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Research Article

EFFECT OF CROP GEOMETRY AND INTEGRATED WEED MANAGEMENT IN *KHARIF* GROUNDNUT (*Arachis Hypogaea*)

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Abstract: A field experiment was conducted at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, S.D.Agricultural University, Sardarkrushinagar during *kharif* season of 2017 on loamy sand soil to study the effect of integrated weed management and crop geometry for getting maximum yield from *kharif* groundnut can be secured by growing crop with pair row sowing of 30-60-30 cm spacing. Interculturing followed by hand weeding at 25 and 40 DAS in *kharif* groundnut effectively controlled weeds and produced higher yield. Maximum yield and net profit from *kharif* groundnut can be secured by growing crop with pair row sowing of 30-60-30 cm spacing along with interculturing followed by hand weeding at 25 and 40 DAS. Under scarcity of labour, groundnut crop can be kept weed free by spraying of pendimethalin 1.0 kg/ha PE + interculturing followed by one HW at 30 DAS.

Keywords: *Integrated Weed Management, Crop Geometry, Day after Sowing*

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Introduction

Improvement Groundnut (*Arachis hypogaea*) is one of the most important edible oil seed crop in the world. It belongs to Leguminosae family. The groundnut originated in South America from where, it spreaded to Asia, Africa, Sudan, Nigeria, U.S.A. and other parts of the world. Groundnut is extensively grown in India during the *kharif* season. Initial slow growth combined with prostate nature of its growth and hot humid climate prevailing during the *kharif* season permit early and severe crop weed competition resulting in loss of yield to the tune of 75 percent [1]. Chemical control of weeds forms an excellent alternative to manual weeding. However, pre-emergence application of herbicides may allow the emergence of weeds after some time. Under such situation, integration of pre-emergence herbicidal treatments with hand weeding or post-emergence herbicides may help in reducing the losses caused by weeds. The present study was therefore initiated to find out an effective and economical weed control method in groundnut. Weeds are generally controlled with the conventional methods *i.e.*, cultural manipulation, either by hand weeding or hoeing which is very effective, but laborious and expensive too. Due to continuous rains, scarcity of labors during peak period and financial limitations make weeding difficult when the crop enters to reproductive stage and it also hinders the pegging and pod development. The effective and economic weed control on large scale is not possible through age old practice of manual and mechanical means. Thus, there is a need to evolve efficient and economical viable system for managing weeds. Crop geometry, particularly in high density crops like groundnut plays important role in harvesting the environmental resources, which ultimately influence the crop productivity. Alterations in crop geometry by way of manipulation in row spacing may impart competing ability in crop plants with weeds. In light of the above facts and paucity of adequate research evidences, the present investigation entitled, "Effect of crop geometry and integrated weed management in *kharif* groundnut (*Arachis hypogaea*)"

Materials and Methods

The field experiment entitled "Effect of crop geometry and integrated weed management in *kharif* groundnut (*Arachis hypogaea*)"was conducted during *kharif* season of 2017 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar which is situated in the North Gujarat Agro-climatic (Zone-IV of Gujarat). The climate of this region is sub-tropical monsoon type and falls under semi-arid region. In general, monsoon is warm and moderately humid, winter is fairly cold and dry, while summer is largely hot and dry. the soil of the experimental plot was loamy sand in texture, low in organic carbon (0.31 %) and available nitrogen (156.56 kg/ha) and medium in available phosphorus (43.41 %) and potash (253.02 kg/ha) content. Electrical Conductivity (EC) was very low showing that the soil was free from salinity hazard. Fifteen treatment combinations comprising, three treatments of crop geometry *viz*., G_1 : Line sowing with 45 cm, G_2 : Paired row sowing with 22.5-45-22.5 cm and G_3 : Paired row sowing with 30-60-30 cm and five treatments of integrated weed management *viz*., W_1 : Unweeded control, W_2 : Interculturing followed by hand weeding (HW) at 25 and 40 DAS, W_3 : Pendimethalin 1.0 kg/ha PE + interculturing and 1 HW at 30 DAS, W_4 : Imazethapyr 100 g/ha at 20 DAS PoE and W_5 : Pendimethalin 1.0 kg/ha PE followed by imazethapyr 100 g/ha at 20 DAS PoE were evaluated in split plot design with three replications. The variety TG 37 was shown on 15th June and recommended dose of fertilizer was 12.5-25-00 N-P-K kg/ha and all other recommended practices were adopted according to as per needed of crop requirement. Statistical analysis of the individual data of various characters studied in the experiment was carried out using standard statistical procedures [2]. Standard error of mean, critical difference (C.D.) at 5 percent level of probability and coefficient of variance were worked out for the interpretation of the results.

