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Grain Yield and Economic Evaluation of Interaction Effects of Seed Rate and N and P Fertilizations on Grain Yield of Bread Wheat Varieties in Northern Ethiopia

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Abstract
A study to investigate the effect of interaction effect of seed rate and N and P Fertilizations on grain yield of bread wheat varieties was evaluated 2014 main cropping season on vertisols of Ofla and Emba Alaje districts of southern Tigray Ethiopia. The design of the experiment was split split plot design and the treatment consists, three recently released bread wheat varieties (Mekele 3, Mekele 4 and Dandaa'), assigned as a main plot, Four level of N/P205 combination (46/46, 92/69,115/92 and 138/115 kg N/P205 ha^{-1}) arranged in a sub plot and , four level of seed rates for each varieties (66,132,177and 221 $kgha^{-1}$ for Mekele 3,72,145,193 and 242 $kgha^{-1}$ for Mekele 4 and 79,158,210 and 263 $kgha^{-1}$ for Dandaa') replicated three times. The analysis of variance (ANOVA) indicate that significantly ($P<0.05$) varietal, fertilizer, seed rate, variety x fertilizer, variety x seed rate, fertilizer x seed rate, variety x fertilizer x seed rate interaction effect on grain yield of bread wheat varieties. Grain yield increase with increasing of seed rate and N/P205 fertilizer rate in the main effect, however in the interaction effect of Variety, fertilizer and seed rate indicate that 138/115kg of N/P205 ha^{-1} with 177 $kgha^{-1}$ seed rate, 115/92 kg of N/P205 ha^{-1} with 72 $kgha^{-1}$ seed rate and 115/92 kg N/P205 ha-1 with 260 $kgha^{-1}$ seed rate reached higher economical return with maximum grain yield production for , Mekele3,Mekele 4 and Dandaa' variety respectively.
Keywords: variety, seed rate, fertilizer, wheat, interaction

1. Introduction

Agriculture sector being the important component of the country's economy and continues to be the single largest sector that is acting as a dominant driving for growth and development of the national economy. Ethiopia is the second largest producer of wheat in sub-saharan Africa following South Africa, about 1.65 million hectares of land is cultivated annually with total production of 3.9 million tons for both bread and durum wheat under rain fed conditions (CSA, 2014). Increasing agricultural productivity is absolutely necessary to feed the increasing population by increasing land productivity. In Ethiopia national mean grain yield of wheat is low (2.45 t/ha) due to the use of unimproved varieties, poor weed management practices, the prevalence of aggressive and virulent crop pathogens, depletion of soil nutrients (Taner et al., 1993), the low level of chemical fertilizer usage (Amsal et al., 1997; Tay et al., 202) and the unavailability of other modern crop management inputs. Mean yield of wheat in tigray region is even lower than the national mean yield (1.84 t ha-1) (CSA, 2014); hhe huge yield gap between the average productivity and the potential of the agricultural lands suggests that the prospect for increasing production through improved crop and soil management, particularly increased use of fertilizers, appropriate seed rate and appropriate pest control is very high. Nitrogen and phosphorus are usually the most limiting nutrient for wheat production. An inadequate supply of N and P fertilizer greatly reduces yields and profit. Too much N can result in lodging, decreased yields and reduced profits. Determining the optimum N and P fertilizer rates is the key to maximize economic yields. In Tgray region 100 and 90% of the cultivated crop land is deficient in Nitrogen and phosphorus nutrients respectively (Un published report of soil Atlas of Tigray, 2014).

Plant density is also a major factor determining the ability of the crop to capture resources and generate yield. It can be developed by using a suitable seeding rate. Growth and yield of wheat are affected by environmental conditions and can be regulated by sowing time and seeding rate (Ozturk *et al*., 2005). Maximum genetic potential of high yielding wheat varieties cannot be harvested without ensuring proper seeding rate. As the plant density increases, the competition for resources especially for nitrogen also increases that badly affect the ultimate yield ((Nazir *et al*., 2000).

