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Effect of vigour levels on growth parameters of groundnut (*Arachis hypogaea* L.)

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Abstract
Experiment was conducted in the Seed Quality Research Laboratory of National Seed Project, University of Agricultural Sciences, Dharwad "to assess the field performance with respect to growth parameters in groundnut (*Arachis hypogaea* L.) Based on vigour levels" during the period of June 2015 to January 2016. Twenty seed lots having varied germination percentages were sown in three replications to study the effect of vigour on field performance. The following evaluations were made: speed of emergence, field emergence (%), plant population per plot, days to 50% flowering, plant height, number of main branches and number of leaves per plant. The results indicated significantly lower growth parameters for less vigorous lots and also it was observed that plant height and number of leaves showed significant differences up to 60DAS after which the difference diminishes unlikely as with days to 50% flowering & the number of branches at different stages of crop growth (30 DAS, 60 DAS, 90 DAS & at harvest) which had no significant difference.

Keywords: germination, groundnut, field performance and seedling vigour

Introduction
The quality of seed is a major concern in agriculture throughout the world. Seed quality is typically measured by different standard germination tests. While the results of a standard germination test may correlate well with field emergence when soil conditions are favorable for rapid emergence, the test cannot predict field performance when soil and environmental conditions impose stress on the germinating seeds, as it often occurs with early planting (Tekrony and Egli, 1991) [25]. Seed vigor is a reflection of those properties that determine the potential for rapid, uniform emergence and the development of normal seedlings under a wide range of field conditions. Thus, seed vigor is an inherent character and it indicates, in totality, those seed attributes which will favor stand establishment in a varied field conditions.

Absence of quality seed results in poor plant stand and low seedling vigour which is one of the major constraints in decreased productivity of groundnut. This owes to the low seed multiplication ratio in *kharif* and poor storability of rabi/summer groundnut produce. Further *kharif* produce cannot be harvested and used for early *rabi* sowing. This necessitates the use of *rabi/summer* produce for sowing both during *kharif* and *rabi* seasons.

Quality groundnut seeds are prerequisite for proper establishment of seedlings of groundnut in soil (Maiti and Ebeling, 2002; Smartt, 1994) [13, 23]. Seed vigour is a very important character in groundnut and must be high during planting so that the seed can resist the many environmental factors affecting germination and field establishment. Germination potential of seed is associated with seedling vigour (Maurya *et al.,* 2006) [16]**.** With passage of time, reduction in germinability of seeds is bound to occur due to loss of membrane integrity, pest and disease attack etc. The use of high vigor seed lots is justified to ensure adequate stand establishment under different environmental conditions.

Field study conducted by Ghassemi-Golezani and Dali (2014) [8] to evaluate the effects of seed vigor on maize growth and yield revealed that Mean emergence time significantly increased, but mean emergence percentage decreased as seed vigor increased. Sheidaei *et al.,* (2014) [22] conducted the study for evaluating the correlation of laboratory seed quality indices with field emergence. The results of germination percent and seedling vigor index had a high correlation with final seedling emergence percent and cumulative emergence rate.

Considering the importance of vigour in seed quality this study was conducted to evaluate the effect of vigour levels on field performance with respect to different growth parameters in groundnut.

Material and Methods

The experiment involved conducting field studies during kharif 2015-16 at the Seed Quality Research Laboratory, National Seed Project, UAS, Dharwad. In laboratory, twenty seed lots having varied germination percentages of GPBD-4 variety of groundnut formed the twenty treatments which were evaluated for their performance in field by following Randomized Complete Block Design (RCBD) replicated thrice at D-Block, Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad and the same twenty seed lots were sown to study the effect of vigour on field performance. The details of the materials used and methods adopted for the conduct of various experiments are described below.

Spacing: 30 x 10 cm
Plot size: 2 x 1.5 cm^2
Date of sowing: 30-06-2015

Twenty seed lots of GPBD-4 groundnut variety having varied germination percentages were obtained from the seed unit, UAS, Dharwad. The pods were hand shelled and used for studies. For recording observations for different growth attributes, five plants were selected at random and labeled.