Table-1 *Effect of crop geometry and integrated weed management on weed count/m2 at 30, 60, 90 DAS and at harvest of kharif Groundnut*

Treatments	At 30 DAS			At 60 DAS			At 90 DAS			At harvest		
	Grasses	Broad leaves	Sedges	Grasses	Broad leaves	Sedges	Grasses	Broad leaves	Sedges	Grasses	Broad leaves	Sedges
Main plot: Crop Geometry (G) :												
G_1:	2.6(6.76)	2.2(4.77)	3.0(8.83)	4.3(18.55)	3.6(12.53)	4.6(21.21)	4.6(21.06)	3.8(14.30)	4.9(23.79)	5.0(25.19)	4.2(17.60)	5.2(27.38)
G_2:	2.5(6.20)	2.2(4.62)	2.9(7.95)	4.1(16.54)	3.4(11.48)	4.4(19.05)	4.4(18.92)	3.6(13.15)	4.6(21.48)	4.8(22.66)	4.0(16.20)	5.0(24.79)
G_3:	2.5(6.01)	2.1(4.33)	2.8(7.72)	4.0(16.17)	3.4(11.28)	4.3(18.64)	4.3(18.51)	3.6(12.93)	4.6(21.05)	4.7(22.18)	4.0(15.91)	4.9(24.27)
S.Em.±	0.08	0.05	0.06	0.10	0.06	0.10	0.10	0.07	0.10	0.10	0.07	0.11
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. (%)	12.03	8.36	8.98	9.11	7.16	9.06	8.67	6.91	8.56	8.7	7.11	8.50
Sub-plot: Integrated Weed Management (W) :												
W_1:	6.4(40.95)	5.5(29.75)	6.2(38.67)	7.0(48.75)	5.5(30.37)	7.0(49.42)	7.2(51.41)	5.8(33.86)	7.2(52.26)	7.7(59.44)	6.1(37.70)	7.7(59.91)
W_2:	1.3(1.24)	1.2(1.12)	2.1(4.17)	3.0(8.96)	2.6(6.30)	3.5(12.17)	3.2(10.24)	2.8(7.84)	3.8(14.30)	3.7(13.25)	3.1(9.36)	4.0(16.16)
W_3:	0	0	0	3.4(11.23)	2.9(8.02)	3.8(13.98)	3.7(13.83)	3.1(9.12)	4.1(16.32)	4.0(16.24)	3.4(11.35)	4.3(18.22)
W_4:	3.1(9.42)	2.5(5.87)	3.4(11.58)	3.8(14.29)	3.3(10.63)	4.0(16.23)	4.1(16.97)	3.6(12.53)	4.4(19.01)	4.5(20.34)	4.0(16.17)	4.7(22.48)
W_5:	2.1(3.94)	1.8(3.08)	2.7(6.86)	3.6(12.60)	3.1(9.18)	3.9(14.89)	3.9(14.89)	3.2(9.99)	4.1(16.74)	4.3(18.14)	3.8(14.14)	4.5(19.89)
S.Em.±	0.10	0.06	0.08	0.11	0.07	0.12	0.11	0.08	0.12	0.13	0.09	0.13
C.D. at 5 %	0.29	0.17	0.24	0.32	0.21	0.35	0.33	0.22	0.36	0.37	0.26	0.38
Interaction (G × W):	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. (%)	11.73	8.32	8.61	7.92	6.40	8.03	7.67	6.28	7.80	7.8	6.56	7.80

Figures presented in parentheses indicate the transformed data √ (x + 0.5)

Table-2 *Effect of crop geometry and integrated weed management on dry weight of weeds (g/m2) at harvest of kharif groundnut*