Application of fertilizer with appropriate seed rate greatly increases grain yields, and facilitates the adoption of improved high-yielding varieties. None of the recommended bread wheat varieties growing in southern Tigray were evaluated for seed rate at Fertilizer response in the study area. This experiment was, therefore, designed to evaluate effect of different levels of NP fertilization and seed rate for grain yield of recently released bread wheat variety therefore he present study was initiated :-

- To determine the optimum seed rate and N and P fertilizer for different wheat genotypes
- To evaluate the response of bread wheat to the interaction effects of rate of N and P fertilizer

application and seed rate for grain yield

2. Materials and methods

2.1 Experimental area

An experiment was conducted in 2014 main growing season at Ofla and Emba Alaje district, south Tigray, Ethiopia. Ofla district is located about 620 km away from Addis Ababa to the north part of the country and about 150km to the south of Mekele town. The district is located on the geographic coordinates of $13^0$89'85''-$13^0$97'50'' north latitude and $51^0$94'00''-$56^0$21'36'' East longitude. The altitude of this district varies between 1800-2440 meters above sea level and its slope ranges from 8 to 15 percent. Mean annual rain fall is 1000.4mm (from 17 year data) with daily temperature ranged 10-22^{o}c, While Emba Alaje is located on the geographic coordinates of $14^0$22'71''- $14^0$39'17''north latitude and $53^0$05'15''-$56^0$01'42'' East longitude and altitude of 2350 m.a.s.l .The mean annual rain fall for Emba Alaje is 630.9mm (from 14 years data).

The monthly rain fall distribution for 2014 cropping season is presented in figure 1. The dominant soil type is clay. The main rainy season extends from July to September interrupted by some dry weeks in September in both loctions. The major crops grown in the site are Wheat (*Triticum aestivum* L.), Barley (*Hordeum vulgare* L.) and Sorghum (*Sorghum bicolor* L). Wheat is the main stable food crop in the study area.

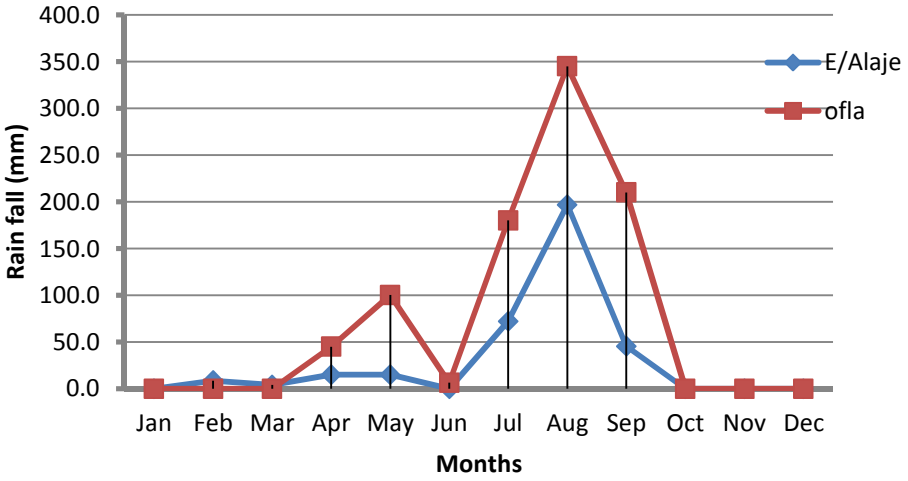

Figure 1 Monthly rain fall of ofla and Emba Alaje areas for 2014 cropping season

2.2 Design and experimental procedure

The experiment was laid out in Randomized Complete Block Design (RCBD) with split split plot arrangement having three replicate. The nitrogen and phosphorus levels were selected in part by considering the national research blanket recommendation of 46/46 kg N/ P205 ha^{-1} for wheat and on the other hand the farmers practice of below and above the recommendation. The cultivars were selected based on their agronomic performance, difference in yield, tillering capacity, seed rate and morphological characteristics. Each plot had 8 rows, 3 m in length and 20 cm between rows. *Planting* was done on 20th julay 2014. At planting all the triple super phosphate (46% P2O5), and 1/3 rd of the nitrogen was applied in basal applied to each plot. The remaining nitrogen was applied 1/3rd tillering (40 days after planting) and 1/3rd at flower initiation.

