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Research Article

Response of Durum Wheat (*Triticum durum* L.) Genotypes to Blended NPSB Fertilizer Rates and Wheat Rust Diseases in Southern Ethiopia

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Lack of improved varieties and soil fertility degradation are among the major factors that limit durum wheat (*Triticum turgidum* L.) production in Ethiopia. The objectives of this study were to determine the response of durum wheat cultivars (i) to nitrogen, phosphorus, sulphur, and boron (NPSB) fertilizer blend; (ii) rust infection; and (iii) partial budget analysis using NPSB fertilizer blend. A 2-location experiment was conducted in 2021 in South Ethiopia to evaluate the response of 4 durum wheat genotypes to blended NPSB fertilizer rates in a randomized complete block design in a 4×4 factorial arrangement. The results showed significant ($P < 0.05$) differences due to genotypes (G), rate of NPSB fertilizer (F), and location (E) for all the parameters. The effects due to the G × F × E interaction were significant ($P < 0.05$) for the number of total tillers, number of productive tillers, and grain yield (GY). A significant ($P < 0.05$) G × E interaction was observed for the majority of parameters except days to 50% heading and plant height. Durum wheat genotype S_3-213037 produced the highest grain yield of 3689.3 kg·ha^{-1} when NPSB fertilizer was applied at a rate of 225 kg·ha^{-1} at Adekoysha. Moreover, partial budget analysis indicated that genotype S_3-213037 accrued a maximum benefit of 112,986.50 birr·ha^{-1} and the highest marginal rate of return of 1356.4% when NPSB fertilizer was applied at a rate of 225 kg·ha^{-1}. Therefore, this study indicated that the application of an NPSB fertilizer rate of 225 kg·ha^{-1} could be used in the production of durum wheat in the East African region with similar agroecologies to the study area.

1. Introduction

Wheat has become one of the most important cereal crops in Ethiopia, ranking 3rd in grain production next to teff (*Eragrostis tef*) [1]. Durum wheat (*Triticum turgidum* ssp. *durum*) is grown in only 8–10% of all the wheat-cultivated areas in the world, whereas in Ethiopia it constitutes about 30% of wheat production [2]. Even though it has low average production and productivity per unit area of land, it is economically an important crop because of its unique end product-making characteristics. It is widely preferred to make pasta products because of its hardness, amber colour, and vitreous endosperm, and it is known as the hardest kernel of all wheat genotypes [3]. Yield and end-use quality of durum wheat mostly depend on the environment, genotype, and effects due to the environment × genotype interaction [4].

The yield reduction in Ethiopian durum wheat production is primarily related to the depletion of nutrients in the soil caused by continuous nutrient uptake of crops, low fertilizer use, and insufficient organic matter application [5]. For the last 3 decades, Ethiopian agriculture has been dependent solely on imported inorganic fertilizer products such as urea and diammonium phosphate (DAP), which contain N and P at 18 and 46%, respectively. However, recent studies showed that most Ethiopian soil lacks both macro- and micronutrients [6]. This low nutrient availability has led to low nutrient uptake efficiency of crops and a reduction in yield. Nutrient mining due to suboptimal fertilizer use on the one hand and unbalanced fertilizer use, on the other hand, has favoured the emergence of multi-nutrient deficiency in Ethiopian soils [5]. Based on the information of Laekemariam and Kibret [6], in addition to the

macronutrients, due to long-year cultivation, some of the micronutrients such as zinc (Zn), boron (B), and copper (Cu) are depleted from the soil in the major crop-producing areas of the country.

The use of balanced fertilizers has a promising role in the growth and development of crop plants, which results in improved quality and quantity of agricultural produce. High fertilizer-responsive varieties express their full yield potential when trace elements are applied along with NP fertilizers [7]. The wheat that is grown in soil ameliorated with micronutrients such as Zn, Fe, and B significantly produces a higher yield than the non micronutrient control when applied in combination with N, P, and S nutrients [8]. It has been acknowledged that the role of macro- and micronutrients is crucial in crop nutrition and important for the productivity of wheat. Soil test-based application of plant nutrients rather than the blanket recommendation of urea (46% N) and DAP (18% N, 46% P_2O_5, and 0% K), especially those containing sulphur (S), B, and other nutrients, is recommended to avert the effects of deficiency on the wheat crop [6].