Treatments			Dry weight of weed (g/m^2) at harvest		
			Grasses	Broad leaves	Sedges
Main plot : Crop Geometry (G) :					
G_1	:	Line spacing with 45 cm	4.8(23.24)	5.0(25.41)	3.6(12.92)
G_2	:	Paired row sowing with 22.5-45-22.5 cm	4.6(21.10)	4.8(23.28)	3.5(12.19)
G_3	:	Paired row sowing with 30-60-30 cm	4.6(20.70)	4.8(22.86)	3.5(12.03)
S.Em.±			0.09	0.09	0.05
C.D. at 5 %			NS	NS	NS
C.V. (%)			7.36	7.08	6.02
Sub-plot : Integrated Weed Management (W) :					
W_1	:	Unweeded control	9.1(82.65)	7.6(57.91)	5.6(31.70)
W_2	:	Interculturing followed by hand weeding at 25 and 40 DAS	3.1(9.13)	3.2(10.25)	2.2(4.70)
W_3	:	Pendimethalin 1.0 kg/ha PE + interculturing and 1 HW at 30 DAS	3.4(11.22)	4.6(20.70)	2.5(5.91)
W_4	:	Imazethapyr 100 g/ha at 20 DAS PoE	4.1(16.32)	4.6(21.24)	3.8(14.61)
W_5	:	Pendimethalin 1 kg/ha PE followed by imazethapyr 100 g/ha at 20 DAS PoE	3.8(14.22)	4.4(19.73)	3.6(12.52)
S.Em.±			0.10	0.11	0.06
C.D. at 5 %			0.29	0.32	0.18
Interaction (G × W) :			NS	NS	NS
C. V. (%)			6.48	6.68	5.21

Figures presented in parentheses indicate the transformed data by √ (x + 0.5)

Result and Discussion

Weed studies

During the experiment on *kharif* groundnut different weed flora *viz*., grasses, broad leaved and sedges were noted.

Effect of crop geometry

It was evident from the data that differences in weed count of grasses, broad leaved and sedges at 30, 60, 90 DAS and at harvest did not differ significantly due to crop geometry. Numerically higher weed count was observed under line sowing with 45 cm (G_1) followed by paired row saplings 22.5-45-22.5 cm (G_2) and paired row saplings 30-60-30 cm (G_3). The results are in close conformity with [3] and [4]. The data presented in [Table-2] indicated that the differences in dry weight of weeds recorded at harvest of groundnut were found non-significant due tocrop geometry.

Effect of integrated weed management practices

An appraisal of data indicated that difference in weeds count at 30, 60, 90 DAS and at harvest were found significant. The weeds count of grasses, broad leaved and sedges obtained maximum with the application of (W_1). All the weed management treatments significantly reduced the population of weeds compared to unweeded control. While lowest weed count was noted under pendimethalin 1.0 kg/ha PE + interculturing and 1 HW at 30 DAS (W_2).

The lower weed count of different types of weed flora under these treatments might be due to effective weed control under these treatments in *kharif* groundnut.

The results are supported by the findings of [5] and [6]. Different weed management treatments significantly influenced dry weight of weeds at harvest. Significantly the lowest dry weight of weeds at harvest was recorded under the treatment W_2 (Interculturing followed by hand weeding at25 and 40 DAS). Treatments W_3, W_5 and W_4 also noted significantly lower dry weight of weeds then that of unweeded control. This was due to significantly lowest category wise weed populations observed as explained in [Table-1]. Whereas, significantly highest weed dry weight was observed under W_1: Unweeded control. Similar results were conformity [7].

Interaction effect

It is evident from the data presented that different crop geometry and integrated weed management treatments found non-significant on weed count at 30, 60, 90 DAS and at harvest and dry weight of weeds.

