The Effect of NP Fertlizer Rates on the Yield and Yield Components of Ginger (Zingiber Offcinale Rosc.) in Kindo-Koysha Woreda; Wolaita, South Ethiopia

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Abstract

A field experiment was conducted at Kindo-Koyisha, Wolaita Zone, South Ethiopia during the 2012/2013 cropping season to evaluate the influences of different rates of NP on yield, yield components. The experiment was laid out in randomized complete block design with three replications. The treatments consisted of five levels of N (0, 23, 46, 62 and 92kg/ha) and four levels of P (0, 10, 20 and 30 kg/ha). Duncan's multiple range tests were employed to compare means at 5% probability levels. The analysis revealed that increase in N level had very highly significant ($p<0.001$) effect on average leaves number per plot, plant height, leaf length, leaf width, leaf area, tiller number per hill, and number of plants per plot in Kindo-Koyisha woreda. The level of P for Kindo-KoyishaWoreda had very highly significant ($p<0.001$) effect on average plant height, leaf length , and leaf area, tillers number per hill and number of plants per plot; and it showed highly significant ($p<0.01$) effect on average leaf significant effect ($p<0.05$) on leaf width.NP interaction highly significantly ($p<0.01$) affected the average leaf area, and number of plots per plot whereas, very highly ($p<0.001$) affected average number of leaves per plant, plant height, and leaf length. The highest record of data obtained at 92kg/ha of nitrogen and 30kg/ha of phosphorous levels in experimental sites. The future studies should articulate towards and studies involving more cultivars, multi-location and additional rates of N and P application, under diverse management practices such as farmers, irrigated or rained conditions, which may facilitate fine-tuning of fertilizer recommendations.

Keywords: Ginger, yields, growth, interaction, fertilizer

1.   Introduction

Ginger (Zingiber officinale Rosc.), a member of the family Zingeberaceae, is an important tropical herbaceous perennial plant; grown as annual is indigenous to tropical India, South East Asia, Australia and Japan, with the main center of diversity in Indo-Malaysia (Purseglove, 1972). Other important producers are Jamaica, Nigeria, Sierra Leone, Thailand, and Australia (Purseglove, 1972; Jansen, 1981; Weiss, 2002; Yiljep et al., 2005).India, China, Indonesia and Nepal are the major producers of ginger in the world, having production of 517.8 thousand tons, 279 thousand tons, 159 thousand tons and 154.1 thousand tons respectively. Nigeria .The cultivation of ginger was started in Ethiopia during 13th century when Arabs introduced it from India to east Africa (Janson, 1981). It is the second most widely cultivated spice in Ethiopia, next to chilies. It is limited mostly in the wetter regions of Southern Nations, Nationalities and Peoples Regional State (SNNPRS) and some parts of western Oromia. Most of the commercial production is practiced in SNNPRS by farmers within Wolaita, Kambata-Tambaro and Hadiya zones (MoARD, 2007).

In Ethiopia, ginger is grown in an area of 45,164ha with production of 716,550t ha^{-1} (MoARD, 2007). Currently, unpublished Southern Agriculture and Rural Developments' report indicates that the area coverage of the Region in the year 2012/2013 was 27615ha, from which Wolaita Zone covers about 11590ha and Kembata-Tambaro Zone covers 9433ha with the average productivity of 285 Qts/ha (BoARD, 2013). Ginger production for the extraction of oleoresins essential oils, as well as the direct use of rhizomes for culinary purposes is increasing worldwide (FAO, 2008). Ginger is a very potential spice crop in SNNPR, Wolaita. In Wolaita ginger is widely grown as a cash crop. The ginger crop, in spice sub-sector, has an immense potential for economic development and poverty reduction through creation and expansion of employment opportunities and distribution of income and foreign exchange earnings. Chemical fertilizers, N and K were highly responsive to ginger production (Sugtto and Mafzuchah, 1995) stated that N and K increased the quality of young ginger rhizome and produced average fresh yield of rhizome. Farmyard is a major fertilizer used for ginger production in SNNPRS. However, it cannot support large scale production since the availability of farmyard manure is limited and the preparation of it is laborious. There is increased use for Nitrogen fertilizer which reaches up to 150kg/ha and the P (DAP) fertilizer use is mostly 100kg/ha in Wolaita area since the year 2009 (WZARDD, 2012). However, the ginger producers at the region, use undetermined rate of DAP and N fertilizers (Endrias Geta, 2011). The people in area do not have any recommended dose of fertilizers though; they were often use chemical fertilizers in ginger crop.

