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Research Article

Yield and Germination of Groundnut (*Arachis hypogeae L.*) Varieties as Influenced by Seed Size

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Abstract

This research was aimed at determining the influence of seed size on germination and yield of three varieties of groundnut. The design used for the experiment was Completely Randomized Block Design (CRBD) involving 3 replicates. Two hundred and seventy seeds were sown per treatment using large, medium and small seeds. Five seedlings selected randomly from each treatment were used to analyze the germination rate/percentage, growth parameters and yield components. The plants from large seed showed higher values of germination percentage (96.67%), shelled seed sizes fresh (257.09%), shelled seed sizes dried (167%), plant (pod and haulm) yield (628%). Statistical analysis (ANOVA) showed significant difference ($p<0.05$) in the number of branches, number of leaves, number of flowers and plant height. There was no significant difference ($p>0.05$) in the weight of shelled seeds (both fresh and dried). Hence, large size seed was found effective for realizing higher yields, increase in groundnut products and monetary benefits to farmers.

Keywords: Groundnut, Germination, Yield, Seed Size.

Introduction

The causes of Africa's food problem are diverse and yet interrelated and increasing food production is a central part of the food security challenge in Africa. Seed is a primordial input for crop production and it is the embodiment of past harvests as well as the promise of future ones. Seeds are regarded as farmers' most precious inputs. The seed is the forerunner of the next generation in the life of a plant and high-quality seed is an important prerequisite for a high crop yield. Only high quality seed will produce strong plants which are resistant to disease and adverse conditions. The seed habit in plants has developed over a long period of time and represents the highest type of plant development [1].

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Seed size has a significant influence on the future performance of the seedling. Within species, larger seeds tend to give faster emergence and produce larger seedlings. In general, however, if seed spacing adopted allows plants to express their potential in full, larger seeds give considerable increase in yield in comparison with smaller seeds [2]. Seed size or weight of plants varies and reflects in the seedling under uniform conditions, but there are no lasting advantages to the seedling regardless of the size of the seed from which it was produced. Furthermore, seeds of identical size and weight give rise to seedlings differing widely in size. The authors in [2] also noted that seed size is correlated positively with seedling size, but then not with inherent vigour of the plant so that grading the seed would not make a more, vigorous stock. The seed supplies energy for germination and differentiation of the embryo, the development of the plant until the synthetic mechanism can become established.

The effect of seed size is not masked by independent growth of the groundnut seedling during the growing season. Small seeds are weaker and more vulnerable than large seeds. Large seed size will usually be advantageous for better vigour on account of the greater amount of nutritive substances, while small seed size is typical of certain varieties and do not then constitute a disadvantage. On the whole, a large, heavy seed has a greater nutritive reserve and usually produces strong seedlings with satisfactory development. The young plant has to live on the nutritive substances contained in the seeds [1]. The size and shape of seeds is extremely variable. They depend on the form of the ovary, the amount of assimilates partitioned into the seed, the condition under which the parent plant is growing during seed formation, and obviously the species[1]. According to [1], the factors which determine the size and shape of seeds are the size of embryo, amount of endosperm present and to what extent other tissues participate in the seed structure. For groundnuts, larger seeds show high germination rates, vigorous growth and high yield [3]. The author in [4] that groundnut plants from larger seeds out yielded plants from smaller seeds due to an increased proportion of effective pods and consequently pod yields. Another situation where large seed size or mass might be an advantage is in poor nutrient soils although this has received little attention [1]. The early growth of large-seeded species may be less affected by the level of soil nutrients [5]. According to [6-7] recorded no such advantage in yield with large seeds, while [4] also reported that differences in size did not influence plant height, number of branches per plant or shelling percentage. Small seed size according to [8], would germinate readily and produce normal plants even though the grain size might be only one-tenth that of the large size grain. He further observed added that the growth rate of the plant from small seed was higher than that of plants from normal seed size but all size of seed tends to attain the same final size.