Growth parameters and yield parameters studies

Effect of crop geometry

Data narrated in [Table-3] indicated that significantly maximum plant height 41.26 cm at harvest, respectively were recorded with paired row sowing with 30-60-30 cm (G_3) spacing, but it was at par with 22.5-45-22.5 cm spacing (G_2) at harvest (40.23 cm). Significantly lowest plant height at harvest (35.87 cm) was found under line sowing with 45 cm row spacing (G_1), this was due to no competition under optimum spacing for the plants to use moisture, nutrients and light. The taller plants in paired row sowing with narrow spacing did not get opportunity to-

Table-3 *Effect of crop geometry and integrated weed management on growth parameters of kharif groundnut*

Treatments	Plant height (cm) at harvest	Number of branches/plant	Number of pods/plant
Main plot: Crop Geometry (G):			
G_1 : Line spacing with 45 cm	35.87	7.13	12.59
G_2 : Paired row sowing with 22.5-45-22.5 cm	40.23	7.59	13.11
G_3 : Paired row sowing with 30-60-30 cm	41.26	8.22	15.64
S.Em.±	0.99	0.18	0.43
C.D. at 5 %	3.89	0.71	1.68
C.V. (%)	9.80	9.12	12.59
Sub-plot: Integrated Weed Management (W) :			
W_1 : Unweeded control	34.34	6.79	8.82
W_2 : Interculturing followed by hand weeding at 25 and 40 DAS	42.82	8.17	17.02
W_3 : Pendimethalin 1.0 kg/ha PE + interculturing and 1 HW at 30 DAS	40.30	7.94	15.84
W_4 : Imazethapyr 100 g/ha at 20 DAS PoE	38.01	7.47	12.07
W_5 : Pendimethalin 1 kg/ha PE followed by imazethapyr 100 g/ha at 20 DAS PoE	40.12	7.87	15.14
S.Em.±	0.96	0.16	0.39
C.D. at 5 %	2.80	0.46	1.14
Interaction (G × W):	NS	NS	Sig.
C. V. (%)	7.35	6.18	9.30

Table-5 *Yield and gross realization (Rs/ha), net return (Rs/ha) and benefit: cost ratio (BCR) of groundnut as influenced by various treatments*

Treatments	Pod yield (kg/ha)	Haulm yield (kg/ha)	Gross realization	Total cost of cultivation	Net return	BCR
Main plot : Crop Geometry (G) :						
G_1	1828	3534	80188	55161	25027	1.45
G_2	2118	4287	93294	60945	32349	1.53
G_3	2250	3895	97790	55754	42036	1.75
S.Em.±	67	133				
C.D. at 5 %	265	523				
C.V. (%)	12.64	13.20				
Sub-plot : Integrated Weed Management (W) :						
W_1	1595	3455	70710	53863	16847	1.31
W_2	2428	4211	105542	60888	44654	1.73
W_3	2243	4110	97940	59630	38310	1.64
W_4	1914	3726	85772	54899	30873	1.56
W_5	2147	4024	97648	57153	40495	1.71
S.Em.±	49	137				
C.D. at 5 %	143	399				
Interaction (G × W) :	Sig.	NS				
C. V. (%)	7.12	10.50				

proliferate laterally due to the less lateral space. Hence, plants were compelled to grow more vertically for the fulfilment of light requirement for photosynthesis. So, here it was found that with the increase in plant density the plant height was increased. These results are in accordance with those reported by Kumar *et al*. (2004). Significantly higher number of branches per plant at harvest (8.22) were recorded under paired row sowing with 30-60-30 cm (G_3) spacing, but remain at par with which 22.5-45-22.5 cm (G_2) spacing (7.16 and 7.59 cm, respectively). Sowing with 45 cm row spacing (G_1) registered significantly lowest number of branches per plant at harvest (7.13).The results given in [Table-5] revealed that numbers of pods per plant were significantly influenced due to different crop geometry. Paired row sowing of groundnut with 30-60-30 cm spacing (G3) recorded the highest pods per plant (15.64) as compared to other treatments. The lowest numbers of pod per plant (12.59) were obtained under G_1 (line spacing with 45 cm). Significantly higher pod yield of 2250 kg/ha was recorded under paired row sowing of 30-60-30 cm spacing (G_3), which was statically at par with paired row sowing with 22.5-45-22.5 cm (2118 kg/ha). Significantly the highest haulm yield of 4287 kg/ha was produced with treatment G_2 (paired row spacings, 22.5-45-22.5 cm), but remained at par with treatment G_3 (Paired row sowing with 30-60-30 cm) with the corresponding value of 3895 kg/ha.