Field emergence (%)

The seeds were sown at 3cm depth in the furrows formed at 30 cm apart in the field. Seeds were placed 10 cm apart in the row. The seedlings with shoot 1cm and more above the ground were counted as emerged. The total seedlings emerged upto 15 days after sowing were considered, and emergence percentage was calculated. Ninety seeds of 3 replications were used in the study.

$$\text{Field emergence (\%)} = \frac{\text{Number of seedlings emerged}}{\text{Total number of seeds sown}} \text{ X } 100$$

Speed of emergence

Number of normal seedlings was counted everyday till the end of test period. The speed of emergence was calculated using the formula suggested by Maguire (1962) [15].

Speed of emergence = n1/d1+n2/d2+n3/d3+ ----------

Where, n = number of emerged seedlings, d= number of days.

Plant height (cm)

Plant height was measured (cm) from the base to the tip of top leaf at 30, 60, 90 and 120 days after sowing.

Number of leaves per plant

The number of fully opened trifoliate leaves was counted in the labeled plants and an average number of leaves per plant were calculated.

Number of main branches

The number of branches on the main axis was counted and an average number of branches were calculated.

Days to 50 per cent flowering

The number of days taken for 50 per cent flowers was computed by recording data of sowing and dates of 50 per cent plants flowered in each net plot.

Plant population per plot

The number of plants survived in each plot was recorded before harvest and plants harvested for destructive sampling for growth observation were also included in the total plant population.

Result and Discussion

Loss of viability and vigour in seeds can affect the crop yield in two ways. Firstly, a decline in seed vigour leading to sub-optimal plant population and secondly use of low vigoured seeds may result in poor performance of the surviving plant (Gelmond *et al.*, 1978) [7]. Substantial loss of yield was reported in peas, beans, barley and onion only when considerable loss of germination was recorded in the seeds (Abdulla and Roberts, 1969) [1]. In groundnut reduction in yield was observed when seed germination declined below 63 per cent in spite of compensating the seed rate (Manjunath, 1993) [14].

Comparative laboratory and field experiments conducted by Odiemah (1991) [19] and Adebisi *et al*., 2003 [3] showed that under certain environmental conditions, there are close relationships between seed testing results and field emergence. Carnago and Vaughan (1973) [4] found a positive correlation between seed vigour and yield in maize. Similarly, Odiemah (1991) [19] reported positive and significant correlation coefficients between six quality traits, field emergence and grain yield. Also specific gravity, standard germination and vigour test were excellent predictor of field maize emergence and grain yield per plant in maize hybrids.

Growth parameters

1. Speed of emergence

Significant differences among the seed lots based on vigour levels were recorded for speed of emergence with a mean value of 7.25 for speed of emergence (Table 1).

The highest speed of emergence was recorded by lot 19 (10.26) which was on par with other vigorous lots i.e. lot 16 (9.77), lot 4 (9.47), lot 17 (9.32), lot 8 (9.94) and lot 5 (9.03). The lowest speed of emergence is recorded by lot 20 (0.40) followed by lot 9 (2.61).

The speed of emergence showed significant relationship with varied vigour levels of seed lots used in the study (Table 1). Higher speed of emergence is noticed by seed lots having higher vigour and vice-versa. Lot 19 exhibited the highest speed of emergence (10.26) in the field and hence considered more vigorous than the rest of the lots. Low vigour seed lots emerged poorly and more slowly. This was not unexpected as TeKrony and Egli (1991) [25] have reported that high vigour seed lots emerged better and faster than low vigour seed lots under stress conditions despite the fact that they had similar high laboratory germination percentages. Similar results were obtained from the present study as lot 8 and lot 19 both had similar germination of 88 percent however, lot 19 had higher speed of emergence (10.26) than lot 8 (Table 1).

2. Field emergence

Significant differences among the seed lots based on vigour levels were recorded with field emergence (%) which are presented in Table 1.