Table 1 the treatments used in the experiment

Main plot factor (Variety)	Sub plot factor (fertilizer rate)	Subsub plot factor (seed rate)
Mekele-3	1. 46-46 N/P205 kgha^{-1} 2. 92-69 N/P205 kgha^{-1} 3. 115-92 N/P205 kgha^{-1} 4. 138-115 N/P205 kgha^{-1}	1. 66 kgha^{-1} 1. 132 kgha^{-1} 2. 177 kgha^{-1} 3. 221 kgha^{-1}
Mekele-4		1. 72 kgha^{-1} 2. 145 kgha^{-1} 3. 193 kgha^{-1} 4. 242 kgha^{-1}
Dandaa'		1. 79 kgha^{-1} 2. 158 kgha^{-1} 3. 210 kgha^{-1} 4. 263 kgha^{-1}

2.3 Data analysis

The Analysis of Variance (ANOVA) on grain yield was computed using the GLM procedure of SAS version 9.0 (SAS institute, 2000) following the standard procedures of ANOVA for RCB design (Montgomery, 1991). The differences among Variety, seed rate and fertilizer were considered significant if the P-values were ≤ 0.05. Leas Significance Test (LSD) was used to compare among varieties at 5% probability level.

Partial budget analysis was done (CIMMYT, 1998) to evaluate the economic profitability of fertilizer and seed rate options and determine the economic optimum rate. Dominance analysis was used to screen treatments which have higher variable cost and lower net return and dominated treatment removed from further consideration.

3. Result and discussion

The analysis of variance showed that the bread wheat varieties, fertilizer rate and seed ,variety by fertilizer interaction, variety by seed rate interaction, fertilizer by seed rate interaction and variety x fertilizer x seed rate interaction significantly ($P<0.05$) (table 2 and 3) affect for in grain yield, this implying that the existence of sufficient variability among varieties tested in the area, Therefore yield optimization of wheat is possible by providing different varieties of wheat, with optimum level of fertilization and seed rate application for producers in a given area.

Table 2 Combined analysis of variance for grain yield of Bread wheat genotypes grown at four seeding rates in two environments and four fertilizer rates

Source of variation	d.f.	m.s.	v.r.	F pr.
Variety (V)	2	5.4718	18.67	<.001
Ferililizer (F)	3	5.8289	19.89	<.001
Seed rate (S)	3	3.5655	12.17	<.001
Variety x Ferililizer (VxF)	6	1.0563	3.6	0.002
Variety x seed rate (VxS)	6	0.9056	3.09	0.007
Ferililizer x seed rate (FxS)	9	3.512	11.98	<.001
Variety x Ferililizer x seed rate (VxFxS)	18	0.5351	1.83	0.025
Residual	190	0.2931		
Total	287			

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Table 3 Combined main effects of fertilizer and seed rate on grain yield of bread wheat variety over ofla and Emba Alaje areas

Variety	GY (t/ha)
Mekele 3	4.904
Mekele 4	4.481
Dandaa'	4.5
LSD	0.154
Ferililizer (N/P205 kgha-1)	
46/46	4.268
92/69	4.539
115/92	4.812
138/115	4.895
LSD	0.178
Seed rate (kgha-1)	
S1	4.408
S2	4.492
S3	4.713
S4	4.901
LSD	0.178
CV (%) 11.7	

where S1=66, 72,&79 kgha-1 for variety Mekele-3,Mekele 4 and Danada' ,S2=132, 145,&158 kgha-1 seed rate for Mekele-3,Mekele 4 and Danada' ,S3=177, 193,&210 kgha-1 seed rate for Mekele-3,Mekele 4 and Danada' and S4=221, 242,&263 kgha-1 seed rate for Mekele-3,Mekele 4 and Danada' respectively

The interactions between cultivars, nitrogen and phosphorus rates were significant ($P < 0.05$) for grain yield indicating grain yield was influenced by N/P fertilization level and seed rate application rate differences.