Despite all the potentials and opportunities of having such a long history with a diversified conducive

agro-ecology base, this spice sub-sector potential remained unexploited. The sub-sector is still not organized or packaged, low in productivity and inefficient. This is attributed to several factors; poor soil fertility, shortage of improved varieties, and poor agronomic practices are the most important ones (Hailemichael *et al.*, 2008; MoARD, 2007). Mostly farmers grow ginger and get the produce with very low yield due to lack of research and technology. It is necessary to determine the correct rate and time of application of the chemical fertilizers for the optimum yield/quality as well as to analyze the economic aspect of fertilizer application (Endrias Geta, 2011). Addressing these constraints perfectly fit into the Agriculture sector policy direction of GTP which focuses on enabling small holding farmers to access and use appropriate improved modern technology, thereby enhancing production and productivity of the sector in Agricultural development.   Therefore, the study was initiated with the following objectives.

- To determine the optimum NP fertilizer rate for growth
- To determine the effect of NP fertilizer rates on growth of ginger;

2.   Materials and Methods
2.1. Description of the study sites
 The study was conducted at Kindo-Koysha woreda, Wolaita Zone, Southern Ethiopia, which is located at 37˚.39-37˚63 E longitude & 6˚79-7˚06 N latitude which is 431 km from Adis Abeba to South- East direction and 36 km from Wolaita Sodo town to South-East direction on the way to Jimma. The altitude of the area ranges from 700 – 2280 m, and the climate is characterized by an erratic rain fall, receiving 400 – 1400 mm per annum with bimodal pattern (Meher & Belg) where 'Belg' cropping season covers from February to June, and 'Meher' season from July to October. The area has an average maximum and minimum temperature of 30.70^c and 19.20^c, respectively.

2.2. Treatments and   Experimental Design
The experiments consisted of, Five levels of N (0, 23, 46, 69 and 92 kg N ha^{-1}), and four levels of P (0, 10, 20 and 30 kg P ha^{-1}) with released cultivars 38/79 or Volbo from the certified seed multiplying model farmer was used. Three to five centimeter long, one-year-old ginger rhizomes having at least one active bud were used as planting material. The experiment was laid out in Randomized Complete Block Design with three replications in factorial arrangement. The plot size was 1.2m*1.5m with 4 rows/plot and 10 plants/row. The spacing was 30 and 15 cm between rows and plants, respectively. There was 50 cm spacing between plots and 1m between replications. The N source was urea and DAP, whereas the sources of P were triple super phosphate. The 60% of N were applied at planting time and the rest of Nitrogen was applied as a top dressing in two equal doses at 45 and 90 days after planting.   For the data, five plants were randomly selected from each inner two rows such as Numbers of leaves/ plant, Leaf length, Leaf area (cm^2) – leaf areas by adjustment factor (K=1.426) (Anteneh *et al.*, 2008).   Plant height, Number of tillers/hill and Date of emergence

