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Original Research Article

Effects of Seed and NPSB Rate on Yield and Yield Related Traits of Emmer Wheat (*Triticumdiccocum*) in the Highlands of Bale, South Eastern Ethiopia

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Abstract: The experiment was conducted at three districts (Sinana, Goba and Agarfa) of Bale zone for three years from 2020-2022 during the main cropping season with the objective of elucidating the effects of seeding and NPSB rate on agronomic performance of emmer wheat. The experimental design in all locations was RCBD with three replications. Four seeding rates (75,100, 125 and, 150 kg ha^{-1}) and four fertilizer levels (0, 50, 100 and 150 kg NPSB ha^{-1}) were used as a treatments. The main effects of seeding and NPSB rate significantly influenced emmer wheat grain yield and bio-mass yield, while interaction effects significantly influenced ($p<0.05$) thousand kernel weight and kernels per spike. Plant height, spike length and harvest index were not significantly influenced by applied seeding and NPSB rates. Main effects of seeding and NPSB rate significantly and variably influenced grain and bio-mass yield of emmer wheat. The highest grain yield 3506 kg ha^{-1} and 34069 kg ha^{-1} were recorded from 125 kg ha^{-1}seed rate and 100 kg ha^{-1}NPSB rate, respectively. The highest bio-mass yield 9693 kg ha-1and 10222 kg ha^{-1} were recordedfrom150 kg ha^{-1}seed rate and 150 kg ha^{-1} NPSB rate, respectively. The highest (56.7 kernels per spike and 50g thousand kernel weight) were obtained from the interaction effects of 125 kg ha^{-1} seed rate and100 kg ha^{-1} NPSB rate, respectively. According to the result of this study optimum emmer wheat grain yield was obtained at seeding rate of 125kg $ha^{-1}$and 100 kg NPSB ha^{-1}. Economic analysis also indicated that economically feasible emmer wheat and NPSB rate were 125 kg ha^{-1} and 100 kg $ha^{-1,}$ respectively. Therefore, emmer wheat producing farmers in the study area and similar agro-ecologies should use seeding rate of 125 kg $ha^{-1}$and NPSB rate 100 kg ha^{-1} to realize maximum grain yield of emmer wheat.

Keywords: Emmer wheat; Seed rate; NPSB rate; Grain yield; Thousand kernel weight: Economic analysis.

1. INTRODUCTION

Emmer wheat (*Triticumdiccocum*) was domesticated in the near east somewhere in the Fertile Crescent. It is speculated that early immigrants of Hamites introduced wheat to Ethiopian highlands 5000 years ago, and Emmer wheat was the first to be introduced (Helback, 1970; Feld man, 1979).

Emmer wheat has been a minor crop in most parts of Ethiopian highlands but is being replaced by teteraploid and hexaploid wheat, which is free threshing unlike emmer wheat. Emmer is still cultivating in Ethiopia (Beteselassie *et al*., 2007). CSA (2016) reported that it covered about 24 thousand hectares and produced 492 thousand quintals in year 2016. Emmer wheat represents about 7% of the country's wheat production and primarily it was produced for house hold consumption and occasionally for regional market (Andrea and Haile, 2002). Emmer wheat is produced, mostly in the highlands of Ethiopia, including Bale, Arsi, Shewa, Harerge, Wello, Gojam and Gonder. There is a significant amount of emmer wheat in Bale zone during both bona and gana production seasons and it is one of the major crops in the region that contribute even more than durum wheat (Demissie and Hailegiorgis, 1985). However, the bread wheat based extension program coupled with the problem of thresh ability in emmer

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wheat is resulted in the decline of emmer wheat production in the highlands of Bale.

Farmers in most areas of the country assert that they produce emmer wheat for its special medicinal and nutritional values. Traditionally, it is believed that broken bones heal faster when emmer wheat is consumed in the form of porridge. As a result, it is recommended for mothers as special diet in maintaining their health and strength after childbirth. Generally, people in Ethiopia appreciate the food value of emmer wheat as compared to other wheats as emmer wheat does not affect stomach when consumed in any form (*Kita, Shankita, Genfo, Kincheand Atmit*) and considered as healthy food (Tesema and Belay, 1991; Tesfaye, 2002).

