
7	PG-1095	3608	2507	3058	-13
8	PG-1096	4384	2721	3553	+01
9	PG-1097	4935	3158	4047	+15
10	PG-1098	5005	4709	4857	+38
11	PG-1099	5325	4878	5102	+45
12	PG-1100	5581	4100	4841	+38
13	PG-1101	4028	3579	3804	+08
14	PG-1102	4089	2854	3472	-01
15	PG-1103	3713	1333	2523	-28
16	PG-1104	6037	5254	5646	+61
17	PG-1105	1455	3601	2528	-28
18	PG-1106	3663	3363	3513	-01
19	ICGV-93095	3136	4938	4037	+35
20	ICGV-93104	2846	2330	2580	-26
	L.S.D (0.05)	808	466		
	C.V (%)	11.33	8.08		

Table 2: *Advance Yield Trials conducted at NARC, Islamabad.*

S. No	Entries	2009 (yield kg/ha)	2010 (yield kg/ha)	Mean (kg/ha)	Increase/ decrease over check (%)
1	PG-1090	4422	3495	4000	+12
2	BARD-479	3852	3298	3575	---
3	PG-1102	3657	3812	3735	+04
4	PG-1100	3789	3268	3529	-01
5	PG-1041	3129	3487	3308	-07
6	PG-1136	4046	3608	3827	+07
7	PG-1137	3215	4155	3685	+03
8	PG-1141	2797	3874	3336	-07
9	PG-1143	3435	3869	3652	+02
10	PG-1144	2871	3873	3372	-06
	L.S.D (0.05)	714	288		
	C.V (%)	11.82	4.58		

Table 3: *Dry pods yield (kg ha^{-1}) of national uniform groundnut yield trials, 2011.*

Entries	NARC, Islamabad	ORI Faisalabad	BARI, Chakwal	GRS, Attock	ARI, Quetta	ARS, Karak	Mean (kg ha^{-1})	Increase over checks (%)
Golden	2198	1446	3151	3036	1892	1527	2208	PG-1090 gave 24 and 21% higher yields over check varieties Golden and BARD-479, respectively
PG-1166	3522	1444	3762	2972	2092	1388	2530	
04CGO02	2795	1099	4951	3671	2017	1850	2731	
PG-1144	3680	1364	3215	2382	2124	2266	2505	
BARD-479	2431	1874	3055	2936	2092	1203	2265	
PG-1090	3776	1469	4340	2931	2017	1850	2731	
PG-1137	2346	1110	3440	1993	2106	740	1956	
L.S.D (0.05)	513	N.S	416	444	N.S	545		
C.V (%)	7.02	20.67	8.78	8.89	48.64	19.81		

Table 4: *Dry pods yield (kg ha^{-1}) of national uniform groundnut yield trials, 2012.*

Entries	NARC Islamabad	Mingora Swat	BARI Chakwal	GRS, Attock	Sariab Quetta	ARS Karak	Mean (kg ha^{-1})	Increase over checks (%)
PG-1090	3875	1619	809	1279	1506	3416	2084	PG-1090 gave 7 and20% higher yields over check varieties BARD-479and Golden, respectively
PG-1137	3127	1896	1296	1308	1558	2616	1967	
BARD-479	3071	1575	1458	1184	1623	2766	1946	
PG-1144	3273	1666	1111	1283	1555	2500	1898	
04CGO02	2995	1896	1444	1327	1530	2366	1926	
PG-1166	3370	1619	1142	1394	1587	2300	1902	
Golden	3016	1709	1296	1438	1530	1466	1743	
L.S.D (0.05)	315	N.S	251	N.S	72	N.S		
C.V (%)	5.37	34.72	11.55	11.11	2.60	30.29		

Table 5: *Performance of PG-1090 at different locations under rain-fed conditions.*

Year	Locations	PG-1090 (yield kg ha^{-1})	BARD-479 (yield kg ha^{-1})	Golden (yield kg ha^{-1})	Increase over check BARD-479 (%)	Increase over check Golden (%)
2013	Mari (Attock)	2335	2003	2066	17	13
2014	Nila (Chakwal)	2550	2051	2093	24	22
2015	Bhegal (Chakwal)	2400	1879	1961	28	22
2016	Hazro (Attock)	1886	1565	1690	21	12
	Average	2293	1875	1953	22	17

higher as compared to check BARD-479 which is popular variety of Pothwar region of Pakistan. The new variety PG-1090 was tested in advance yield trials as a pre-requisite for variety approval purpose.

