



RESPONSE OF GINGER (*Zingiber officinale* ROSC.) AS INFLUENCED BY PLANTING DATE, INTRA – ROW SPACING AND NPK FERTILIZER

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ABSTRACT

Field experiment was conducted during the 2015, 2016 and 2017 wet seasons at the National Root Crop Research Institute Vom, Plateau State to study the response of ginger (*Zingiber officinale* Rosc.) The treatments consisted of two separate planting dates (April and May), three intra-rows spacing (10, 20 and a constant 30cm) as well as NPK fertilizer application rates (0, 50, 100 and 150 kg/ha) were factorially combined and laid out in a randomised complete block design (RCBD) with three replications. The results obtained revealed that planting date, intra-row spacing and NPK fertilizer application significantly increased plant height, leaf area, leaf area index, number of rhizomes and weight of rhizomes. It could be concluded that planting date during the month of May, intra-row spacing of 30 x 20 cm and fertilizer application rate of 100kg/ha seem more promising and produced higher yields of ginger in Vom, Plateau State environs.

Key words: Fertilizer, Ginger, Planting, Spacing and Yield.

INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) is an underground rhizome crop belonging to the family zingiberaceae which grows in the tropics. It bears bud on top of its stubby fingers which when planted has tangled roots below the soil surface. Ginger is cultivated vegetatively from its rhizomes. The crop requires warm and humid climate. It thrives well from sea level to an altitude of 1500m under a well distributed rainfall of 150-300mm during growing season. A mature ginger rhizome is fibrous and has a striated texture. The outer skin of the rhizome is brownish, while the inner flesh depending on the variety may be red or yellow in colour. It is one of the spice crops that is used as condiment or as flavouring agent in the preparation of non-alcoholic beverages (Asumugha *et al.*, 2006). Ginger is widely used in food, beverages, confectionery and medicinal values.

Over centuries, ginger has been introduced to various parts of the world like: The Caribbean, the Americas and Africa. Presently, the top growers of the crop include: China, India, Jamaica, Indonesia and Fiji. Food and Agricultural Organization (FOA), (2015) reported that the global production of ginger started in Nigeria in 1974 (Peter *et al.*, 2005) and it has since been the largest exporter in Africa, where it ranked fifth in the world. The area of production by then was restricted to mostly Kaduna state. Also states like Bauchi, Nasarawa and Plateau are among major producers of the crop. The Nigeria's production in 2005 was estimated at 110,000 metric tines, (FOA, 2005).

In the Nigerian market, ginger is available in various forms such as: fresh ginger rhizome, dry ginger rhizome and powder ginger. Goyit (2012) reported that two commercial cultivars of ginger are produced in Nigeria; the Yellow and the black types mostly grown in Kaduna state, with reasonable farmers from parts of Bauchi, Nasarawa and Plateau province. The yield of ginger has been reported to vary greatly depending on the climate and planting time (Peter *et al.*, 2005). Planting date in ginger production is greatly required for its optimum growth and yield. This is because crop season varies accordingly (Sharma, 2000). Early and late planting affects the growth, performance and yield of ginger (Raut *et al.*, 2004). Take for instance, during wet seasons when

rains are fully established, it enhances the sprout or emergence of ginger because the newly planted rhizomes seeds are housed in a soft, cool and moisten environment.

Considering the effect of planting date, in split plot design field trail was conducted during the 2008/2009 farming seasons in Konkan, India, where three different planting dates were involved (15th April, 15th May and 15th June) the effects of different dates of planting was significant. The highest sprouting was observed in 15th April planting date. This might be due to congenial weather conditions, favourable soil temperature and optimum soil spacing (Aggarwal, 2000). The different planting dates also showed significant effects on the plant height throughout the growth stage. The 15th April planting date showed highest plant height at 120 DAP than other planting dates. Again, 15th April planting date recorded the longest rhizomes over other planting dates. These findings are in conformity with the results recorded by Ishimine *et al.* (2004) in turmeric. To improve the yield of ginger proper planting period is an important non-monetary input in crop production. Plant spacing is among the major factors influencing the performance of ginger. Plant spacing, whether rain fed or under irrigated condition is one of such important agronomic practices that greatly has an impact on ginger plant. Ginger increased linearly as the spacing reduces due to superior yield in the case of high plant population over low plant population (Gosh and Bendopadly, 2008).