Emmer wheat is orphan crop and little is known about its improved agronomic practices (seed rate, row spacing and fertilizer rate) that optimize the grain yield of Emmer wheat. Therefore, the present study was initiated with the objectives of establishing the appropriate seeding rate and fertilizer rate for Emmer wheat production in the study area.

Objectives:

- To determine the appropriate seed and NPSB rate for Emmer wheat production in the highlands of Bale
- To determine economically feasible NPSB rate for emmer wheat production

2. MATERIAL AND METHODS

2.1. Description of the Study Area

The experiment was conducted for three years (2020-2022) at three locations (Sinana, Goba and Agarfa) in main cropping season. The altitude of the experimental site is 2400 masl for Sinanaa,2650 for Goba and 2350 for Agarfa. Average annual rainfall (mm) is 860, 940 and 560 for Sinana, Goba and Agarfa respectively. Maximum temperature (°C) is 21 for Sinana, 20 for Goba and 22 for Agarfa. Minimum temperature (°C) is 9 for Sinana,7 for Goba and 8 for Agarfa.Soil types are Pellic Vertisols, Chromic Luvisols and Cambisols for Sinana, Goba and Agarfa, respectively. Soil PH is 7.7 for sinana, 6.4 for Goba and 6.7 for Agarfa.

2.2. Treatments and Design

The treatments consisted of combinations of four seeding rate (75,100, 125 and, 150 kg ha^{-1}) and four fertilizer levels (0, 50, 100 and 150 kg NPSB ha^{-1}). The experiment was laid out as Randomized Complete Block design (RCBD) in a factorial arrangement with three replications. Treatments were assigned to each plot randomly. The size of each plot was (1.6x2.5m=4m^2). The distance between plots and blocks were 0.5 m and 1.5 m respectively. Recently released emmer wheat variety Hydero was used as a test crop. NPSB was used as a source of fertilizer. Field activities such as land preparation and weed control were carried out accordingly.

3. STATISTICAL DATA ANALYSIS

Analysis of variance (ANOVA) was done using Gen Stat 15th edition and means comparisons for the significantly different variables were made among treatments using least significant differences (LSD) test at 0.05 level of significance.

4. RESULTS AND DISCUSSION

4.1 Soil Analysis Before Planting

Selected physico-chemical properties of the soil were determined for composite surface soil (0-20 cm) samples collected before sowing (Table1). Accordingly, the texture of the soil of the experimental site is dominated by the clay fraction. The clay texture indicates the high degree of weathering that took place in geological times and the high nutrient and water holding capacity of the soil.

Soil pH values for both locations varied from 7.7to 6.7 for soils of the experimental sites (Table 1). pH status was categorized as neutral soil Jones (2003). Based on these results the pH value is optimum range for most crop production since most plant prefer the pH range 5.5 to 7.0. Soil Organic Matter values for both locations varied from 2.18 to 1.83 for soils of the experimental sites (Table 1). As the rating range established by Tekalign (1991) soil organic matter content categorized under moderate and low for Sinana and Agarfa, respectively. Soil Total Nitrogenvalues for both locations varied from 0.16 – 0.15. As ratings suggested by Landon (1991) for soil total nitrogen soils of the experimental site were rated into low for Sinana and Agarfa**.** Available Phosphorousvalues for both locations varied from 6.8-11.7 (Table 1). According to the rating established by Cottenie (1980) the studied soils have low phosphorus content for both locations Sinana and Agarfa.