The embryo weight is proportional to seed weight so the effect is not due to a relatively larger embryo in the small seed. Differences in seed size show differences in growth. This advantage is manifested from the very start as large seeds have larger cotyledons, producing positive feedback for, these capture lighter and leads to faster growth and elongation. A positive relationship between cultivar seed size and yield has been reported [9-10]. These variable results imply that the growth and yield response to seed size at planting cannot be generalized and specific recommendations are required for different genotypes and environments. Farmers are often advised to select large and well-filled seeds for planting; but in many

developing countries supply of seeds are limited and farmers often have no alternative than using seeds of lower quality. It is now becoming increasingly appreciated that successful vegetable production is very dependent upon a supply of satisfactory seed [1].

Large scale cultivation could not be implemented until the problem of poor germination, emergence of seed and poor yielding varieties occurring frequently has been solved. Little attention has been recorded on impact of size of seed on yield of edible legume such as groundnut in the country.

In view of increasing concerns about poverty and unemployment, especially among low-income categories in Nigeria, the need for investments in the small-scale sub-sector becomes necessary [11]. Groundnut, an important oil seed crop, provides significant sources of cash through the sales of seed, cakes, oil and haulms. Groundnut plays an important role in the diets of rural populations. Groundnut production and processing is one of the major activities of the rural people in Benue State. Hence it is a source of livelihood for many people such as groundnut processors, groundnut farmers, marketers, transporters, etc. transformation of groundnut industry through processing would enhance the overall economic development through the income and employment generation in the rural economy of Benue State.

Groundnut are used in various forms, the oil which is the cheapest of all types of vegetables oil and most extensively used oil in many countries as cooking oil, manufacture of margarine, preparation of salad. It is used widely all over Africa as soap thickener. Groundnuts are also important in the confectionery trade and the stable oil is preferred by the deep-frying industries, since it has a smoke point of 229.4°C compared to the 193.5°C of extra virgin olive oil. The oil is also used to make margarines and mayonnaise [12]. The cake is used for animal feedstock and as a fertilizer. The shells are the dry *pericarp* of the mature pods contains chemical decomposition cellulose, carbohydrate, protein, minerals and lipids. Therefore, quality seeds always play an important role in the groundnut growth. Good seed is essential in establishing the designed plant population, good development and yield. This indicates that seed size is one of the components of seed quality in further crop development. For this reason, this study is aimed at determining the influence of seed size on germination and yield of three groundnut varieties.

Research Method

The study adopted a randomized block design with three varieties of groundnut replicated thrice. All the groundnut varieties are improved cultivars released by Institute for Agricultural Research ABU Zaria. The treatment consisted of three varieties and three seed sizes. The study was carried out at Benue State University Makurdi. Makurdi is the capital of Benue State and is located on latitude 7^{o} 30'N and 7^{o} 45'N longitudes 8^{0} 30'E and 8^{0} 55'E of the equator. The metropolis lies within the Benue valley in the middle belt zone of Nigeria, and divided by the River Benue into the North and South banks. Evergreen vegetation is present all year round for animal grazing and farming activities which includes the cultivation of crops like soya beans, yams, beni seeds, maize etc.

The experimental field was prepared for sowing with hoe and cutlass and leveled evenly. Seeds were randomly sorted to different grades based on their varieties and using weighing balance the seeds were sorted out into various sizes: small seed (0.9-0.13g), medium seeds (0.22-0.35g), large seeds (0.52-0.60g) before planting. The planting distance between rows was 60cm and 20cm within rows which accommodated 810plants. Two seeds were sown per hole at planting depth of 5cm. The seeds were treated with seed dressing chemical (Dress force chemical) before planting to protect the seedlings from diseased soil, early foliar insect and pest throughout the crop growth stage. Irrigation was done at the required period before the onset of rain. Weeding was done using hoe and hand picking when weeds were tender. Weeding began two weeks after planting until peg formation, to ensure that pegs were not destroyed.

The data was analyzed using the analysis using the statistical analysis software (SPSS) and was also subjected to ANOVA and the differences between the means were compared using the Least Significant Difference (LSD) method at 5%.