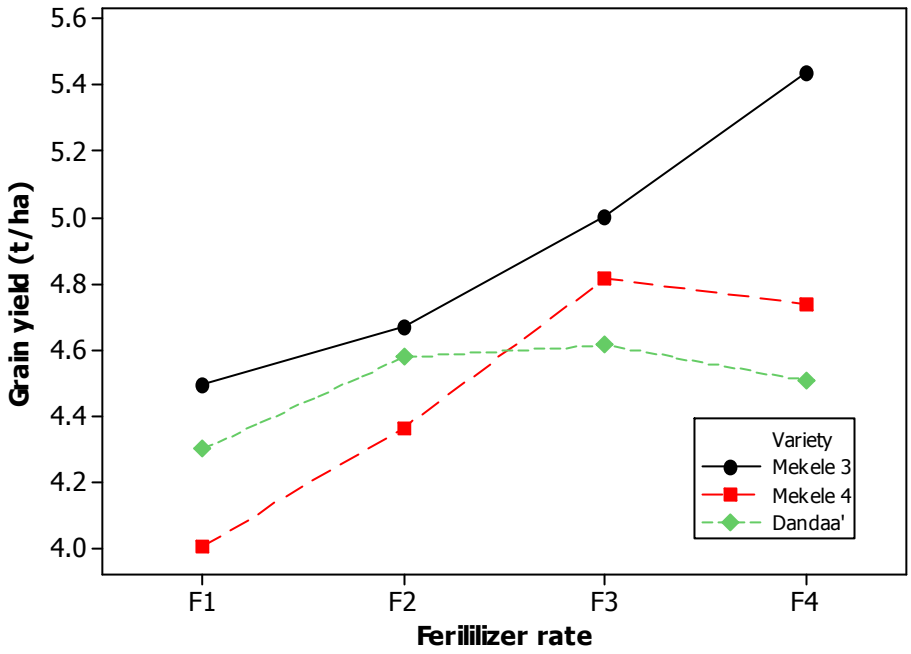

Figure 13 Fertilizer response of different bread wheat variety

In the two way interaction between variety and fertilizer Mekele 4 and Dandaa' respond up to 115/92 N/P205 kgha^{-1} and turn down applying fertilizer level beyond this, however variety Mekele 3 respond linearly with increasing N and p fertilizer application. In the three way interaction presented in table 4, The cultivars show better grain yield performance at the highest rate of nitrogen and phosphorus fertilization (138/115 kg ha^{-1}

N/P205 with 177 kg ha-1 and 193 kg ha^{-1} seed rate for and Mekele 4 respectively); while cultivar Dandaa' show maximum grain on 115/92 kg ha^{-1} N/P205 and seed rate of 260 $kgha^{-1}$,this is probably due to the highest response by these cultivars to N and P and use efficiency.

In agreement to this study higher seed arte at 125 kgha-1 had significantly highest grain yield ($P<0.05$) of 1150.3 and 1175.6 $kgha^{-1}$ compared to lowest Seed rate of 75 $kgha^{-1}$ which had the lowest grain yield of 1018.7 and 1033.6 $kgha^{-1}$ (Njuguna,et al., 2010). Hamid *et al*., 2002 and Khan *et al*., 2002 also concluded that maximum grain yield was obtained with the increase in seed rate while minimum grain yield was produced by low seed rate. Studies conducted by Amsal et a.,l 1997 to determine the effects of crop management factors in four priority wheat production zones of' Ethiopia indicated an increase of 13 - 315% due to improved variety, 20-88 % due to the application of 60 N + 26 P kgha-1 fertilizer. Mekele 3 Variety gives high grain yield than the other varieties evaluated in the area with determined fertilizer and seed rate management practices. This is due to that the earliness of this variety which helps to escape the moisture deficiency in the late September (figure1) which affects the late maturing Dandaa' variety.

Table 4 Combined interaction effect of N P fertilizer and seed rate grain yield of Bread wheat variety over ofla and Emba Alaje areas

		Seed rate			
Variety	N/P205(kgha-1)	S1	S2	S3	S4
Mekele 3	46/46	3.504	4.158	5.212	5.115
	92/69	4.066	4.119	4.958	5.549
	115/92	4.94	5.039	4.386	5.654
	138/115	5.373	5.369	6.069	4.95
Mekele 4	46/46	3.424	4.063	4.051	4.488
	92/69	3.871	4.316	4.38	4.894
	115/92	5.221	4.829	4.022	5.187
	138/115	5.13	3.897	5.239	4.689
Dandaa'	46/46	4.132	4.241	4.516	4.31
	92/69	4.107	4.801	4.548	4.857
	115/92	4.438	4.554	4.275	5.191
	138/115	4.686	4.521	4.898	3.924
	CV (%) 11.7				
	LSD (5%) 0.89				