The results showed significant relation of field emergence with varied vigour levels of seed lots. Highest emergence percentage was recorded with vigorous seed lots i.e. lot 16 (89.26%) which was on par with lot 5 (87.04%), lot 4 (85.93%), lot 19 (84.44%), lot 8 (80.74%) and lot 15

(80.74%). However, low vigorous seeds showed decline in field emergence values. Reductions in seedling emergence due to seed aging and lowering vigor (Table 1) could be related to lipid peroxidation, mitochondrial dysfunction and less ATP production (Mc Donald, 1999) [17]. Kapoor *et al*., 2010 [10] showed that low seed vigor due to seed aging was the result of biochemical changes. Ellis (1992) [6] reported that seed vigor influences the early growth of plant both directly through physiological injury or necrotic lesions and indirectly through percentage emergence and emergence rate. Similar results were reported for winter oil seed rape (Ghassemi-Golezani *et al.*, 2010) [9]. Perry, 1978, Kraak *et al*., 1984, Durrant *et al.* 1985 and Adebisi *et al*., 2003 [20, 12, 5, 3] had earlier reported strong correlations between standard germination and field emergence and seedling vigour index. This was probably due to the favourable environmental conditions encountered by seed during the period of field emergence and therefore standard germination can always be taken as a reliable predictor of sesame seed vigour and performance in the field (Adebisi, 2008) [2].

3. Plant population per plot

The data on final plant population per plot differed significantly among the lots due to vigour levels with mean a mean of 40.53 plants per plot.

The highest final plant population was recorded by lot 8 (55.67) which is on par with lot 4 (51.33), lot 5 (51.00), lot 15 (49.67), lot 19 (48.67), lot 16 (48.00), lot 2 (47.67), lot 7 (45.67) and lot 14 (45.33). The lowest final plant population is recorded by lot 20 (7.00) followed by lot 9 (20.67).

Plant population per plot gave significant relation with varied vigour levels (Table 1). Among the seed lots lot 8 has highest (55.67) plant population per plot. Final plant population was found to be higher in seed lots with higher vigour levels. The number of plants per m^2 at final harvest for low vigour seed lots was reduced by 33 - 50% in field pea seeds (Taweekul *et al*., 1998) [24]. Standard germination and seedling vigour index were found to be positively correlated with field emergence at low (133,333 plant ha-1) and high (266,667 plant ha-1) plant population environments in sesame (Adebisi, 2008) [2]. Sheidaei, 2014 [22] reported that germination percent and seedling vigor index had a high correlation with final seedling emergence percent and cumulative emergence rate.

4. Days to 50% flowering

The data of different seed lots with varied vigour levels is presented in table 1 and it was found to be non-significant with respect to days to 50 per cent flowering.

There was no significant effect of vigour levels on days to 50% flowering on groundnut seed lots. 50% flowering is achieved in all the seed lots on somewhat similar day with mean days of 31.57 (Table 1).

Table 1: Effect of vigour levels on speed of emergence, field emergence, plant population per plot and days to 50 per cent flowering of groundnut (GPBD-4) variety

Seeds Lots	Germination (%)	Speed of emergence	Field emergence (%)	Plant population per plot	Days to 50% flowering
L_1	62.00 (51.94)*	5.07	44.44	25.00	31.00
L_2	86.50 (68.45)	8.25	76.30	47.67	32.33
L_3	74.00 (59.33)	7.50	72.96	44.33	32.00
L_4	96.50 (79.33)	9.47	85.93	51.33	31.33
L_5	90.50 (72.14)	9.03	87.04	51.00	32.33
L_6	58.50 (49.90)	5.13	45.93	33.67	32.33
L_7	73.50 (59.00)	8.57	67.52	45.67	31.00
L_8	88.50 (70.19)	9.04	80.74	55.67	31.33
L_9	39.50 (38.92)	2.61	26.30	20.67	31.67
L_{10}	73.50 (59.03)	7.51	67.04	42.67	31.33
L_{11}	60.00 (50.76)	4.76	48.89	31.67	32.00
L_{12}	52.50 (46.42)	6.45	61.48	40.67	31.33
L_{13}	65.00 (53.73)	7.38	64.44	38.67	31.67
L_{14}	80.50 (63.81)	8.57	77.41	45.33	31.33
L_{15}	80.00 (63.50)	8.30	80.74	49.67	31.67
L_{16}	91.50 (73.05)	9.77	89.26	48.00	30.00
L_{17}	77.50 (61.69)	9.32	73.33	44.33	31.33
L_{18}	68.00 (55.58)	7.59	64.81	39.00	32.00
L_{19}	88.50 (70.19)	10.26	84.44	48.67	30.67
L_{20}	9.50 (17.92)	0.40	7.26	7.00	32.67
Mean	70.80 (58.24)	7.25	65.31	40.53	31.57
S.Em. ±	1.08	0.46	3.88	3.94	0.56
C.D. (0.05)	4.07	1.31	11.12	11.28	NS

*NS-Non significant

5. Plant height (cm)

The data related to plant height as influenced by varying vigour levels is presented in Table 2.