Cation exchange rating established by Hazelton (2007) the soil of the study sites were high to moderate for sinana and Agarfa, respectively**.**

Table 1: Selected soil physicochemical characterization of the experimental locations

Locations (Districts)	**pH (1:2.5H_2O)**	**Available P (mg kg^{-1})**	**Total N%**	**OM%**	**CEC (cmol kg^{-1})**	**Texture**
Sinana	7.7	6.8	0.16	2.18	49.24	Clay
Agarfa	6.7	11.7	0.15	1.83	37.38	Clay

4.2 Grain Yield

The ultimate goal in crop production is maximum economic yield, which is a complex function of individual yield components in response to the genetic potential of the cultivars and inputs used.

Analysis of variance indicated significant differences ($P \leq 0.05$) among Seed and NPSB rate for grain yield, while interaction was not significant (Table2). Grain yield increased as rate of NPSB applied increased from the lowest to the highest level. Mean Grain yield ranged from 2205 kg ha^{-1} for the lowest treatment (0 kg NPSB ha^{-1}) to 3529 kg ha^{-1} for the highest treatment (150 kg NPSB ha^{-1}) indicating grain yield variation under the different NPSB rate treatments. The second highest treatment (100 kg NPSB ha^{-1}) gave the second highest grain yield (3506kg ha^{-1}) statistically similar to the highest treatment. The increase in grain yield in response to increasing rate of blended NPSB fertilizer indicated the importance of availability of balanced nutrients for better growth and development of Emmer wheat.

The result also revealed that Seed rate125 kg ha^{-1} gave the highest grain yield (3406kg ha^{-1}) while the lowest grain yield (2376 kg ha^{-1}) was recorded from the lowest seed rate (75 kg ha^{-1}). Similar finding was reported with those of Hameed *et al*., (2003) and Ijaz *et al*., (2003), who reported that grain yield increased as seed rate increased.

Table 2: Effects of seed and blended NPSB fertilizer rate on mean plant height and grain yield of emmer wheat

	Plant height (cm)					**Grain yield (kg ha^{-1})**				
NPSB kg ha^{-1}	0	50	100	150	Mean	0	50	100	150	Mean
Seed rate kg ha^{-1}										
75	101.2	103.8	106.1	108.8	105.7	1896	2283	2517	2808	2376c
100	101.2	106.3	107.0	105.0	104.9	2276	2968	3160	3752	3039b
125	102.7	104.7	104.1	109.3	105.2	2352	2890	4570	3813	3406a
150	102.9	105.7	104.4	108.9	105.5	2297	2977	3775	3743	3198ab
Mean	102	105.1	105.4	108		2205c	2779b	3506a	3529a	
CV (%)			8.8					20.3		
LSD(0.05)										
SR			NS					273.8		
NPSB			NS					283.8		
SRxNPSB			NS					NS		

Means with the same letter in a column and row are not significantly different at 5% level of significance; NS=Non significant; SR=Seed rate; CV (%) = Coefficient of variation (%).

4.3 Bio-mass Yield

Biological yield is an important factor because farmers are also interested in straw in addition to grain yield. Analysis of variance indicated significant differences ($P \leq 0.05$) for main effects of seeding and NPSB rate in biomass yield, while interaction was not significant (Table 3).

Increasing the seed rate proportionally increased biomass production. The highest bio-mass yield 9693 kg ha^{-1}was obtained from the highest seeding rate 150 kg ha^{-1}. The lowest 6632 kg ha^{-1}was obtained from the lowest seed rate 75 kg ha^{-1}. Similarly, NPSB rate increase proportionally the bio-mass yield. The highest (10222 kg ha^{-1}) was recorded with the highest NPSB (150 kg NPSB ha^{-1}), the lowest (6556kg ha^{-}1) was recorded by the control (Table 3). Increasing the application of blended fertilizer rates increase the growth, vegetative condition and the production of yield and above ground biomass yield of emmer wheat. According to Melkamu *et al*., (2019) blended fertilizer supply had a marked effect on the aboveground biomassyield of wheat.