2.3. Soil analysis
The soil samples were air-dried and ground to pass 2 and 0.5 mm (for total N) sieves. All samples were analyzed following standard laboratory procedures as outlined by Sahlemedhin and Taye (2000). Organic carbon and total N contents of the soil were determined following the wet combustion method of Walkley and Black, and wet digestion procedure of Kjeldahl method, respectively. The available P content of the soil was determined following Olsen method. Soil texture was analyzed by Bouyoucos hydrometer method. The cations exchange capacity (CEC) of the soil was determined following the 1N ammonium acetate (pH 7) method. Ca and Mg contents were measured by using EDTA titration, whereas the exchangeable K and Na in the extract were measured by flame photometer. The pH (1:2.5 solid: liquid ratio) of the soils was measured in water using pH meter with glass-calomel combination electrode. Exchangeable acidity of the soil was determined by leaching exchangeable hydrogen and aluminum ions from the soil samples by 1N KCl solution.

2.4. Statistical analysis
The mean values of each parameter were analyses using variance /ANOVA/ following the SAS statistical package (Version 9.0) the statistical significance was determined using LSD to compare means at 5% probability levels.

3.   Results and Discussion
3.1. Physico-chemical Properties of Soils
Soil analysis of the locations before sowing (Table 1) showed that soil pH, available P, CEC and Total N found in the range of slightly acidic based on Herrera (2005) classification, whereas, Kindo Koyisha Woreda. Textural analysis showed that the same textural class according to the present study soil textural class was sandy clay both locations. The lack of soil textural class difference between two locations its might be attributed to the similarity in parent material from which the soils originate.

Table 1:- Physico-chemical Properties of Soils before sowing during 2012/13

Location	N	P	PH	CEC	OC	Texture class
K/Koyisha	0.1	2.08	5.9	10.4	1.52	Sandy clay

3.2. Responses of ginger on NP fertilizer

The effect of N P on the ginger 38/79 or Volbo yield and yields components at Kindo-Koyisha Woreda was evaluated by considering the performance of the growth parameters. The analysis showed that the level of N had very highly significant ($p<0.001$) effect on average leaves number per plot, plant height , leaf length, leaf width , leaf area, tiller number per hill, and number of plants per plot (Table 2).The level of P for Kindo-Koyisha Woreda had very highly significant ($p<0.001$) effect on average plant height , leaf length, and leaf area, tillers number per hill and number of plants per plot; and it showed highly significant ($p<0.05$) . The NP interaction highly significantly ($p<0.01$) affected the average leaf width and very highly significant ($p<0.001$) affected plant height and significant effect ($p<0.05$)

Table 2: Means squares of the growth parameters by NP at Kindo Koyisha during 2012/13

Characters	MSN	MSP	MSN*P	MSE
LPP	91.9529***	11.6926**	1.4041NS	2.0573
PH	347.2056***	100.4240***	35.1157***	5.2006
LL	41.7086***	17.5234***	1.7121NS	1.3030
LW	0.9758***	0.0758*	0.0745**	0.0206
LA	1922.5373***	350.7479***	74.8667*	33.1309
TPH	16.0204***	2.3358**	0.4238NS	0.2726
NPP	924.9542***	100.1819*	17.6431NS	11.8042

*Figures in parenthesis indicate the degree of freedom, MSN= Nitrogen mean square, MSP=phosphorus mean square, MSN*MSP=Nitrogen phosphorous interaction mean square, Mse= error mean square,*, **, *** = Significant at 0.05, 0.01and 0.001 respectively. Ns = non-significant, LPP= average number of leaves per plant, PH= average plant height, LL= average leaf length, LW= average leaf width, LA=average leaf area, TPH= average tillers number per hill, and NPP= average number of plants per plot.

3.3. Interaction effect of NP Fertilizer on ginger plant

The interaction effect of between N and P levels and the different growth parameters and among the parameters, N levels correlated significantly and positively with leaf number per plant, plant height, leaf length, leaf width, leaf area, tillers number per plant, and number of plants per plot at Kindo-Koyisha Woreda (Table 3).Correlation analysis at Kindo-Koyisha woreda, also showed significant and positive relationship between P and plant height, leaf length and leaf area and it showed none significant between leaf number per plant, leaf width, tillers number per plant and number of plants per plot (Table 3).