Significant differences among the seed lots with respect to plant height was observed at 30 and 60 days after sowing (DAS) with mean plant height of 5.81 cm and 22.90 cm respectively. Highest plant height at 30 DAS was recorded with lot 4 (7.27 cm) which differed significantly with lot 19 (5.57 cm), lot 11 (5.50 cm), lot 9 (5.13 cm), lot 18 (5.13 cm), lot 6 (4.63 cm), lot 1 (4.49 cm) and lot 20 (3.50 cm). Lowest plant height at 30 DAS was recorded for lot 20 (3.50cm) followed by lot 1 (4.49 cm) which were less vigrous.

At 60 DAS lot 8 recorded the highest plant height (25.17cm) which differ significantly with lot 1 (22.07 cm), lot 15 (21.88 cm), lot 11 (21.57 cm), lot 9 (20.77 cm), lot 12 (20.27 cm) and lot 20 (16.37 cm). However, lot 20 recorded the lowest plant height followed by lot 12.

The lots did not differed significantly as the growth period progressed to 90 and 120 days after sowing (DAS) with mean plant height of 26.27 cm and 29.53 cm respectively.

Plant height showed significant differences among the seed lots based on vigour levels initially at 30 and 60 DAS. High vigorous seed lots produced taller plants however, as the crop reaches maturity the differences among the lots in terms of plant height were not significant. At 30 DAS lot 4 recorded highest plant height and at 60 DAS lot 8 recorded highest plant height (Table 2). The results are on par with the results of correlation analyses revealed that standard germination and seedling vigour index-1 exhibited significant positive relationships with field emergence and plant height (Adebisi, 2003) [3] and also the initial differences in plant height among vigour levels however diminished as the plants progressed from the juvenile to the reproductive phase as nitial plant development during the first 56 days, as measured by plant height and dry matter accumulation, was affected by seed vigor mainly when differences on seed physiological potential became wider. (Rodo and Marcos-Filho, 2003) [21].

Table 2: Effect of vigour levels on plant height at different growth stages of groundnut (GPBD-4) variety

Seed lots	Plant height 30 DAS (cm)	Plant height 60 DAS (cm)	Plant height 90 DAS (cm)	Plant height at harvest (cm)
L_1	4.49	22.07	25.73	29.57
L_2	6.73	24.38	26.20	28.93
L_3	6.63	23.61	27.00	30.13
L_4	7.27	23.65	26.93	31.30
L_5	5.87	24.03	25.73	29.53
L_6	4.63	23.23	25.33	27.37
L_7	6.73	23.00	26.80	29.73
L_8	5.97	25.17	27.53	29.86
L_9	5.13	20.77	25.33	29.49
L_{10}	6.10	24.69	27.00	29.83
L_{11}	5.50	21.57	24.47	27.90
L_{12}	6.07	20.27	25.73	29.23
L_{13}	6.17	24.20	26.60	28.50
L_{14}	6.17	23.59	26.40	30.63
L_{15}	5.97	21.88	25.27	28.00
L_{16}	6.77	23.07	28.07	30.07
L_{17}	5.83	24.59	27.47	30.63
L_{18}	5.13	22.91	26.87	30.27
L_{19}	5.57	24.93	27.13	31.23
L_{20}	3.50	16.37	23.80	28.33
Mean	5.81	22.90	26.27	29.53
S.Em. ±	0.58	0.92	0.81	1.28
C.D. (0.05)	1.67	2.64	NS	NS

*NS= Non-significant DAS: Days after sowing

6. Number of branches

The data related to number of branches as influenced by vigour levels is presented in Table 3.

No significant differences among the seed lots with respect to the number of branches was found with mean number of branches 5.76, 8.62, 10.22 and 10.22 at 30, 60, 90 and 120 days after sowing (DAS) respectively.

Similar results were found by Munir and Abdel-Rahman (2000) who noticed that primary branches per plant and seed yield were not significantly affected by seed size which was related to seed vigour in faba beans.