Results and Discussion

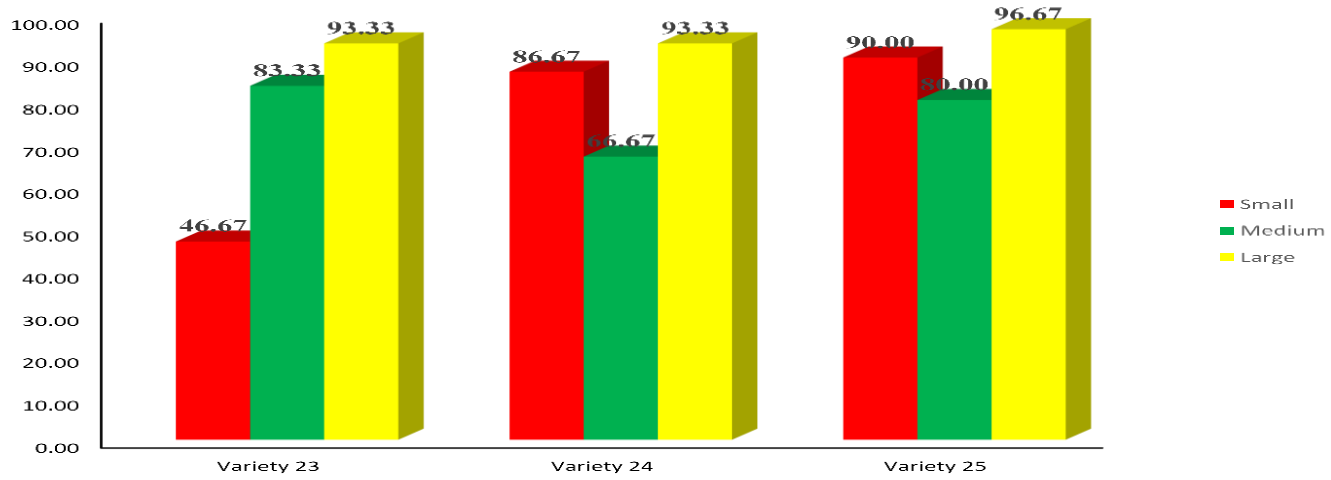
Analysis of data indicates that significant differences were observed in germination percentage among seed sizes (Table 1 and Figure 1). The germination percentage was maximum in large seed with 96.67 percent followed by small seed with 90.00 percent which were significantly superior to medium seed with 83.33 percent. Significant variation among the varieties in respect of germination was observed.

The interaction between varieties and seed sizes were found significant. Irrespective of varieties, large seed had shown better germination than medium and small especially in variety24 and variety25.

Table 1. Emergence of three varieties of Groundnut based on seed size

Variety	Seed Size			F	p-value	LSD (5%)
	Small	Medium	Large			
Samnut 23	14	25	28	6.792	0.029*	4.85
Samnut 24	26	20	28	4.333	0.680	NS
Samnut 25	27	24	29	1.462	0.304	NS
F	6.038	1.5	0.111			
p-value	0.037*	0.296	0.897			
LSD (5%)	5.04	NS	NS			

***** *There is a significant difference (p<0.05).*
NS = *No Significance difference (p>0.05).*



f =4.184; df = 26; p-value = 0.014; LSD (5%) = 5.03; alpha level = 5%*

** There is a significant difference (p<0.05)*

Figure 1. Rate of emergence/germination in percentage

Table 2 Shows there was a significant difference (P < 0.05) between the numbers of branches produced by the various seed sizes except for 2 weeks after planting there was no significant difference where the effect of the large seed plants produced greater number of branches. Cultivar differences were significant. The varieties had no significant effect on the number of branches per plant 6 weeks after planting. Groundnut variety and seed size significantly affect the number of branches.