It is important to mention that the variety again produced the maximum mean dry pod yield of 4000 kg ha^{-1} which is 12% higher over check variety BARD-479 (Table 2). After testing in preliminary and advance yield trials, its testing was started country wide under National Uniform Yield Trials at six locations i.e. Islamabad, Swat, Chakwal, Attock, Quetta and Karak. On an average of all six locations, PG-1090 performed out rightly better than other varieties and dry pod yield was the highest mean dry pods yield of 2731 and 2084 kg ha^{-1} during the years 2011 and 2012, respectively. The yield was 21% and 20% higher than the Check. However, maximum production was obtained at Chakwal with 4355 kg ha^{-1} followed by PG-116 and PG-1137. Minimum production was obtained at Faisalabad location showing that its environment is not suitable for groundnut production, however, at Faisalabad its production was higher than the other varieties. As regards the production, Entry PG-1090 was found to have a clear edge over check varieties and showed 21 to 24 and 7 to 20% higher yield over best check varieties BARD-479 and Golden (Tables 3, 4 and Figures 3, 4). As a last check measure, the variety under discussion was tested at farmer's field at four locations on large plots for connective four years in traditional groundnut growing areas i.e. Mari (Attock), Hazro (Attock), Nila

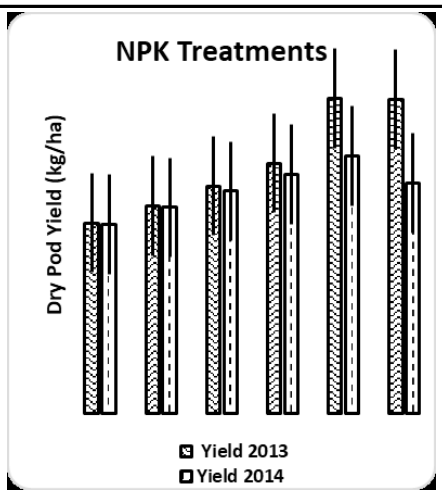

Figure 1: *(NPK) 0-0-0, 20-40-0, 30-60-0, 20-80-20, 20-80-50, 30-80-100.*

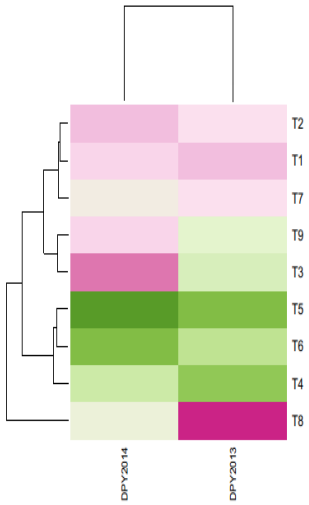

Figure 2: *The most green color showed the highest yield while the most redish one showed the lowest.*

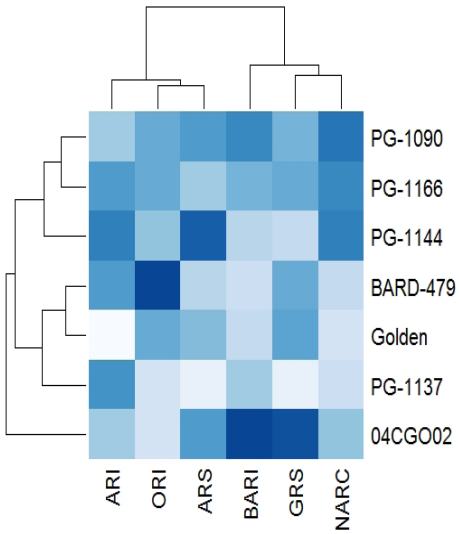

Figure 3: *The heat map showing the yield differences at different locations. The lighter color showed the lower yields while the darker one expressed the higher ones. e.g. at NARC the most darker color is shown in PG-1090 having Dry Pod Yield (4340 kg ha^{-1}) while the most lighter one shown against BARD-479 having DPY (1203 kg ha^{-1}).*