Table 3: Effects of seed and blended NPSB fertilizer rate on mean bio-mass yield and spike length of emmer wheat

	Bio-mass yield (kg ha^{-1})					**Spike length(cm)**				
NPSB kg ha^{-1}	0	50	100	150	Mean	0	50	100	150	Mean
Seed rate kg ha^{-1}										
75	4944	6306	7417	7861	6632c	7.7	8.2	7.6	7.4	7.7
100	6889	7894	9117	9917	8454b	7.7	7.6	7.7	7.8	7.7
125	6667	7472	9861	11111	8778b	7.7	7.6	7.7	7.6	7.6
150	7722	8750	10300	12000	9693a	7.2	7.3	7.3	7.7	7.4
Mean	6556d	7606c	9174b	10222a		7.6	7.7	7.6	7.6	
CV (%)			11.8					12.7		
LSD(0.05)										
SR			458					NS		
NPSB			463					NS		
SRxNPSB			NS					NS		

Means with the same letter in a column and row are not significantly different at 5% level of significance; NS=Non significant; SR=Seed rate; CV (%) = Coefficient of variation (%).

4.4 Number of kernels per spike

The number of kernels per spike was significantly affected ($P \leq 0.05$) by main effects of blended NPSB fertilizer, seed rate and by the interaction effect. The result indicated that interaction of seed rate and NPSB rate was significantly affected number of kernels per spike. The analysis result showed that the highest number of kernels per spike (50) was obtained from 125 kg ha^{-1}seed rate & 100 kg ha^{-1}NPSB rate. The lowest number of kernels per spike (36.8) was recorded by zero fertilizer rate and the lowest seed rate (75 kg ha^{-1}) (Table 4).

This indicated that the number of kernels per spike was more enhanced by NPSB, which might be because P is essential in development of grains and Boron also plays a vital role in grain setting of crops. Therefore, the supply of boron containing fertilizer helps in grain filling and ultimately sterility is reduced and number of grains per spike increased. These also showed the synergistic effect of the fertilizer resulting in increased kernel number per spike and grain production.

4.5 Thousand of kernel weight

The analysis result showed that the interaction effect of Seed rate and NPSB rate significantly affected ($P \leq 0.05$) thousand kernels weight of emmer wheat. The highest thousand kernel weight (56.7g) was recorded at seed rate (125kg ha^{-1}) and 100kg ha^{-1} NPSB, while the lowest (39.3g) was recorded at Zero fertilizer rate and lowest seed rate (75kg ha^{-1}) (Table4).

When the rate of NPSB fertilizer increased from zero to 100 kg ha^{-1} the thousand kernels weight was increased. The increase in thousand kernels weight with increased rates of NPSB might be due to the provision of adequate and balanced nutrients which enhanced accumulation of assimilate in the grains, resulting in good grain filling and development of bigger kernels. In line with this result, Rahman *et al.*, (2011) reported maximum 1000 kernels weights of 49.4 g and 46.6 g for wheat in two consecutive years with the application of 120 kg N ha-1.

Table 4: Effects of seed and blended NPSB fertilizer rate on mean number of kernels per spike and thousand kernel weight of emmer wheat

	Number of kernels per spike					TKW(g)				
NPSB kg ha^{-1}	0	50	100	150	Mean	0	50	100	150	Mean
Seed rate kg ha^{-1}										
75	36.9h	36.8h	37.6h	39.4fgh	37.7	39.3j	41.7i	42i	44h	41.8
100	37.1gh	39.7fg	42.6de	46.0bc	41.3	43.7h	46.7g	49.3f	52.7d	48.1
125	36.8h	41.7ef	50.0a	47.3ab	43.9	42.3i	44h	56.7a	54c	49.2
150	38.4h	41.3ef	44.4cd	47.3ab	42.9	39.3j	42.3i	55.3b	51.3e	47.1
Mean	37.3	39.9	43.6	45.0		41.2	43.7	50.8	50.5	
CV (%)			7					2.6		
LSD(0.05)										
SR			1.0					0.4		
NPSB			1.2					0.5		
SRxNPSB			2.7					1.2		

Means with the same letter in a column and row are not significantly different at 5% level of significance; NS=Non significant; SR=Seed rate;TKW=Thousand kernel weight; CV (%) = Coefficient of variation (%).

