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Effects of Plant Spacing and Population Density on Growth, Yield and Yield Attributes of Groundnut

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Abstract: **The world's most significant annual legume, groundnut (Arachis hypogaea L.), is primarily farmed for food, animal feed, and oilseed. Three years in a row, the experiment was run at two different locations. Three replicates were used in the split-spilt plot design of the experiment. Pre-tagged samples of five plants per plot were used to record data on growth and yield parameters such as days to 50% emergence, days to 75% emergence, 50% flowering, days to 75% maturity, stand count at maturity, mature pod/plant, branch number/plant, dry pod yield, shelling%, 100 seed weight, and pest and disease reaction. Plant spacing and variety had no discernible effects on the phenologcal phases of groundnut growth at either site. The quantity of ripe pods per plant and the weight of the seeds were significantly impacted by variabilities. While NC-343 had a larger seed weight at both Babile and Goffa, the variety Werer 961 had more pods. Only the stand count at maturity was considerably impacted by inter-row spacing, but both SCAM and MPPP were impacted by intra-row spacing. At both sites, a high population density was noted with smaller intrarow and interrow separations of 10 cm and 50 cm, respectively, and declined consistently with increasing inter and intra spacing, although MPPP fell inconsistently with increased intra spacing. For both locations, there was no statistically significant interaction between the inter- and intra-spacing. Groundnut grain yield was highly influenced by the year, variety, and intra- and inter-spacing. In both areas, a higher yield was obtained during the 2011 cropping season. Though there were minor variations, the three-year production from Goffa was largely excellent, and 2012 was not good for the Babile location. At Babile, the yield was drastically decreased (514 kg/ha) as a result of irregular and little rainfall. There was shown to be a statistically significant (P<0.05) variation in grain yield between the two kinds. While NC-343 produced 1829 kg/ha in Goffa and 1432 kg/ha at Babile, Werer 963 produced an average grain yield of 2259 kg/ha at Goffa and 1630 kg/ha at Babile, respectively.**

Keywords: **Plant Spacing, Population, Density, Yield, Inter-Row, Intra-Row.**

1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) Is an important annual legume in the world mainly grown for oilseed, food and animal feed [1]. It contains the highest amount of oil (47-53%) and protein (25- 36%) in the seed [2].

In Ethiopia, groundnut is mainly grown for food and oil production. Roasted seeds are consumed as a snack while crashed seeds are added into different dishes; it is also used in the preparation of peanut butter, candies and other confectionery products.

Groundnut widely grows in the drought prone areas of Ethiopia due to its exceptional quality in striving moisture stresses. It is well distributed in the warm lowlands of the country; more specifically eastern Hararge of Oromia region and Metekel zone of Benishangul-gumuz region produce significant quantity while some other lowland areas of Gamogofa,

Illubabor, West Gojam,North Shoa, North and South Wello, East and West Wellega, and Western Tigray area also of immense potential (CSA 2010). Despite the huge potential for groundnut production, in 2010, the total harvested area was 49,602.97 ha with a national average yield of 1444 kg/ha [3]. This yield is very low compared to leading producers and the potential yield of groundnut in the country. Under optimal condition, improved varieties give pod yield as high as 6 t/ha [4]. This genetics has not been realized under wide scale. Lack of widely adapted improved varieties, poor agronomic practices, soil and climatic conditions are the major limiting factors.

Yield of any crop is a function of genetic factor as influenced by climate and management. The crop must be given proper management so that better growth can take place. Of the management practices, spacing is the most important one for determining yield. It is important to accommodate the most appropriate number of plants per unit area of land to obtain better yield. Proper spacing in line sowing is to be recommended to maintain required number of plant population and to undertake intercultural operations for harvesting a better yield. Improper spacing and plant density affect the normal physiological activities of the crop. In densely populated crop, the inter-specific competition between the plants is high. Again, wider spacing leads to lower yield resulted from uneconomic utilization of space. There are two general concepts to describe the relationship between plant density and seed yield. Firstly, irrespective of plant spacing within and among rows, plant density must be such that the crop develops a canopy able to intercept more than 95% of the incoming solar radiation during early reproductive growth, and so maximize seed yield [5]. Secondly, a nearly equidistant plant arrangement minimizes interplant competition and produces maximum seed yield [6].

Among the various factors that influence the yield of peanut, plantation with proper row spacing is very important. Planting density is one of the main factors that plays an important role on growth, yield ground nut. [7] reported that accumulation of plant dry matter and branch formation were found to be greater and yield attributes like pod/plant, yield/plant and 1000-grain weight were the highest when the crop is grown with proper spacing. Optimum spacing ensures proper growth of the aerial and underground parts of the plant through efficient utilization of solar radiation, nutrients, water, land as well airspaces [8].