FAO (2008) reported that farmers, in sub-Saharan Africa used an average of 80kg NPK/ha yearly compared to 100-120NPK kg/ha in regions that experience rapid growth in agricultural productivity. Similarly, African Fertilizer Summit (AFS, 2006) also argued that the low soil fertility is one of the main causes of Africa's persistent food insecurity. No wonder, Hosnner and Juo (1989) affirmed that this ugly trend is due mainly to mineral exploitation through extensive cropping without nutrient replenishment over the years. Therefore, definite suggestions in fertilizer rates, soil management and better agronomic practices be adopted to give better yield in ginger production.

MATERIALS AND METHODS

Field experiment was conducted during the 2015, 2016 and 2017 wet seasons at the national root crop research institute, potato programme Kuru, Jos (09 44 10'' N and 08 48 21'' E) The physical and chemical analysis of the experimental field revealed that the soil textural class ranged between sandy-loam to sandy-clay loam with an average soil pH of 5.6.

The treatments consisted of two planting dates (April and May), Three different intra-row spacing (10, 20 and 30 cm) as well as four levels of NPK 15:15:15 fertilizer (0, 50, 100 and 150 kg/ha) which were factorially combined and laid out in a randomized complete block design in three replicates. Soil samples were collected at five different locations within the experimental site to determine the three major elements in the soil, thus, Nitrogen, Phosphoresce and Potassium. The samples were randomly taken using auger at a depth of 0-30cm before the commencement of the experiment in each year of the study.

Thereafter, the land was cleared of shrubs and debris. It was ploughed and harrowed twice in order to obtain a fine tilt. A total land area of 576m² and a unit plot of 2m x 3m (6m²) were sketched with boundaries properly demarcated. Three blocks containing 24 plots each were laid out with space between the plots and blocks at 0.5m and 1m respectively. First planting date was April 21, and second planting date was May 21st. Intra-row spacing of 10, 20 and 30cm were carried out according to treatments. Also, fertilizer application of 0, 50, 100 and 150 kg/ha was carried out according to the treatments. The experimental site was weeded manually using hoe and

sometimes through hand pulling to maintain a weed-free plot. The parameters assessed were: plant height, number of leaves; stem girth, number of rhizome, and rhizome weight. Plant height, leaf area, leaf area index, number of rhizome and weight of rhizome kg/ha. All the data collected were subjected to statistical analysis according to Steel and Torrie (1980). Duncan multiple range test (DMRT) was employed to separate the significantly different means.

RESULTS AND DISCUSSION

Effect of planting date, spacing and NPK fertilizer application on plant height of ginger during the 2015 cropping season is presented in Table 1. Plant height of ginger was significantly ($P \leq 0.05$) affected by NPK fertilizer application at 6 and 12 weeks after planting (WAP), where the application of 100 kg NPK/ha produced the tallest plants, which was significantly higher than the control (0 kg NPK/ha). At 9 weeks after planting a spacing of 20cm significantly produced taller plants than 30 and 10cm spacing rates.

Fertilizer application significantly ($p < 0.05$) affected leaf area throughout the period of study. At 6, and 9 weeks after planting, application of 100 kg NPK/ha significantly produced the largest leaf area, while the control plots recorded the least value. However, the result further revealed that, at 12 weeks after planting, application of 150 kg NPK/ha produced largest leaf area than other treatments. The result further revealed that the control plots produced reduced leaf area. There was no significant interaction between the treatments during the period of the study (Table 22).

Leaf area index showed significant difference at 6 weeks after planting, where and intra-row spacing of 30 cm produced the highest leaf area index. Again at 6 weeks after planting, application rate of 150 kg NPK/ha significantly ($P \leq 0.05$) increased leaf area index. However, this observation differs at 12 weeks after planting where the application rate of 100 kg NPK/ha produced the highest value of leaf area index. While 150 kg NPK/ha application rate produced the least leaf area index at the same 12 WAP (Table 25).

The effects of planting, intra-row spacing and NPK fertilizer application on yield components of ginger in 2015, 2016 and 2017 seasons are presented on Tables 4. During the 2015 seasons, there was significant ($P \leq 0.05$) difference on the number of rhizome (kg/ha). Intra-row spacing of 20 cm produced highest number of rhizomes than other two seasons (Table 4). During the study period, intra-row spacing of 20 cm in 2017 planting season produced the highest ginger weight. While the control plots recorded the least values. There was an interaction between NPK fertilizer and planting seasons (Table 5).