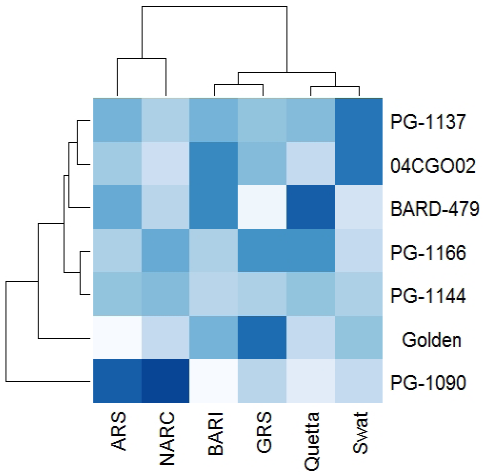

Figure 4: *The heat map showing the yield differences at different locations. Lighter color showed the lower yields while the darker one expressed the higher ones. e.g. at NARS the most darker color is shown in PG-1090 having DPY (3875 kg ha^{-1}) while the most lighter one shown against BARD-479 having DPY (1184 kg ha^{-1}).*

(Chakwal) and Bhegal (Chakwal).Combine results of four years indicated that candidate variety (PG-1090) produced 17 to 22% higher yield over check varieties Golden and BARD-479, respectively (Table 5). After testing and proving that PG-1090 has extra mile production than the prevailing varieties, agronomic trials for different sowing dates, row and plant spacing and fertilizer application were conducted for two years during 2013 and 2014. Sowing date trials were started from 1st April to 15th July to assess the best sowing date for its cultivation while harvesting was made in the month of September. Data indicated that 15th April is the best sowing date with maximum production of 2196 kg ha^{-1} and 2542 kg ha^{-1} during 2013 and 2014, respectively. However, sowing can be carried out up to 1st June with slight yield reduction (Table 6). As regards the row spacing, 45 x 15cm is the best for maximum production, however, 45 x 10cm and 45 x 20cm are also appropriate with slight yield loss (Table 7 and Figure 2). In agronomic trials nutrient application is much important, hence, fertilizer trials with six different doses were conducted having NPK @ 20-40-0 to 20-80-50 and 30-80-100kg ha^{-1}, respectively. The results showed that best fertilizer dose is 20-80-50 NPK with maximum yields using appropriate inputs (Table 8 and Figure 1). Pod and Kernel characters like shelling percentage, 100g Kernel weight and 20cm pod length was also better than both check varieties BARD-479 and Golden (Table 10). Over and under fertilization can affect the net economic results. Earliness of any crop depends on the early flower initiation. Flowers are the basic reproductive unit which plays. Pivotal role for enhancing yields of all seed crops Kaba *et al.* (2014).

Links Researchers

Information regarding flowering is very important in selection for improvement Lim and Gumpil (1984). Early onset of flowering is a basic component of early maturity and the first 25 flowers developed mature pods Baily and Bear (1973). Statistical analysis of the data showed that days to 50% flowering were significantly affected by varieties (Table 9). Lowest days to flowering were recorded for PG-1090, PG-1102, PG-1136 and PG-1143 while maximum days were reported for PG-1137 and PG-1141. Craufurd *et al*. (2000) reported that some genotypes of groundnut commenced flowering from 26-34 days after planting. Variances in days to flowering may be due to its genetic makeup as confirmed by Ishag (2000).

Table 6: *Effect of different sowing dates on the yield of Line PG-1090.*

Sowing dates	Dry pods yield (kg ha^{-1}) 2013	Dry pods yield (kg ha^{-1}) 2014
First April	1875	2240
15th April	2196	2542
First May	1865	2259
15th May	1841	2135
First June	1808	2059
15th June	1814	1964
First July	1665	1722
15th July	1740	1813
L.S.D (0.05)	88	211
C.V (%)	2.71	5.77

Table 7: *Effects of row and plant spacing on the yield of Line PG-1090.*

Row and plant spacing (cm)	Dry pods yield (kg ha^{-1}) 2013	Dry pods yield (kg ha^{-1}) 2014
30x10	1811	1963
30x15	1938	1883
30x20	2207	1778
45x10	2463	2187
45x15	2478	2448
45x20	2304	2333
60x10	1965	2045
60x15	1421	2098
60x20	2129	1943
L.S.D (0.05)	396	215
C.V (%)	11.00	6.00

Oil percentage and protein content are the most important features of oilseed crops especially groundnut. Results showed that PG-1090 has 3% higher oil content than both the check varieties while it has even 2% higher protein content as compared to checks showing its superiority in qualitative characters also (Table 10). Disease susceptibility is another important feature for the sustainability of variety in field. Hence, PG-1090 was screened under field conditions for important fungal disease of groundnut (*Cercospora personata*) along with the check varieties.