Table 2. Number of branches

Treatment	Mean number of branches				
	WK 2	WK 3	WK 4	WK 5	WK 6
Variety					
Samnut 23	19	32	59	80	91
Samnut 24	21	39	69	93	116
Samnut 25	22	43	81	108	133
F	8.78	12.652	8.043	14.011	2.662
p-value	0.001*	0.000*	0.001*	0.000*	0.082
LSD (5%)	5.02	5.70	12.55	15.20	NS
Seed Size					
Small	17	32	57	74	99
Medium	19	38	75	102	120
Large	26	45	77	106	121
F	1.164	9.168	7.795	7.298	10.894
p-value	0.322	0.000*	0.001*	0.002*	0.000*
LSD (5%)	NS	6.02	12.61	16.90	20.71

***** *There is a significant difference (p<0.05)***.**
NS = *No Significance difference (p>0.05).*

Number of Leaves

Results of the number of leaves at all sampling days are presented in Table 3. Seed size affects leaf production as there was gradual increase among variety and seed sizes, and differences were also significant in all varieties and seed sizes.

Table 3. Number of leaves

Treatment	Mean number of leaves				
	WK 2	**WK 3**	**WK 4**	**WK 5**	**WK 6**
Variety					
Samnut 23	21	76	238	319	390
Samnut 24	24	81	296	326	473
Samnut 25	28	73	325	433	533
F	8.867	2.606	10.496	9.241	5.947
p-value	0.001*	0.086	0.000*	0.000*	0.005*
LSD (5%)	4.182	NS	49.62	69.56	78.39
Seed Size					
Small	20	75	229	294	398
Medium	25	72	313	359	491
Large	26	82	317	425	507
F	6.846	5.416	7.524	8.685	10.191
p-value	0.003*	0.008*	0.002*	0.001*	0.000*
LSD (5%)	4.33	7.35	52.15	70.21	72.86

***** *There is a significant difference (p<0.05)***.**
NS = *No Significance difference (p>0.05).*

Significant differences were observed in plant height, due to seed sizes and Varieties (Table 4 and Figures 2a &2b). The plant height increased with increased in age of the crop and attained maximum plant height at harvest in all the seed sizes. Plant height was significantly higher in large seed with 44.7 cm and small seed with 44.7 cm which were superior to medium seed with 43.7 cm. The Varieties also differed significantly in plant height and variety 24 recorded significantly higher plant height with 48.3 cm compared to that of variety 25 with 45.1cm and variety 23 with 39.7 cm.

Table 4. Plant Height

Treatment	Mean number of Height (cm)				
	WK 2	WK 3	WK 4	WK 5	WK 6
Variety					
Samnut 23	16.8	19.0	26.7	33.2	39.7
Samnut 24	19.1	20.1	28.2	37.5	48.3
Samnut 25	17.5	18.2	29.1	36.7	45.1
F	8.509	5.416	2.985	2.770	0.110
p-value	0.001*	0.008*	0.061	0.074	0.896
LSD (5%)	2.13	1.84	NS	NS	NS
Seed Size					
Small	16.6	18.7	28.1	37.1	44.7
Medium	16.7	18.1	26.7	33.5	43.7
Large	20.0	20.6	29.2	36.7	44.7
F	2.478	2.606	2.516	3.926	8.075
p-value	0.096	0.086	0.093	0.027*	0.001*
LSD (5%)	NS	NS	NS	3.70	4.95