Plant heights were significantly taller at fertilizer application rate of 100 kg NPK/ha and decreased at application rates 50 kg NPK/ha. This plant behaviour of response to applied fertilizer could be due to more uptake of nutrient during growth period resulting to increase in cell division and elongation which ultimately increased plant growth. This result is in agreement with the findings of Henke *et al.* (2007) who reported that application of 100 kg NPK/ha significantly increase plant height with their genetic materials under this condition. The decreasing trend in plant height at N-rate above 100 kg NPK/ha may be due to the fact that higher N-rate invariably hindered the uptake of certain other essential nutrients for efficient vegetative growth. This result agrees with the findings of Zalalem *et al.* (2009) who reported that higher rates of N-application on acidic soils hinder efficient utilization of most other soil nutrients which leads to growth retardation.

Fertilizer application significantly affected number of rhizome per plant, primary, secondary and weight kg/ha respectively. All yield components were highest at 100 kg NPK/ha of fertilizer. This behavioural pattern of response in yield components to fertilizer application is expected since NPK fertilizer plays an important role in ginger size development. Vaezzadeh *et al.* (2012) stated that NPK fertilizer showed good responses for different crops across different locations. Results from the study conducted revealed that, increase in yield components especially in 2017 seasons could be due to the availability of more moisture and translocation of dry matter content from sources to sinks as earlier reported by Akinrinde (2006).

Tuber yield responded to planting date in a similar trend as fertilizer application. Planting date in the month of May registered maximum yield weight of ginger than when sown in the month of April. The variation in climatic conditions might have accounted for this. This result coincides with the findings of Olojede *et al.* (2004), that ginger is greatly affected by prevailing environmental conditions and cultural practices. Increased yield in ginger at a spacing of 20 cm recorded highest values of ginger than other spacing rates during the study period. When plants are sown too close or wider apart affect the growth and development of crops. No wonder, Hossain *et al.* (2005) reported that planting pattern affects nutrient availability of crops which eventually determines its output.

Table 1: Effect of planting date, intra-row spacing and NPK fertilizer on plant height of ginger (*Zingiber officinale* Rosc.) in Vom during 2017 wet season

Treatment	Weeks After Planting (WAP)			
	3	6	9	12
Planting Date (Months)				
21 st April	13.88	17.19	20.72	24.24
21 st May	14.06	17.36	21.04	24.49
LS	NS	NS	NS	NS
SE±	0.25	0.38	0.34	0.28
Spacing (cm)				
10	14.44	17.54	19.45 ^c	24.63
20	13.72	16.98	22.94 ^a	24.15
30	13.76	17.32	20.14 ^b	24.33
LS	NS	NS	**	NS
SE±	0.30	0.38	0.42	0.34
NPK Fertilizer (kg/ha)				
0	13.34	15.64 ^d	18.55	22.85 ^d
50	14.20	17.29 ^c	21.12	24.49 ^c
100	14.85	21.43 ^a	21.84	28.80 ^a
150	13.49	17.75 ^b	22.01	25.32 ^b
LS	NS	**	NS	**
SE±	0.65	0.53	0.59	0.48
Interaction				
N X S	NS	NS	NS	NS
N X PD	NS	NS	NS	NS
S X PD	NS	NS	NS	NS
N X S X PD	NS	NS	NS	NS

Means followed by different letter(s) within a treatment group are significantly different using Duncan's Multiple Range Test (DMRT) WAP = Weeks After Planting, N = fertilizer, S = Spacing, PD = Planting date, LS = Level of Significant, SE± = Standard Error, * = Significant at (0.05), ** = Significant at (0.01), NS = Not significant.

Table 2: Effect of planting date, intra-row spacing and NPK fertilizer on leaf area of ginger (*Zingiber officinale* Rosc.) in Vom during the 2017 wet season.

Treatment	Weeks After Planting (WAP)			
	3	6	9	12
Planting Date (Months)				
21 st April	17.96	14.33	14.09	14.35
21 st May	16.57	14.37	14.30	14.17
LS	NS	NS	NS	NS
SE±	1.25	0.71	0.73	0.68
Spacing (cm)				
10	17.02	14.25	14.1	14.04
20	18.00	14.58	14.40	14.37
30	16.77	14.22	14.08	14.34
LS	NS	NS	NS	NS
SE±	1.53	0.87	0.89	0.84
NPK Fertilizer (kg/ha)				
0	15.99	11.83 ^d	11.15 ^d	12.67 ^d
50	17.42	12.17 ^c	12.62 ^c	13.19 ^c
100	17.48	17.45 ^a	16.16 ^a	16.53 ^b
150	18.18	16.95 ^b	16.40 ^b	16.76 ^a
LS	NS	* *	* *	* *
SE±	2.16	1.22	1.27	1.88
Interaction				
N X S	NS	NS	NS	NS
N X PD	NS	NS	NS	NS
S X PD	NS	NS	NS	NS
N X S X PD	NS	NS	NS	NS

Means followed by different letter(s) within a treatment group are significantly different using Duncan's Multiple Range Test (DMRT) WAP = Weeks After Planting, N = fertilizer, S = Spacing, PD = Planting date, LS = Level of Significant, SE± = Standard Error, * = Significant at (0.05), * * = Significant at (0.01), NS = Not significant.