Table 8: *Effects of NPK fertilizers on the yield of Line PG-1090.*

Treatments N-P-K (kg ha^{-1})	Dry pods yield (kg ha^{-1}) 2013	Dry pods yield (kg ha^{-1}) 2014
0-0-0	1915	1899
20-40-0	2084	2068
30-60-0	2285	2233
20-80-20	2514	2400
20-80-50	3160	2585
30-80-100	3152	2316
L.S.D (0.05)	70	366
C.V (%)	4.89	8.94

Table 9: *Days to flower and 50% flowering data.*

S. No.	Variety	Days to flower initiation (Mean)	Days to 50% flowering (Mean)
1	PG-1041	31	33
2	PG-1141	33	35
3	BARD-479 (check)	35	37
4	PG-1136	29	31
5	PG-1100	29	31
6	PG-1090 (NARC-2019)	28	30
7	PG-1143	29	31
8	PG-1102	27	29
9	PG-1137	33	35
10	PG-1144	29	31

Table 10: *Pods and kernel characters of groundnut entry PG-1090 as compared to checks.*

Characters	PG-1090	Golden (check)	BARD-479 (check)
Shelling (%)	70	68	66
100-kernel weight (g)	66	61	61
20-pods length (cm)	58	58	57
Protein (%)	28	26.	26
Oil content (%)	53	50	50

Table 11: *Disease data of the Line PG-1090 under Natural Field Conditions at NARC, Islamabad.*

Lines	Disease reaction (0-9 scale)
PG-1090	3 MR*
BARD-479 (check)	4 S**
Golden (check)	4 S

**MR (Moderately Resistant); **S (Susceptible).*

The data showed that under 0-9 disease scale, its rating was 3MR as compared to check varieties having

4MR, so the variety under discussion is found to be moderately resistant to Tikka disease (Table 11). So, the candidate line was proved a high yielding with high nutritional value and tolerant to major disease through its good performance in all agronomic trials as given in (Tables 6, 8 and 9).

Table 12: *Temperature and rainfall of different locations year 2011 (Degree Celsius).*

	Months											
Location	January	February	March	April	May	June	July	August	September	October	November	December
Islamabad high	20	20	31	36	42	41	38	38	35	33	29	23
Low	2	5	10	12	20	24	24	22	20	12	8	2
Rainfall	21.9	281.56	121.26	154.91	111.14	89.24	205.42	229.89	121.2	88.8	15.6	1.3
Attock high	22	23	32	38	45	44	39	38	38	37	29	40
Low	1	6	9	12	19	24	23	24	20	12	9	0
Rainfall	23	285.91	121.76	143.32	95.39	71.65	190.17	213.01	146	83.4	27.3	2
Chakwal high	20	20	31	36	42	41	38	38	35	33	29	23
Low	2	5	10	12	20	24	24	22	20	12	8	2
Rainfall	17.8	245.78	99.75	125.02	86.11	75.33	180.09	249.62	133.8	75.6	13.8	1.4
Karak high	3	6	16	19	38	38	36	36	32	31	22	18
Low	0	4	16	17	16	16	17	20	16	9	0	1
Rainfall	27.2	238.15	57.49	67.79	14.30	0.0	9.3	27.84	18.70	3.1	27.6	1.5
Mingora high	3	6	16	20	38	38	36	36	32	30	22	18
Low	0	4	16	18	16	16	17	20	16	10	0	1
Rainfall	17.99	53.69	63.54	81.81	41.4	72.04	122.7	42.91	240.6	39.7	53.3	14.2
Faisalabad high	20	22	31	40	43	42	38	38	34	34	28	24
Low	7	10	15	18	23	20	23	23	23	18	15	6
Rainfall	0.2	97.6	10.04	43.24	47.38	35.36	83.7	93.57	155	5.7	1.2	0
Quetta high	16	17	27	32	37	38	38	39	32	31	24	18
Low	-2	-3	2	7	13	16	20	19	12	6	3	-5