***** *There is a significant difference (p<0.05)*.
NS = *No Significance difference (p>0.05).*

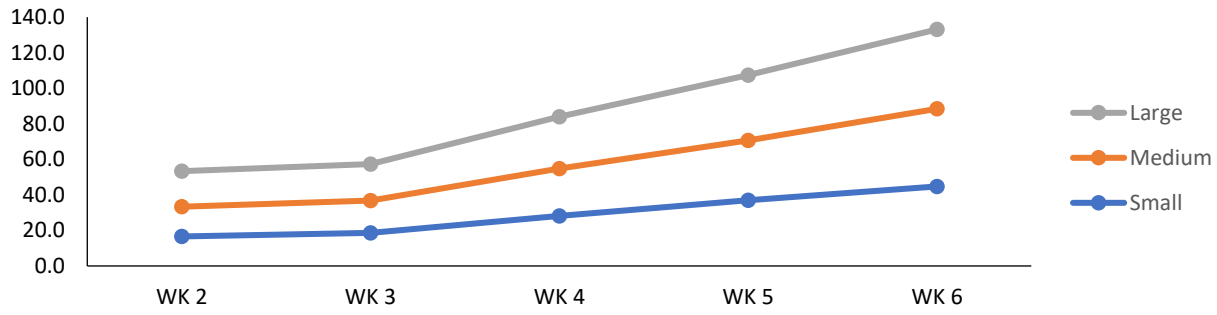


Figure 2a. Mean heights based on seed size

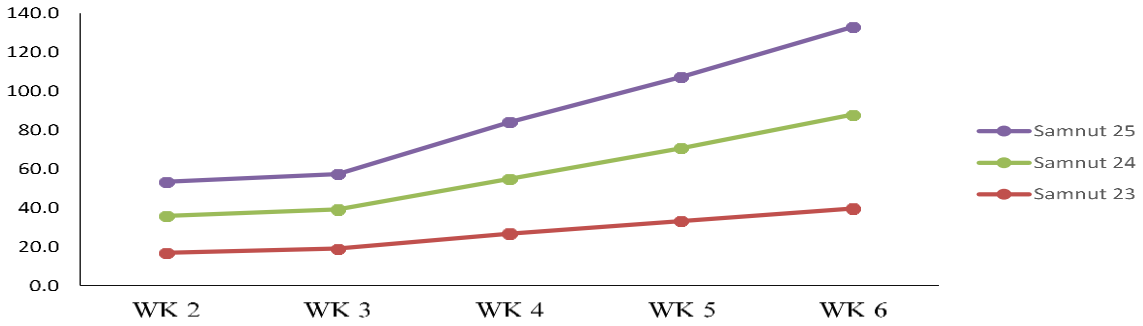


Figure 2b. Mean heights based on variety

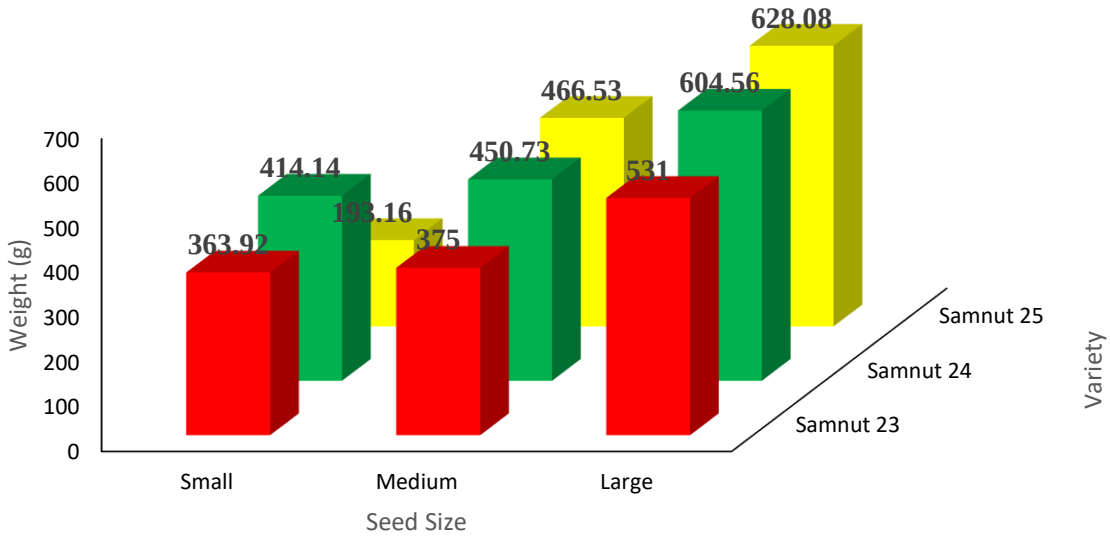
Varieties were shown variation in days to 50 percent flowering (Table 17). Among the varieties Samnut 25 took a smaller number of days to 50 per cent flowering compared to Samnut 24 and Samnut 23. Significant differences were observed among seed sizes and the large seeds have a greater number of flowers compared to the other seed sizes. And within the varieties Samnut 25 has a greater number of flowers showing clearly the significant differences between ($p<0.05$) and seed sizes.