Table 3: Effect of planting date, intra-row spacing and NPK fertilizer on leaf area index of ginger (*Zingiber officinale* Rosc.) in Vom during the 2016 wet season.

Treatment	Weeks After Planting (WAP)			
	3	6	9	12
Planting Date (Months)				
21 st April	1.90	0.98	0.98	1.58
21 st May	1.87	1.09	1.28	1.70
LS	NS	NS	NS	NS
SE±	0.5	0.11	0.13	0.14
Spacing (cm)				
10	1.06	0.13 ^c	0.15	1.22
20	1.14	0.18 ^b	1.20	1.24
30	1.15	1.31 ^a	1.24	1.27
LS	NS	*	NS	NS
SE±	0.06	0.13	0.16	0.18
NPK Fertilizer (kg/ha)				
0	1.64	0.07 ^d	0.48	1.21 ^c
50	1.95	0.16 ^c	0.26	1.60 ^b
100	1.97	1.60 ^b	1.47	2.58 ^a
150	1.98	2.40 ^a	1.33	1.17 ^d
LS	NS	* *	NS	* *
SE±	0.09	0.19	0.23	0.26
Interaction				
N X S	NS	NS	NS	NS
N X PD	NS	NS	NS	**
S X PD	NS	NS	NS	NS
N X S X PD	NS	NS	NS	NS

Means followed by different letter(s) within a treatment group are significantly different using Duncan's Multiple Range Test (DMRT) WAP = Weeks After Planting, N = fertilizer, S = Spacing, PD = Planting date, LS = Level of Significant, SE± = Standard Error, * = Significant at (0.05), * * = Significant at (0.01), NS = Not significant.

Table 4: Effect of planting date, intra-row spacing and NPK fertilizer on yield components on the number of rhizome of ginger (*Zingiber officinale* Rosc.) in Vom during the 2015, 2016 and 2017 wet seasons.

Treatment	Number of Rhizomes		
	2015	2016	2017
Planting Date (Months)			
21 st April	66.86	78.58	79.97
21 st May	74.53	80.71	82.14
LS	NS	NS	NS
SE±	6.19	2.58	2.56
Spacing (cm)			
10	82.75 ^a	80.12	83.96
20	61.33 ^c	78.54	82.08
30	68.00 ^b	80.26	77.13
LS	**	NS	NS
SE±	7.59	3.32	3.14
NPK Fertilizer (kg/ha)			
0	74.44	91.64	83.94
50	67.22	87.84	85.67
100	69.06	73.85	78.92
150	72.06	65.66	75.69
LS	NS	NS	NS
SE±	10.74	4.72	4.4
Interaction			
N X S	NS	NS	NS
N X PD	NS	NS	NS
S X PD	NS	NS	NS
N X S X PD	NS	NS	NS

Means followed by different letter(s) within a treatment group are significantly different using Duncan's Multiple Range Test (DMRT) WAP = Weeks After Planting, N = fertilizer, S = Spacing, PD = Planting date, LS = Level of Significant, SE± = Standard Error, * = Significant at (0.05), ** = Significant at (0.01), NS = Not significant.

Table 5: Effect of planting date, intra-row spacing and fertilizer on rhizome weight(kg/ha) of ginger (*Zingiber officinale* Rosc.) in Vom during the 2015, 2016 and 2017 wet seasons.