Where S1=66, 72,&79 kgha-1 for variety Mekele-3,Mekele 4 and Danada' ,S2=132, 145,&158 kgha-1 for Mekele-3,Mekele 4 and Danada' ,S3=177, 193,&210 kgha-1 for Mekele-3,Mekele 4 and Danada' and S4=221, 242,&263 kgha-1 for Mekele-3,Mekele 4 and Danada' respectively

Data presented in figure 2 indicate the economic analysis of wheat as affected by various seed rates and different N/P levels. In the interaction effect of N/P fertilizer level, seed rate and variety, highest net margins were shown when applying 177 $kgha^{-1}$ seed rate and 138/115 $kgha^{-1}$ N/P205 with (Eth birr 57206.7), this gave 16.5 per birr invested for variety, Fertilizer and seeding rate. Applying high fertilizer rate without increasing seed rate or increasing seed rate without increasing fertilizer level had lowest net income realized, however, investing more than 138/115 $kgha^{-1}$ N/P205 it seems non profitable. In ofla and Emba Alaje wheat growing areas bread wheat produce maximum economic benefit than the other variety tested with studied seed rate and fertilizer level flowed by Mekele 4 and Dandaa' respectively.

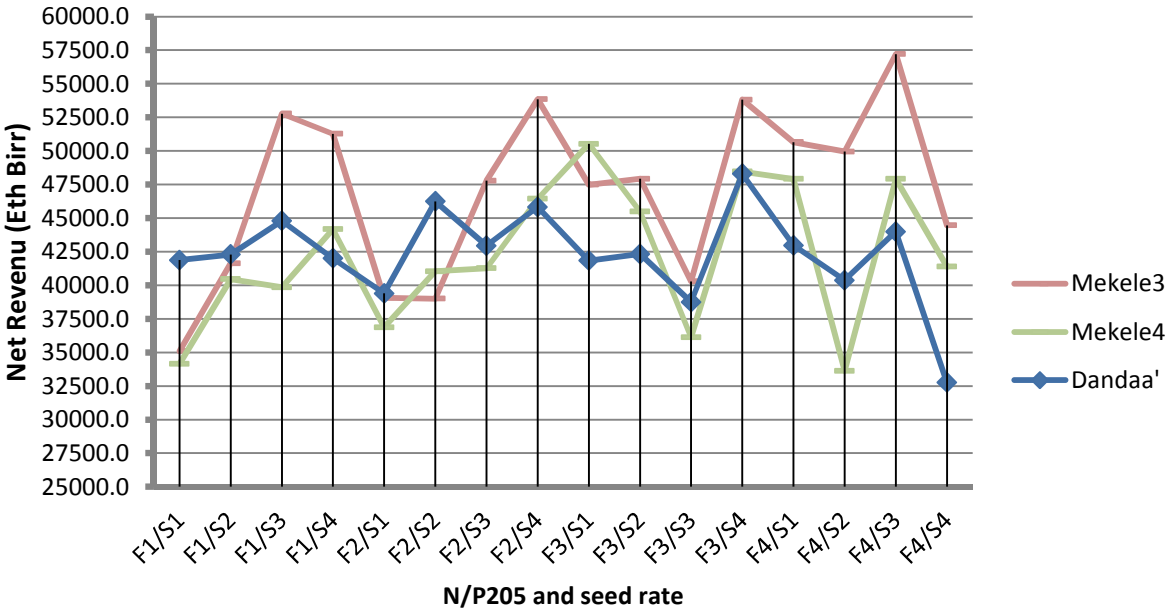

Figure 3 Partial budjet analysis for fertilizer and seed rate for the tested variety

Where F1=46/46 kg of N/P205 ha-1, F2=92/69 kg of N/P205 ha-1, F3=115/92 kg of N/P205 ha-1, F4=138/115kg of N/P205 ha-1, S1=66, 72,&79 kgha-1 for variety Mekele-3,Mekele 4 and Danada' ,S2=132, 145,&158 kgha-1 for Mekele-3,Mekele 4 and Danada' ,S3=177, 193,&210 kgha-1 for Mekele-3,Mekele 4 and Danada' and S4=221, 242,&263 kgha-1 for Mekele-3,Mekele 4 and Danada' respectively.