Table 5. Number of Flowers

Treatment	Mean No. of flowers
Variety	
Samnut 23	6
Samnut 24	7
Samnut 25	9
F	6.408
p-value	0.004*
LSD (5%)	2.51
Seed Size	
Small	5
Medium	7
Large	9
F	4.371
p-value	0.019*
LSD (5%)	2.61

***** *There is a significant difference ($p<0.05$)***.**

Figure 3 shows the pod yield of the plants with Samnut 25 having the highest yield among the varieties followed by the rest varieties and there was Significant difference($p>0.05$) while that of the seed sizes the large seeds has the highest pod yield and there was significant difference within the rest seed sizes.



f =12.833; df = 45; p-value = 0.000; LSD (5%) = 119.80; alpha level = 5%*

** There is a significant difference (p<0.05)*

Figure 3. Yield weight based on Pods and Haulms

Results of the harvest index and shelling percentage are presented in Table 6. Among the varieties, Samnut 25 had the greatest harvest index and this was significantly higher than the harvest index of other varieties. Samnut 24 and Samnut 24 recorded similar harvest index. In trems of seed size the large seed has the highest 16.92 and small seeds have the least 15.06. The shelling percentage was significantly higher in large seed with 14.80 percent followed by medium sized seed with 11.88 percent which were superior to small seed with9.89. The lowest shelling percentage was recorded in Samnut 23 (11.70%) followed by Samnut 24 (11.72 %) and Samnut 25 (13.14 %).

Table 6. Harvest Indexes based on seed size and variety

Varieties	Harvest Index	Shelling Percentage
Samnut 23	15.06	11.70
Samnut 24	15.09	11.72
Samnut 25	16.92	13.14
Seed Size		
Small	12.73	9.89
Medium	15.29	11.88
Large	19.05	14.80

Significant differences were observed in number of pods per plant among seed sizes and varieties. (Table7). The number of pods per plant was significantly higher in plants raised from large sized seed with 99.00 pods per plant followed by medium sized seed with 82.20 pods per plants which were superior to small sized seed with 65.67 pods per plant. The Varieties also differed significantly; Pods per plant were higher in Samnut 25 with 87. 93 pods per plant followed by Samnut 24 with 84.27 pods per plant and Samnut 23 with 74.67 pods per plant. The interaction was found significant, irrespective of varieties plants established from large and medium sized seed had shown better performance on bearing number of pods per plant than, small seed. There was Significant differences in pod weight per plant due to seed sizes and Varieties were observed (Fig 7). Significantly higher pod weight was obtained with large size seed with (198.52) and medium sized seeds with (165.42) and small sized seed with (120.48. Varieties also differed significantly and the pod weight was higher with Samnut 24 (290.61) followed by Samnut 25 with (290.61) and Samnut 23 with (205.24).

The present research study on groundnut varieties Samnut25, Samnut 24 and Samnut23 were used in order to work out comprehensive information on the performance of three varieties replicated thrice on yield and germination in relative to seed size.

The present investigation results indicated that the use of large seed resulted in higher germination percentage. This might be due to higher reserve food material in the cotyledons of large seed size because seedling development during germination is mostly dependent upon the transfer of food reserves from the cotyledons. Similar results were reported by [14] in groundnuts, [15] in chickpea and [16] in cluster bean.