Treatment	Rhizome Weight kg/ha		
	2015	2016	2017
Planting Date (Months)			
21 st April	1.59	2.52	12.72
21 st May	1.77	2.70	2.87
LS	NS	NS	NS
SE±	0.15	0.01	0.10
Spacing (cm)			
10	1.42 ^c	1.53 ^c	1.83 ^c
20	2.06 ^a	2.72 ^a	3.16 ^a
30	1.59 ^b	1.57 ^b	2.38 ^b
LS	**	**	**
SE±	0.18	0.13	0.13
NPK Fertilizer (kg/ha)			
0	1.78	2.07	3.14
50	1.83	2.70	2.80
100	1.67	2.60	2.65
150	1.46	2.38	2.60
LS	NS	NS	NS
SE±	0.26	0.18	0.17
Interaction			
N X S	NS	NS	NS
P X N	NS	NS	NS
S X N	NS	NS	NS
P X Y	NS	NS	NS
S X Y	NS	NS	NS
N X Y	NS	**	NS
P X S X N X Y	NS	NS	NS

Means followed by different letter(s) within a treatment group are significantly different using Duncan's Multiple Range Test (DMRT) WAP = Weeks After Planting, N = fertilizer, S = Spacing, PD = Planting date, LS = Level of Significant, SE± = Standard Error, * = Significant at (0.05), ** = Significant at (0.01), NS = Not significant.



REFERENCES

- Africa Fertilizer Summit (2006). Abuja Nigeria. Une 9 – 13, 2006 Pp 117 – 138
- Aggarwal, S. (2000). Effect of dates of planting and mulch materials on the growth and yield of ginger (*zingiber officinale Rosc.*) M. Sc. (Ag) Thesis, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan.
- Akirinde, E. A. (2006). Strategies for improving crops use-efficiencies of fertilizers. *Journal of Tropical Agriculture* (ISSN:1553 – 9873).
- Asumugha, G. N., Ayaegbunam, H. N., Ezulike, T. O. and Nwosu, K. L. (2006). Guide to ginger production and marketing in Nigeria. National Root Crops Research Institute, Umudike, Nigeria. Ext.Guide 7:1 – 7.
- Baboo, R., and Mishra, S. K. (2001). Growth and pod production of cowpea (*vigna sinensis sari*) as influenced by inoculation, nitrogen and phosphorus. *Annals of Agricultural Resources*. 22:104 – 106.
- FOA (2008) Food and Agricultural Organizations. Economics and Social Development. The Statistical Data Division.
- FOA (2008). Crop statistics. FASTAT.<http://fastat.FAO.org>
- FOA (2015). Quarterly bulletin of statistics on crop production of the Food and Agricultural Organization of the United Nations, Rome, Italy. 1 – 501 – 6.
- Gosh, D. K. and Bandyopadhyay, A. (2008). Effect of different spacing of French bean (*phaseolus ullgaris L.*) on its growth and yield grown as intercrop with coconut. *Indian Coconut Journal*. 3(12):19 – 22
- Goyit, I. (2011). Influence of poultry manure and NPK (15:15:15) on the growth and yield of ginger (*Zingiber officinale Rosc.*) Unpublished M. Sc. Thesis. Crop production, ATBU Bauchi, Nigeria.
- Henke, J., Breustedt, G., Sieling, K. and Kage, H. (2007). Impact of uncertainty on the optimum nitrogen fertilization rate, agronomic ecological and economic factor in an oilseed rape-based crop rotation. *Journal of Agricultural Science Cambridge*. 5:455 – 468.
- Hossain, M., Yokio, I. K. M. and Akamine, H. (2005). Effects of planting pattern and planting distance on growth of turmeric (*Curcuma longa L.*). *Plant production science*. 1.95 – 105.
- Ishimine, Y., Hossain, M. A., Motumura, K., Akamine, H. and Hirayana, T. (2004). Effect of planting date on emergence, growth and yield of turmeric (*Cucuma longa L.*) in Okinawa Prefecture, South Japan. *JPM. J. Trop. Agric*. 48.10 – 16.
- Olojede, A. O. C., Nwokacha, C. C., Eke-Okoro, O. N. and Emechuke, J. K. U. (2004). Varietal response of living stone potato (*Plectranchus esculentus*) to NPK fertilizer application at Umudike NRCRI *Annual report*, 86 – 117.
- Peter, K. V., Nybe, E. V. and Kurien, A. (2005). Yield gaps and constrains in ginger. In. Ravindran P. N., Nirmal Bic (eds.) *Ginger the genus zingiber* (CRC Press. Bocaraton) Pp. 527 – 532.
- Raut, M. P., Jadhao, B. J., Raut, U. A. and Adapawar, R. M. (2004). Effect of dates of planting and spacing on growth and yield of turmeric var. Krishna and Selam. *Crop Production Journal*. 1:41 – 42.
- Sharma, S. K. (2002). Effect of sowing time and spacing levels on seed production of pea cultivar Arkel. *Seed Research*. 30(1): 88 – 91.