Effect of integrated weed management

The data presented in [Table-4] revealed that the plant height was significantly influenced due to integrated weed management treatments at harvest. Significantly higher plant height (42.2 cm) was observed under W_2 (Interculturing followed by hand weeding at 25 and 40 DAS), but it was found on at par with treatment W_3 (20.28 cm and 40.30 cm, respectively) and W_5 (19.96 cm and 40.12 cm, respectively). Significantly lowest plant height (34.34 cm at harvest) was noticed under unweeded control (W_1). The highest plant height observed under W_2 (Interculturing followed by hand weeding at 25 and 40 DAS) was because of weed free situation due to effective suppression of weeds by interculturing and hand weeding. These results are in conformity with observations of [8] [9] and the lowest plant height in unweeded control was due to more competition between crop and weeds for moisture, nutrient, light and space. The results are in conformity with the findings of [10]. Treatment W_2 (Interculturing followed by hand weeding at 25 and 40 DAS) bearded significantly more number of branches per plant at harvest (8.17), but it remained at par with treatment W_3 (Pendimethalin 1.0 kg/ha PE + interculturing and 1 HW at 30 DAS) and W_5 (Pendimethalin 1 kg/ha PE followed by imazethapyr 100 g/ha at 20 DAS PoE) at 30 DAS and W_3 as well at harvest. Significantly, the lowest numbers of branches per plant were observed under W_1 (Unweeded control). The higher number of branches in W_2 treatment was attributed to better growing conditions due to clean control of weeds and improving soil aeration with the aid of interculturing and hand weeding operations. The data furnished in [Table-3] cleared that number of pods per plant were significantly influenced due to integrated weed management treatments. Treatment W_2 (interculturing followed by hand weeding at 25 and 40 DAS) produced significantly maximum number of pods per plant (17.02), while the lowest number of pods per plant (8.82) were recorded under treatment unweeded control (W_1). Significantly highest pod yield of 2428 kg/ha was obtained with treatment W_2 (interculturing followed by hand weeding at 25 and 40 DAS). Significantly lowest pod yield (1595 kg/ha) of groundnut was noticed under unweeded control plot (W_1). The treatment W_2 (interculturing followed by hand weeding at 25 and 40 DAS) gave higher haulm yield (4211 kg/ha). This treatment remained at par with treatment W_3 (Pendimethalin 1.0 kg/ha PE + interculturing and 1 HW at 30 DAS) and W5 (Pendimethalin 1.0 kg/ha PE followed by imazethapyr 100 g/ha at 20 DAS PoE) with the corresponding haulm yield of 4110 kg/ha 4024 kg/ha, respectively.

The magnitude of increase in pod yield due W_2, W_3 and W_5 over W_1 was to the extent of 52.23, 40.63 and 34.61 percent, respectively. This might be due to effective weed control through integrated weed management practices resulted in decrease plant competition and increase in yield attributing parameters like pods per plant, and pod yield per plant. This might be also due to support the results like pod yield and haulm yield increase is due to decrease in number of weeds, dry weight and higher weed control efficiency. Cumulative effect of herbicides and hand weeding facilitating peg penetration and pod development with less weed competition and consequently higher pod yield has been reported by [11] and [12].

Interaction effect

The interaction effect of crop geometry and integrated weed management treatments on plant height and number of branches at harvest were found non-significant. Numbers of pods per plant were significantly affected due to interaction effect between different crop geometry and integrated weed management treatments. Significantly the highest number of pods per plant (19.7) was observed under treatment combination G_3W_2 (paired row spacings with 30-60-30 cm and interculturing followed by hand weeding at 25 and 40 DAS), which remained at par with G_3W_3 (paired row spacings with 30-60-30 cm and pendimethalin 1.0 kg/ha PE + interculturing and 1 HW at 30 DAS) with the value of 17.9. Treatment combination G1W1 (line spacing with 45 cm and obtained under unweeded control) recorded significantly the lowest (6.5) number of pods per plant. Significantly the highest pod yield (2700 kg/ha) was observed under treatment combination G_3W_2 (paired row sowing of 30-60-30 cm spacing and interculturing followed by hand weeding at 25 and 40 DAS), but it remained at par with G_3W_3 (2553 kg/ha) and G_2W_2 (2468 kg/ha). This might due to paired row sowing and effective weed control through hand weeding at 25 and 40 DAS interval, which reduced crop weed competition, increased nutrient availability to crop that led to higher pod yield. Interaction effect between different crop geometry and integrated weed management treatment was not observed significant with respect to haulm yield of groundnut.