Table 5: Effects of seed and blended NPSB fertilizer rate on mean harvest index of emmer wheat

NPSB kg ha^{-1}	0	50	100	150	Mean
Seed rate kg ha^{-1}					
75	39	36	34	35	36
100	33	38	35	38	36
125	36	39	46	35	39
150	30	34	37	32	33
Mean	34	37	38	35	
CV (%)	21				
LSD(0.05)					
SR			NS		
NPSB			NS		
SRxNPSB			NS		

4.6 Economic Analysis

The economic analysis was based on the procedures by CIMMYT (CIMMYT, 1988). Partial budget and Net benefit analysis were performed for NPSB fertilizer and seed rate and the decision for selecting the profitable treatments were made based on the highest Net benefit (Table 6 & 7). The Net benefit analysis indicated that 100 kg NPSB $ha^{-1}$and Seed rate 125kg ha^{-1}gave the highest net benefit, 88,265 and 88,075 Birr/ha, respectively. There for, the best NPSB and seed rate for emmer wheat productivity and profitability in the high lands of bale are 100 kg NPSB $ha^{-1}$and seed rate, 125 kg ha^{-1}, respectively.

Table 6: Partial budget analysis result for NPSB rate study on Emmer wheat

	Treatments (NPSB kg/ha)			
	0	50	100	150
Average yield (kg/ha)	2205	2779	3506	3529
Adjusted yield (kg/ha)	1985	2501	3155	3176
Gross field benefits (Birr/ha)	59550	75030	94650	95280
Cost of NPSB (Birr/ha)	0	2000	4000	6000
Cost of labour to apply NPSB (Birr/ha)	0	38	75	113
Harvesting, packing and transportation (Birr/ha)	3970	5002	6310	6352
Total costs that vary (Birr/ha)	3970	5040	6385	6465
Net benefits (Birr/ha)	55580	69990	88265	88815

Cost of NPSB 4000 Birr 100 kg^{-1}or (40 Birr kg^{-1}NPSB); NPSB application cost of 50 kg NPSB ha^{-1}(Halfday);100 kg (One day):150kg (One and half day) @ 75 Birr /day; harvesting, packing and transportation 200 Birr per 100 kg; sale price of emmer wheat 3000 Birr per 100 kg (30 birr/kg).

Table 7: Partial budget analysis result for seeding rate study on Emmer wheat

	Treatments (Seed rate kg/ha)			
	75	100	125	150
Average yield (kg/ha)	2376	3039	3406	3198
Adjusted yield (kg/ha)	2138	2735	3065	2878
Gross field benefits (Birr/ha)	64140	82050	91950	86340
Cost of Emmer wheat (Birr/ha)	2250	3000	3750	4500
Sowing and transportation (Birr/ha)	75	100	125	150
Total costs that vary (Birr/ha)	2325	3100	3875	4650
Net benefits (Birr/ha)	61815	78950	88075	81690

Sowing and transportation cost 100 Birr per 100 kg; sale price of emmer wheat 3000 Birr per 100 kg (30 birr/kg).

4.7 CONCLUSION AND RECOMMENDATIONS

An experiment was conducted with the objectives of assessing the effect of seed and NPSB rate on grain yield and yield components of emmer wheat. The results of the experiment revealed that seed and NPSB rate significantly influenced some important emmer wheat agronomic traits. Therefore, from the results of three years' data over locations, it was observed that seed rate (125kg ha^{-}1) and NPSB rate (100kg NPSB ha^{-1}) were the most promising and economically feasible seed and NPSB rate for emmer wheat production and productivity. Emmer wheat producing Farmers in Bale highlands and similar agro-ecologies advised to use *125 kg* ha^{-1} seed rate and *100 kg NPSB* ha^{-1} fertilizer rate to realize maximum emmer wheat grain yield.