Table 3:- Correlation of ginger crop growth and yield components at Kindo-Koyisha Woreda during 2012/13

	N	P	LPP	PH	LL	LW	LA	TPH	NPP
N	1.00	0.00	0.82***	0.71***	0.65***	0.79***	0.80***	0.82***	0.76***
P		1.00	0.26	0.35*	0.39**	0.19	0.31*	0.28	0.25
LPP			1.00	0.90***	0.89***	0.83***	0.93***	0.84***	0.82***
PH				1.00	0.91***	0.83***	0.93***	0.0.81***	0.85***
LL					1.00	0.69***	0.89***	0.79***	0.83***
LW						1.00	0.94***	0.77***	0.79***
LA							1.00	0.84***	0.87***
TPH								1.00	0.84***
NPP									1.00

N= Nitrogen, P=phosphorus, LPP= average number of leaves per plant, PH= average plant height, LL= average leaf length, LW= average leaf width, LA=average leaf area, TPH= average tillers number per hill, and NPP= average number of plants per plot.

3.4. Effects on ginger on Yield and yield components

The effects of different levels of N on the ginger growth parameters i.e., average number of leaves per plant, plant height, mean leaf length, mean leaf width, mean leaf area, mean tillers number per hill and mean plant number per plot showed a very highly significant effect and the highest mean number of leaves (20.42) was recorded at 92kg/ha N level and the lowest (13.12) were obtained at 0 kg/ha N levels. Similarly, the N level showed very highly significant effect on mean plant height, mean leaf length, mean leaf width, mean leaf area,

tillers number per hill and number of plants per plot with the highest mean 55.13, 20.27, 2.56, 74.05, 6.49, and 56.25 at 92kg/ha N respectively and with lowest record of 41.21, 15.57, 1.78, 39.91, 3.70 and 34.33 at 0kg/ha level respectively. The levels of P had a very significant effect on meanaverage number of leaves per plant, plant height, mean leaf length, mean leaf width, mean leaf area, mean tillers number per hill and mean plant number per plotwith the highest mean 18.32, 52.70, 19.72, 2.27, 64.29, 5.85 and 52.90 at 30kg/haphosphorus level respectively and with lowest mean of 16.25, 46.68, 17.27, 2.11, 53.18, 4.91 and 46.72 were recorded at 0kg/ha of phosphorus level (Table 3).

Table 4:- Means values of yield and yields components of ginger varieties of - 38/79 at Kindo-Koyisha during 2012/13

Nitrogen	LPP	PH	LL	LW	LA	TPH	NPP
0	13.12d	41.21d	15.57c	1.78d	39.91d	3.70d	34.33d
23	16.53c	49.57c	18.57b	2.12c	56.05c	4.85c	50.13c
46	18.11b	51.29c	19.39ab	2.25b	62.28b	5.74b	52.75bc
69	18.79b	53.21b	19.78a	2.30b	64.57b	6.31a	54.18ba
92	20.42a	55.13a	20.27a	2.56a	74.05a	6.49a	56.25a
C.V.	8.24	4.55	6.1	6.53	9.70	9.63	6.94
SE	$\pm$ 1.17	$\pm$1.86	$\pm$ 0.93	$\pm$0.12	$\pm$4.70	$\pm$0.43	$\pm$ 2.81
Phosphorous							
0	16.25b	46.68c	17.27c	2. 12b	53.18c	4.91c	46.73c
10	17.23ab	49.65b	18.55b	2.19ab	58.15b	5.35b	48.60bc
20	17.77a	51.29ab	19.33ab	2.23a6	1.86ab	5.57ab	49.87b
30	18.32a	52.70a	19.72a	2.27a	64.29a	5.85a	52.90a
C.V.	8.24	4.55	6.1.	6.53	9.70	9.63	6.94
SE	$\pm$ 1.17	$\pm$ 1.86	$\pm$ 0.93	$\pm$0.12	$\pm$4.70	$\pm$ 0.43	$\pm$ 2.81

Means followed by the same letter in the same column were not significantly different at p<0.05 levels according to Duncan's Multiple Range test LPP= average number of leaves per plant, PH= average plant height, LL= average leaf length, LW= average leaf width, LA=average leaf area, TPH= average tillers number per hill, and NPP= average number of plants per plot.