Proper row and plant spacing determined the yield of a particular variety in a specific agro-ecological environment ([9] provided other factors are not limiting. Varieties of different growth habits required different spacing to express their yield potentials [10]. Semi-spreading groundnut (Virginia) varieties need wider spacing to take hold of the available resources without competition. In the other hand, higher population with closer spacing required to get maximum yield potential from erect (Spanish) varieties ([10-13]). [12] recommended 45 cm and 15 cm row and plant spacing for Spanish bunch varieties while [10] suggested 30 cm and 10 cm row and plant spacing respectively. Nevertheless, there has been no published research works in Ethiopia on this aspect though some observational trials under taken in research station under irrigated condition; hence, it is pertinent to establish proper spacing for recently released varieties. The present experiment was initiated to determine the optimum row and plant spacing for NC-343 and Werer 961 (erect type) varieties released for rain fed condition.

2. MATERIAL AND METHODS

Description of the Study Area

The experiment was conducted at two locations (Gamo Goffa and Babile) for three consecutive years (2010, 2011 and 2012). Gamo Gofa Zone of Southern Nations, Nationalities and Peoples` Regional State (SNNPR), Southern Ethiopia was found at 5^0 57 – 6^0 71’ N and $36^0$37’- 37^0 98’ E and altitude of 680 to 4207 m.a.s.l. The general elevation of the Gamo Gofa zone ranges from 680 to 4207 meters above sea level. The highest point is called Mount Gughe, which is 4207 meters above sea level and the highest Mountain peak in the zone as well as in the SNNPR. Babile is situated at 09º 13’N and 42º19’E,with altitude of 1655 m.a.s.l with annual total rainfall of 719.2 mm. the mean minimum and maximum temperatures are 15.4 and 28.3 ºC respectively. The soil of Babile has sandy loam texture with pH of 7.6. It is representative of semi-arid agro ecology.

Experimental design and treatments

The experiment was laid out in split-spilt plot design with three replicates. Each plot measured 4.8 m x 4.2 m or 8 rows of 0.5 m row spacing, 7 rows of 0.6 m row spacing and 6 rows of 0.7 m row spacing. A net plot which measured 6 rows of 0.4 m row spacing, 5 rows of 0.5 m row spacing and 4 rows of 0.6 m row spacing was taken for crop growth data and

yield analysis. The factors tested were groundnut variety, inter row spacing and intra row spacing. These comprised two varieties (werer-961 and Nc-343), 3 inter-row spacing (50 cm, 60 cm and 70 cm) and three intra row spacing (10 cm, 15 cm and 20 cm). Initial weed control was carried out using hand hoe three weeks after planting (WAP). Hand pulling was subsequently used to achieve effective weed control at six WAP.

Data collection

Data collection and analysis: Data on growth and yield parameters like Days to 50% emergence, Days to 75% emergence, 50% flowering, Days to 75% maturity, Stand count at maturity (SCAM), Matured pod/plant (MPPP), branch number/plant, Dry pod yield (kg/ha), Shelling%, 100 seed weight (HSW) and Pest and disease reaction were recorded from pre-tagged samples of 5 plant/plot. For getting the data on yield and yield components matured plants from Net plot area of each plot were harvested.

Statistical Analysis

The data collected were subjected to statistical analysis using Genstat discovery edition18th. The analysis of variance procedure was followed to determine whether differenced existed among treatments. Treatments were compared using the least significant difference (LSD) at 5 % probability level.

3. RESULT AND DISCUSSION

Phenology and growth

The result of this experiment indicated that all the phenologcal stages of groundnut development (days to 50% emergence, days to 50% flowering and days to 75% physiological maturity), were not significantly influenced by variety and plant spacing at both locations.

Yield components

From the data combined for three years it was observed that varietal difference had significant effect on number of matured pods per Plant (MPPP) and hundred seed weight (HSW) (Table 1 and 2). Werer 961 had more pods whereas NC-343 had heavier seed weight at both Babile and Goffa.

Inter row spacing was only significantly affected stand count at maturity (SCAM) while intra row spacing influenced both SCAM and MPPP. High population density was recorded with narrower (50 cm) inter row spacing and narrower (10 cm) intra row spacing and decreased consistently with increasing inter and intra spacing at both locations where as MPPP was inconsistently decreased with increased intra spacing. The interaction between inter and intra spacing was non-significant for both locations.

Grain Yield

Grain yield of groundnut was significantly affected by year, variety, inter and intra spacing. Higher yield was obtained in 2011 cropping season from both locations (Table 1 and 2). The three years yield from Goffa was relatively satisfactory despite slight differences while 2012 was detrimental for Babile location severely reduced yield (514 kg/ha) was obtained due to low and erratic rain fall at Babile. Statistically significant difference ($P<0.05$) was detected between the two varieties in grain yield. Werer 963 gave average grain yield of 2259 kg/ha at Goffa and 1630 kg/ha at Babile respectively while NC-343 resulted 1829 kg/ha at Goffa and 1432 kg/ha at Babile respectively.