Table 3: Effect of vigour levels on number of branches at different growth stages of groundnut (GPBD-4) variety

Seed lots	Number branches (30 DAS)	Number branches (60 DAS)	Number branches (90 DAS)	Number branches (At harvest)
L_1	6.33	9.33	10.93	10.93
L_2	5.93	8.27	9.53	9.53
L_3	6.20	9.40	11.13	11.13
L_4	5.87	8.27	10.00	10.00
L_5	5.67	8.13	9.13	9.13
L_6	5.73	9.33	11.20	11.20
L_7	5.87	8.20	9.87	9.87
L_8	5.27	8.47	10.07	10.07
L_9	5.40	8.67	10.40	10.40
L_{10}	5.60	9.07	10.87	10.87
L_{11}	6.00	8.20	10.67	10.67
L_{12}	6.20	8.27	9.67	9.67
L_{13}	5.27	8.00	9.73	9.73
L_{14}	5.33	8.60	9.60	9.60
L_{15}	5.93	9.00	9.87	9.87
L_{16}	6.13	8.00	9.73	9.73
L_{17}	6.00	8.73	9.93	9.93
L_{18}	6.07	9.20	10.83	10.83
L_{19}	6.13	9.40	11.00	11.00

L_{20}	4.20	7.80	10.27	10.27
Mean	5.76	8.62	10.22	10.22
S.Em. ±	0.36	0.63	0.63	0.63
C.D. (0.05)	NS	NS	NS	NS

*NS= Non-significant DAS: Days after sowing

7. Number of leaves per plant

The data related to number of leaves per plant as influenced by vigour levels is presented in table 4. Significant differences among the seed lots with respect to number of leaves was found at 30 and 60 days after sowing (DAS) with mean number of leaves of 24.45 and 385.55 respectively. Highest number of leaves at 30 DAS was recorded for lot11 (27.73) which differ significantly with lot 18 (22.67), lot 14 (21.47), lot 13 (20.07) and lot 20 (19.53). Lowest number of leaves at 30 DAS was recorded for lot 20 (19.53) followed by lot 13 (20.73).

At 60 DAS lot 19 recorded the highest number of leaves (95.13) and it differed significantly with lot 15 (75.53), lot 8 (74.87) and lot 16 (61.00). However, lot 16 recorded the lowest number of leaves.

As the growth period progressed to 90 and 120 days after sowing (DAS) the varation among the seed lots for number of leaves was non-significant with mean number of leaves of 442 and 534 respectively. Similarly, Khurana and Singh (2000) noted that vigorous bold seeds affected leaf area in Abizia plant particularly at the beginning of growth cycles.

Table 4: Effect of vigour levels on number of leaves at different growth stages of groundnut (GPBD-4) variety

Seed lots	Number of leaves (30 DAS)	Number of leaves (60 DAS)	Number of leaves (90 DAS)	Number of leaves (At harvest)
L_1	25.33	94.10	110.72	131.17
L_2	26.53	86.15	114.78	146.00
L_3	23.40	91.47	113.50	136.47
L_4	26.07	81.63	106.87	117.57
L_5	24.47	84.47	101.27	129.23
L_6	24.67	91.13	112.92	140.05
L_7	24.47	89.93	107.12	129.73
L_8	23.47	74.87	103.05	119.00
L_9	24.27	82.67	111.87	140.88
L_{10}	26.93	85.33	112.97	141.42
L_{11}	27.73	92.53	123.08	140.20
L_{12}	26.73	85.00	119.00	137.17
L_{13}	20.07	84.07	101.82	121.37
L_{14}	21.47	89.60	110.77	129.60
L_{15}	25.13	75.53	101.22	125.83
L_{16}	26.47	61.00	97.72	132.27
L_{17}	25.00	81.07	110.37	126.45
L_{18}	22.67	90.53	115.55	140.35
L_{19}	24.53	95.13	116.52	135.06
L_{20}	19.53	94.82	121.05	150.27
Mean	24.45	85.55	110.61	133.50
S.Em. ±	1.55	5.97	7.32	9.41
C.D. (0.05)	4.44	17.10	NS	NS

*NS= Non- significant DAS: Days after sowing

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