The Samnut 25 in terms of seedling emerge among variety was superior; and the Samnut23 registered the lowest percent germination. This agrees with the working of Stephen 2009 that genotype exhibit different growth and yield potential. There was significant difference ($p<0.05$) between the number of branches produced by the various seed sizes except for two weeks after planting, there was no significant difference. This agrees with [1] who found that the difference in seed size did not influence the number of branches. According to Bharathi (2010. The plants from large seed recorded significantly higher leaves throughout the growth stages also there was significant difference across the varieties and their various seed sizes. The plant from large seed produced more leaf area, a greater number of primary and secondary branches which in turn increased the dry matter.

Plants heights at 5 weeks after planting and 6 weeks after planting, showed significant difference between large seed and other seeds. The author in [14] had reported that soft white winter wheat plant grown from large and medium seeds were taller, heavier and had more tillers than plants from small seeds. Cotyledonary reserve in large seeds has influence in the initial growth of crops but has little importance in subsequent growth once leaves emerge, is similar to the recent observation. There was no significant difference between treatments but large seeded plants showed early growth. Samnut 25 emerged rapidly with the highest height, also the greatest height of (44.7cm) was reported for both Samnut23 and Samnut 25 and this suggests the differential response of genotypes to environmental changes. The author in [17]

have reported that, there is differential growth in response to environmental changes as far as plants are concerned.

Plant established from large seed size has lesser number of days to 50% flowering as compared to medium and small seed. This may be due to higher seedling vigor continued by the large size seed which resulted in early flowering. Similar results were observed in groundnut by [18].

There were significant differences ($p<0.05$) among seed sizes and variety on the plant (pod and haulm) with increase in seed size from large to small. This might be due to the fact that the plants from small seed were not able to supply the required metabolites for better pod development because of low vigor throughout the growth stages. The early vigor, higher leaf and dry matter production in plants from large seed might have increased the number of filled pods. The higher photosynthetic efficiency coupled with translocation of metabolites might have resulted in proper filling of pods in plant from large seed.

Shelled seed weight (dried and fresh) increased with increase in seed size. Increase in seed weight might be due to a greater number of filled pods when large seeds were used for sowing. The plants from large seed and medium were more vigorous and rapid establishment of seedlings which resulted in increase in total dry matter from early stages itself which was evident from increased plant height, higher leaf, a greater number of branches increased photosynthetic activity in leaves which have helped for better pod filling.

Generally, the plants from small-sized seeds had relatively lower value as regards the harvest index and shelling percentage. The author in [1] had observed that differences in seed size did not significantly influence shelling percentage. The results showed that the minor season cultivation had higher economic and low biological yield than the major season cultivation.

The numbers of pods per plant and pod weight per plant were superior in large size seed when compared to all other seed sizes. This might be due to increased photosynthetic activity in the leaves and translocation of more metabolites to developing pod, which resulted in maximum number of filled pods in large size seed than medium, and small seeds. Similar result was obtained by [14].

The present study indicated that the germination percentage, plant growth parameters, total dry matter production, yield components were high in Samnut 25 varieties and Samnut 24 as compared Samnut 23 in all the seed sizes. Such attributes were gradually increased with increase in seed size from Small to Medium and Large size seed. Plants established from small seed recorded lesser growth parameters, yield components as a result of low reserve food materials in seed, less seed initial vigor, slow growth rate of seedlings and plants in turn showed reduction of yield and yield attributes.

Conclusion

The results presented showed that the plants from large seeds emerged rapidly as compared to the medium and small seed sizes. The plants from large seed size showed faster growth rate especially in the initial growth stage as expressed in the height, fresh weight and the crop growth rate. Seedling establishment was favored in large seeds as many seedlings of small seeds displayed low seedling survival. The faster growth rate in plants from large seeds did however; translate into remarkable higher pod yield as compared

to that of the plants from small seeds. Large seeds have been found to produce higher seed fresh and dry weight. Pod yield of plants from large seeds was higher than those from other seed sizes in all the verities. Results also showed that seed size becomes very important in the growth of groundnut showed an effect among the verities. The varietal differences in the study suggest that among the three genotypes, Samnut 25 should be recommended for effective production.

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