It was also reflected in the significant and positive correlations that existed between the level of applied N and mean leaves number per plant (r=0.85***), plant height (r=0.92***), leaf length (r=0.85***), leaf width (r=0.87***) cm. leaf area (r=0.89***), tiller number per hill (r=0.89***), and number of plants per plot (r=0.91***) (Table 4). N either in single or in combination had significant effect on the yield and other yield attributes of ginger. It is revealed that both N and K had positive impact on ginger production but the effect of N was found to be more distinct than the effect of K. However, with the increase of N levels, other field parameters of ginger linearly increased (Haque *et al.,* 2007). The study in the Bangladesh showed that yield contributing parameters progressively increased with the increase rates of N up to 180 kg/ha which was significantly different over 0 Nitrogen and this result handled at kindo Koyisha, agree with the findings of Bangladesh. Here 4 levels of N was used in treated plots but 150 kg N/ha responded best and the highest plant height 56.3cm and 87.1cm), maximum leaves number (17.30 and 18.30 /plant and fingers number (27.8 and 14.5 /plant) respectively in both the years Haque *et al.,* 2007). Fertilizer nitrogen significantly increased the number of third order shoots and fourth order rhizome branches, and the total yields of shoots and rhizomes. A rate of application of 200–300 kg N/ha was required for maximum yield in Australia. Therefore, a good supply of nitrogen to the plant stimulates root growth and development as well as uptake of other nutrients (FAO, 2000; Brady and Weil, 2002).

4. Conclusion and Recommendation

Information on fertility status of soils and crop responses under different fertility management strategies are very crucial for profitable and sustainable agricultural production. In view of this, a study was conducted to investigate the influence of N and P application on yield and yield traits of 38/79 or Volvo ginger variety at Kindo-Koyisha (Pajena-Mata) during 2012/2013 cropping season. The experiment was laid out in randomized complete block design with three replications. The treatments consisted of five levels of N (0, 23, 46, 69 and 92kg ha-[1]) and four levels of P (0, 10, 20, and 30kg ha [-1]). A total of 20 fertilizer treatments were used in a factorial arrangement. The analysis revealed that increase in NP level had very highly significant (p<0.001) effect on growth and yield components at Kindo-KoyishaWoreda . Nitrogen and phosphors interaction highly significantly (p<0.01) affected the average leaf area , and number of plots per plot whereas, very highly (p<0.001) affected average number of leaves per plant, plant height, and leaf length. Even though there was no possibility to measure the data of ginger yield (rhizome/tuber) due to the outbreak of Bacterial wilt disease over

all ginger fields in the region which is with no preventive mechanism, the shoot part data in this study showedthe maximum record at 92kg/ha of Nitrogen and 30kg/ha of Phosphorous in experimental sites. Particularly, the nitrogen level increase reveals progressive increment for all ginger yield components (growth parameters). Therefore, results of this study pointed out to the possibility of promoting higher yields by manipulation of growth aspects through use of N and P (92 kg N along with 30 kg P/ha) applications. Even though significant increase in yield attributes were observed in response to the increased rates of N and P, it is premature to arrive at definite recommendations based on this study as it was conducted in only two location over single season by adopting one variety. In view of this, the future studies should articulate towards and studies involving more cultivars, multi-location and additional rates of N and P application, under diverse management practices , which may facilitate fine-tuning of fertilizer recommendations.

Acknowledgement

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