Conclusion

The results from the study suggest that application of 138/115kg of N/P205 ha-1 with 177 kgha-1 seed rate, 115/92 N/P205 $kgha^{-1}$ with 72 kgha-1 seed rate and 115/92 N/P205 $kgha^{-1}$ with 260kgha-1 seed rate seems reached more economical with maximum grain yield production for Mekele 3, Mekele 4 and Dandaa' variety respectively. However, for those resource poor farmers 92/69 N/P205 $kgha^{-1}$ with 221 kgha-1 seed rate and 92/69 N/P205 $kgha^{-1}$ with 158 kgha-1 seed rate for mekel3 and Danada respectively.

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References

Amsal T., D. G.tanner,A.Gorfu and T. Gelto (1997): The effects of several crop management factors on bread wheat yields in the Ethiopian highIands. African Crop Science Journal 4, 161-174.

Amsal Tarekegn, D.G. Tanner, Amanuel Gorfu, Tilahun Geleto, and Zewdu Yilma. 1997. The effect of several crop management factors on bread wheat yields in the Ethiopian highlands. *African Crop Sci. J. 5: 161-174.*

CSA (Central Statistical Authority). Agricultural Sample Survey. 2013 / 2014 (2006 E.C.).Report on Area and Production for Major Crops: Private Peasant Holding'Meher' Season. Statistical Bulletin 532 CSA, Addis Ababa, Ethiopia

Hamid, E., F.H. ,J. Bakht, A.W. Shah and A.A. Shad. 2002. Effect of different planting dates, seed rates and nitrogen levels on wheat. Asian J. Plant Sci. 1: 502-506.

Khan, J.A., O.P. Tiwari, G.K. Shrivastava and A.P. Singh. 2000. Effect of irrigation schedules, levels and split application of nitrogen on yield attributes and yield of late sown wheat (*Triticum aestivum* L.). Deptt. of Agron. College of Agric. Indira Gandhi Krishi Vishwavidyalaya, Raipur (M.P.). Annals of Agric. Res. Publication date: 29/07/2010, http://www.biosciences.elewa.org/JAPS; ISSN 2071 – 7024

Montgomery D.C. 1991. Design and analysis of experiment. 3rd edition. John Wiley and Sons, New York. USA.

Nazir, M.S., A. Jabbar, Z. Waheed, A. Gaffar and M. Aslam, 2000. Response of late sowed wheat to seeding density and nitrogen management. Pak. J. Biol. Sci., 3: 998-1001.

Njuguna M.,M., Munene, H., Mwangi., J., Waweru and T.E., Akuja.2010. Effect of seeding rate and nitrogen fertilizer on wheat grain yield in marginal areas of eastern Kenya, Journal of Animal & Plant Sciences, 2010. Vol. 7, Issue 3: 834- 840.

Ozturk, A., O. Caglar and S. Bulut, 2005. Growth and yield response of facultative wheat to winter sowing, freezing sowing and spring sowing at different seeding rates. J. Agron. Crop Sci., 192: 10-16.

SAS institute (2000) the statistical analysis soft ware system for windows. Version 9,SAS institute INC.,Cary NC., USA

Tanner, D.G., Amanuel Gorfu and Asefa Taa. 1993. Fertilizer affects on sustainability in the wheat-based small-holder farming systems of southeastern Ethiopia. *Field Crops Res.* 33: 235-248.

Taye Bekele, Yesuf Assen, Sahlemedhin Sertsu, Amanuel Gorfu, Mohammed Hassena,D.G. Tanner, Tesfaye Tesemma, and Takele Gebre. 2002. Optimizing fertilizer use in Ethiopia: Correlation of soil analysis with fertilizer response in Hetosa Wereda, Arsi Zone. Addis Ababa: Sasakawa-Global 2000.

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