Table 1. Groundnut yield and yield components as influenced by variety, inter and intra row spacing at Goffa

Source of variation	Stand count at maturity	Matured pods/plant	Yield kg/ha	Shelling%	100Seed weight
Year					
1	64.32	31.12	1642	66.79	41.05
2	86.65	31.83	2387	56.05	42.24
3	69.41	33.78	2102	63.05	37.25
$LSD_{0.05}$	4.14	NS	159	2.12	1.51

Variety (V)					
Werer 961	78.05	33.50	2259	62.86	37.82
NC-343	68.86	30.99	1829	61.07	42.54
$LSD_{0.05}$	3.38	2.20	130	NS	1.23
Inter Spacing(R)					
50	77.07	31.09	2370	62.19	39.93
60	72.89	32.39	2034	61.96	40.76
70	70.41	33.26	1727	61.74	39.85
$LSD_{0.05}$	4.14	NS	159	NS	NS
Intra spacing (I)					
10	89.44	28.68	2241	63.72	41.44
15	72.33	34.80	2065	61.87	39.59
20	58.02	33.35	1817	60.25	39.47
$LSD_{0.05}$	4.14	2.70	159	2.12	1.51
Mean	73.46	32.25	2044	61.96	40.18
CV%	14.79	21.97	20.45	8.98	9.86

NS=none significant

Higher yield advantage of Werer 963 might be due to high population density as NC-343 had poor stand at maturity (Table 1 and 2).

Table 2. Groundnut yield and yield components as influenced by variety, inter and intra row spacing at Babile

Source of variation	Stand count at maturity	Matured pods/plant	Yield kg/ha	Shelling%	100 seed weight
Year					
1	70.07	11.98	1095	73.08	45.13
2	93.26	26.08	2984	73.16	48.39
3	27.07	10.44	514	73.68	51.68
$LSD_{0.05}$	7.68	1.60	161	NS	1.89
Variety					
Werer 961	78.88	18.98	1630	72.71	43.31
NC-343	48.06	13.36	1432	73.91	53.49
$LSD_{0.05}$	6.27	1.31	132	NS	1.55
Inter Spacing (R)					
50	71.87	16.25	1811	73.59	49.27
60	62.57	16.42	1490	73.33	47.83
70	55.96	15.83	1293	73.00	48.10
$LSD_{0.05}$	7.68	NS	161.5	NS	NS
Intra Spacing (I)					
10	74.32	14.71	1682	73.20	48.72
15	63.54	16.62	1560	73.76	48.54
20	52.56	17.17	1352	72.96	47.95
$LSD_{0.05}$	7.68	1.60	161	NS	NS
Mean	63.47	16.17	1531	73.31	48.40
CV%	31.79	26.05	27.71	5.58	10.29

NS=none significant

The most compelling, the results revealed narrow inter spacing (50 cm) and narrow intra spacing (10 cm) performed better than wider spacing at both locations though their interaction was not significant. Superior grain yield (2370 kg/ha and 1811 kg/ha) were obtained with 50 cm spacing while the lowest grain yield (1727 kg/ha and 1293 kg/ha) were obtained at Goffa and Babile respectively. At Goffa, the highest grain yield (2241 kg/ha) was achieve with 10 cm and the

lowest grain yield (1817 kg/ha) was recorded with 20 cm intra spacing. Similarly, at Babile the maximum grain yield (1682 kg/ha) compared to the lowest grain yield (1352 kg/ha) obtained with wider intra spacing (20 cm) despite its failure in statistical significance (P>0.05). Moreover, grain yield consistently decreased with increasing inter and intra row spacing. This finding support [12] who recommended 45 cm and 15 cm row and plant spacing and very close to [10] finding of 30 cm and 10 cm row and plant spacing.

No significant interactions occurred between spacing and variety for any of the measured characteristics, indicating that the two varieties used in the experiment were at par in growth habit.

4. CONCLUSION AND RECOMMENDATION

The study concluded that higher groundnut yield was obtained as plant density increased. Narrow row spacing of 50 cm and intra spacing of 10 cm had shown superior yield advantage per a given area. Also if only one variety is to be used, selecting Werer 963 could be advantageous. Farmers in respective locations should revise their genotype and agronomic practice so as to enhance productivity of groundnut.

Furthermore, the potential of Goffa area as could be seen from stable groundnut yield over years, should be exploited for groundnut production by aggressive expansion as erratic rain fall could discourage groundnut production at traditionally groundnut belt Babile.

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