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REFERENCES

- Andrea, C. A., & Haile, M. (2002). Traditional emmer wheat processing in highlands of Ethiopia . *J Ethio Biol*, 22, 179–217.
- Beteselassie, N., Fininsa, C., & Badebo, A. (2007). Sources of resistance to stem rust (Puccinia graminis f. sp. tritici) in Ethiopian tetraploid wheat accessions. *Genetic resources and crop evolution*, *54*, 337-343.
- BOSTID (Board on science and technology for international development, National research council (BSTIDNRC) (1996). *Lost crop of Africa*, Vol. I Grains. The National Academy of science. National academic press, Washington D.C USA.
- Cottenie, A. (1980). Soil and plant testing as a basis of fertilizer recommendations. FAO soil bulletin 38/2. Food and Agriculture Organization of the United Nations, Rome.
- CSA. (2016). Central Statistical Agency, Agricultural sample survey 2016, volume one,report on area and production of major crops, Addis Ababa, Ethiopia
- Damania, A. B., Hakims., & Moualla, M. Y. (1992). Evolution of variation in T.dicoccon of wheat

improvement in stress environment. *Hereditas*, 116, 163-166.

- Demissie, A., & Hailegiorgis, M. (1985). “Belg” Collecting in Bale administrative region. PGRC/E-ILCA Germplasm Newsletter, 10, 6-11.
- Feldman, M. (1979). Wheats (Triticumspp). *Evolution of crop plants*. Simmonds N.W (ed.) Longman group limited, Lodon.
- Hameed, E., Wajid, S. A., Shad, A. A., Bakht, J., & Muhammad, T. (2003). Effect of different planting dates, seedrates and nitrogen levels on wheat. *Asian J Plant Sci*, *2*(6), 464-474.
- Helback, H. (1970). Commentary on the phylogenies of *Triticum* and *Hordium*. *Econ Bot*, 20, 350-360.
- Hazelton. (2007). *Interpreting Soil Test Results*, CSIRO Publishing, 150 Oxford Street (P O Box 1139) Collingwood VIC 3066, Australia.
- Ijaz, A. K., Bakht, J., Wajid, S. A., Khan, N. M., & Ullah, I. (2003). Effect of seed rate on the yield and yield components of wheat under irrigated conditions of Peshawar. *Asian J Plant Sci*, 1, 513-515.
- Landon, J. R. (1991). Booker Tropical Soil Manual: A hand book for soil survey and Agricultural Land Evaluation in the Tropics and Subtropics. Longman Scientific and Technical, Essex, New York. 474p. OR John Wiley & Sons Inc., New York.
- Rahman, M. A., Sarker, M. A. Z, Amin, M. F., Jahan, A. H. S., & Akhter, M. M. (2011). Yield response and nitrogen use efficiency of wheat under different doses and split application of nitrogen fertilizer. Bangladesh. *Journal of Agricultural Research*, 36(2), 231-240.
- Tekalign, T. (1991). Soil, plant, water, fertilizer, animal manure and compost analysis. Working Document No. 13. International Livestock Research Center for Africa, Addis Ababa.
- Teklu, Y., Hammer, K., & Roder, M. S. (2007). Simple sequence repeats marker polymorphism in Emmer wheat TriticumdiccoconSchrank): Analysis of genetic diversity and differentioation. *Genetic Resources and Crop Evolution*, 54, 543-554.
- Tesema, T., & Belay, G. (1991). Aspects of Ethiopian Tetraploid wheat with emphasis on durum wheat genetics and breeding research. A historical perspective (Gebremariam, H., Tanner, D.G, and Hulluka, M. (eds.). Addis Ababa Ethiopia.
- Tesfaye, K. (2000). Morphological and Biochemical diversity of Emmer wheat *(Triticumdiccocum)* in Ethiopia. MSc. Thesis Addis Ababa university, Science faculty, Department of Biology, Applied Genetics section.
- Tesfaye, K., Asfaw, Z., & Bekele, E. (2002). Agroethnobotanical study of Emmer wheat *(Triticumdiccocum)*in the southeastern highlands of Ethiopia. A paper presented at the workshop of 8th International of Congress of International Society Ethno biology.

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