Table-4 *Interaction effect of crop geometry and integrated weed management on number of pods/plant at harvest of kharif groundnut*

Treatments	W_1	W_2	W_3	W_4	W_5
G_1	6.5	15.7	13.9	12.1	14.7
G_2	10.4	15.7	15.7	10.5	13.3
G_3	9.6	19.7	17.9	13.6	17.5
S.Em.±	0.68				
C.D. at 5%	1.98				
C.V. (%)	9.3				

Economic studies

An economics indicating total income, total cost of cultivation, net return and benefit: cost ratio (BCR) under various crop geometry and integrated weed management treatments are presented in [Table-5].

Effect of crop geometry

Maximum net profit of Rs 42,036/ha with higher benefit : cost ratio (BCR) (1.75) was obtained when crop was sown at paired row spacing of 30-60-30 cm (G_3) followed by paired row spacing of 22.5-45-22.5 cm (G_2), which realized net profit of Rs 32,349/ha with benefit : cost ratio (BCR) of 1.53. Data further indicated the lowest net profit of Rs 25,027/ha and benefit: cost ratios (BCR) (1.45) were obtained under treatment G_1 (line sowing with 45 cm).

Table-6 *Interaction effect of crop geometry and integrated weed management on pod yield (kg/ha) of kharif groundnut*

Treatments	W_1	W_2	W_3	W_4	W_5
G_1	1484	2115	1803	1821	1917
G_2	1628	2468	2372	1923	2198
G_3	1672	2700	2553	1999	2326
S.Em.±	85				
C.D. at 5%	248				
C.V. (%)	7.12				

Effect of integrated weed management practices

Perusal of data presented in [Table-5] revealed that the highest net profit of Rs 44,654/ha was obtained with treatment W_2 (Interculturing followed by hand weeding at 25 and 40 DAS) followed by W_5 (Pendimethalin 1.0 kg/ha PE followed by imazethapyr 100 g/ha at 20 DAS PoE) realized worth Rs. 40,495/ha. Similar trend that of net return was also observed in case of benefit: cost ratio (BCR). Treatment W_2 (Interculturing followed by hand weeding at 25 and 40 DAS) recorded maximum benefit: cost ratio (BCR) value of 1.73. The minimum net profit (Rs 16,847/ha) and benefit: cost ratio (BCR) (1.31) were observed under treatment W_1 (Unweeded control).

Interaction effect

Data given in [Table-5] indicated that the highest net return of Rs. 57,185/ha with benefit : cost ratio (BCR) value of 1.96 were realized under treatment combination G_3W_2 (Paired row spacing 30-60-30 cm along with interculturing followed by hand weeding at 25 and 40 DAS). The next best treatment combination was G_3W_3 (Paired row spacing 30-60-30 cm along with Pendimethalin 1.0 kg/ha PE + interculturing and 1 HW at 30 DAS) gave net return of Rs 52371/ha with benefit: cost ratio (BCR) of 1.90.

Conclusion

From the one year experimentation, it is concluded maximum yield from *kharif* groundnut can be secured by growing crop with pair row sowing of 30-60-30 cm spacing. Interculturing followed by hand weeding at 25 and 40 DAS in *kharif* groundnut effectively controlled weeds and produced higher yield. Maximum yield and net profit from *kharif* groundnut can be secured by growing crop with pair row sowing of 30-60-30 cm spacing along with interculturing followed by hand weeding at 25 and 40 DAS. Under scarcity of labour, groundnut crop can be kept weed free by spraying of pendimethalin 1.0 kg/ha PE + interculturing followed by one HW at 30 DAS.

Application of research: Research related with agricultural practical practices and useful for the farmer's community

Research Category: Integrated Weed Management

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Study area / Sample Collection: Field area

Cultivar / Variety / Breed name: Groundnut (*Arachis hypogaea*) TG 37

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