Rainfall 26.3, 220.15, 52.99, 65.32, 16.3, 0.03, 12.3, 36.11, 17.6, 3, 8.9, 0.8

Table 13: *Temperature and rainfall of different locations year 2012 (Degree Celsius).*

	Months											
Locations	January	February	March	April	May	June	July	August	September	October	November	December
Islamabad high	20	20	31	36	42	41	38	38	35	33	29	23
Low	2	5	10	12	20	24	24	22	20	12	8	2
Rainfall	55.02	108.7	65.4	179.7	89.63	17.93	95.37	157.24	95.55	34.6	9.1	96.5
Attock high	22	23	32	38	45	44	39	38	38	37	29	40
Low	1	6	9	12	19	24	23	24	20	12	9	0
Rainfall	54.53	111.5	71.6	214.6	90.81	18.2	61.59	126.19	87.69	37.6	7.6	101
Chakwal high	20	20	31	36	42	41	38	38	35	33	29	23
Low	2	5	10	12	20	24	24	22	20	12	8	2
Rainfall	37.41	72.2	55.6	133.9	71.52	16.52	85.07	137.47	85.69	29.1	8.3	72.1
Karak high	3	6	16	19	38	38	36	36	32	31	22	18
Low	0	4	16	17	16	16	17	20	16	9	0	1
Rainfall	46.35	71.1	21.8	86.3	14.6	0.2	3.25	5.1	20.76	0	10.1	42.3
Mingora high	3	6	16	20	38	38	36	36	32	30	22	18
Low	0	4	16	18	16	16	17	20	16	10	0	1
Rainfall	16.82	39.8	81.1	85.4	134	73.4	145.7	102.17	194.06	37.3	28	132.7
Faisalabad high	20	22	31	40	43	42	38	38	34	34	28	24
Low	7	10	15	18	23	20	23	23	23	18	15	6
Rainfall	20.65	21.2	17.8	79.2	14.8	7.8	10.77	64.87	102.82	10.8	0.3	16.6
Quetta high	16	17	27	32	37	38	38	39	32	31	24	18
Low	-2	-3	2	7	13	16	20	19	12	6	3	-5

Rainfall 41.62, 69.5, 20.1, 99.6, 15.4, 0.5, 5.1, 4.9, 19.8, 0, 5, 41.

Table 14: *Soil types of all the locations used for testing of groundnut material in NUYT.*

Locations	Soil texture	FAO classification	USDA classification
NARC, Islamabad	Sandy loam	Haplic yermosols	Typic camborthids
BARI, Chakwal	Sandy loam to loam	Haplic yermosols	Typic camborthids
GRS Attock	Sandy loam to loam	Haplic yermosols	Typic camborthids
ORI, Faisalabad	Sandy clay loam	Haplic yermosols	Typic camborthids
ARS, Karak	Sandy clay	Haplic yermosols	Typic camborthids
Mingora, Swat	Sandy	Haplic yermosols	Xerollic calciorthids
Sariab, Quetta:	Silty clay loam	Haplic yermosols	Typic camborthids

Hence, NARC-2019 (PG-1090) is a high yielding groundnut candidate medium duration variety which was approved by variety evaluation committee, PARC and Punjab seed council, Lahore for commercial cultivation in Pakistan.

Conclusions and Recommendations

Medium duration high yielding Virginia decumbat-2 growth type variety NARC-2019 (PG-1090) was developed based on consistently significant superior pod yield across locations, and seasons with 10 - 15 days earlier maturity than existing varieties BARD-479 and Golden. It has yield potential of over 4300 kg ha^{-1} with an average yield of 2400 kg ha^{-1}. It has more oil content as well as protein content showing its qualitative superiority over other lines. At the same time, it possesses moderate resistance against Tikka Disease (*Cercospora personata* L.) and less defoliation at harvest. Hence, it is suited for general cultivation in all the groundnut growing areas of Pakistan with higher yield and higher nutrition.

Novelty Statement

The study under this paper is first and novel study to develop and approve a groundnut variety with high production potential with high quality characteristics for commercial cultivation in Pakistan.

Author's Contribution

All the authors helped in different tasks like designing, data collection, making write up, reference collection and draft reading for finalization of the paper.

Conflict of interest

The authors have declared no conflict of interest.

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