There are several combinations of blended fertilizers developed by the Ethiopian Agricultural Transformation Agency (ATA) for different agroecologies of the country. Blended NPSB (18.9% N, 37.7% P_2O_5, 6.95% S, and 0.1% B) fertilizer is one of them and is currently available in the market. Obviously, the response of a crop to the application of fertilizer varies with genotypes, climatic conditions, soils, and agronomic practices. Laekemariam and Kibret's [6] report on Ethiopian soil analysis indicated that soil fertility degradation is one of the major factors that limit crop production in the Wolaita Zone. In addition, the lack of improved varieties is also another limiting factor of durum wheat production. To overcome such problems, developing new varieties with an optimum level of inorganic fertilizer was considered part of the solution in this study. The objectives of this study were to determine the response of durum wheat cultivars (i) to nitrogen, phosphorus, sulphur, and boron (NPSB) fertilizer blend; (ii) rust infection; and (iii) partial budget analysis of using NPSB fertilizer blend.

2. Materials and Methods

2.1. Experimental Site. A field experiment was conducted during the 2021 cropping season at Sodo Zuria (Kokate Kebele) and Damot Gale (Adekoysha Kebele) woredas of the Wolaita Zone, SNNPRS, Ethiopia. Kokate (6° 55′ 36.1″N, 37° 50′12.1″E) is elevated at 2165 m.a.sl. The average annual rainfall for this area ranges between 1300 and 1365 mm, while the average minimum and maximum temperatures are 13 and 23°C, respectively. Adekoysha (6°83′ 0″N, 37°73′0″E) is elevated at 1907 m.a.sl. The average annual rainfall experienced in this area ranges between 1200 and 1300 mm, and the minimum and maximum temperatures are 14.3 C and 25.6 C, respectively [9].

2.2. Genotypes. Initially, for a wheat variety development research project, 142 durum wheat landrace accessions were obtained from the Ethiopian Biodiversity Institute (EBI). The landraces were screened for disease resistance and grain yield by the researchers of Wolaita Sodo University, Department of Plant Science, in collaboration with the Ethiopian Institute of Agricultural Research (EIAR) at the greenhouse and field research stations of Debre Zeit, Kulumsa, and Ambo Agricultural Research Centers. Following the evaluation of the results, only 34 lines were selected for the next cycle of progeny evaluation. Subsequently, the 34 advanced lines were subjected to a multilocation yield trial in Wolaita Zone's major wheat-growing areas. Finally, three of the top-performing promising lines of durum wheat genotypes (S_3-213037, S_3-222450, and S_3-214606) and the standard cultivar "Alem Tena" of durum wheat were used in this experiment. Details of the average field performance data of the four selected genotypes are presented in Table 1.

2.3. Experimental Procedure. The land that was previously under Irish potato production was ploughed, and harrowing was performed using a disk plough. The field was leveled using hand tools manually to make seedbeds and arrange the plots. After leveling the soil, the field trial layout was prepared and then the crop was sown in the second week of July 2021. During sowing, seeds were drilled in a 10-row experimental unit measuring 2 m × 2 m at a spacing of approximately 0.2 m between the rows at an equivalent seeding rate of 125 kg·ha^{-1}. The experiment was conducted in a randomized complete block (RCB) design with a factorial arrangement in 3 replicates. Different levels (0, 75, 150, and 225 NPSB kg·ha^{-1}) of blended NPSB (18.9% N, 37.7% P_2O_5, 6.9% S, and 0.1% B) fertilizer were used for the study, and the recommended rate of nitrogen fertilizer was applied uniformly to all plots in the form of urea (46%N). Urea was applied in splits at sowing time and at the growth stage of GS 20–29 (time of tillering or vegetative growth stage) [10], while NPSB was applied whole at sowing. The middle 8 rows from each plot were used for yield determination, while the outermost rows were kept as border plants.

2.4. Data Collection

2.4.1. Soil Data. Soil samples were taken from both trial sites at a depth of 0–20 cm diagonally across the experimental field using an auger before sowing. Soil samples were prepared as described in Tadesse et al. [11]. The samples were air-dried under shade at approximately 20–25°C, composited into 1 sample, and then submitted to the Areka Agricultural Research Center Soil Laboratory. The sample was analyzed for selected physicochemical properties, namely, organic carbon, texture, soil pH, cation exchange capacity (CEC), total N, and available P, S, and B. Organic carbon content was determined by volumetric methods [12]. Total N was analyzed by the micro-Kjeldahl digestion method with

Table 1: Mean performance of durum wheat genotypes for 10 agronomic traits and three wheat rust diseases obtained from a multilocation trial conducted in Wolaita wheat-growing areas.

Genotype	DH	DM	GFP	AGB	TSW	GY	HI	PH	SL	NPTPP	YR	LR	SR
213037	61.5	107	45.5	15	31.28	4.81	33.39	99.7	9.7	9.5	R	R	R
214606	60	108.8	48.5	9.75	31.63	3.2	34.83	85.4	9.2	6	R	R-MR	R-MR
222450	60	99.7	40	11.2	33.07	4.31	39.33	95.1	9.3	7.4	R	R	R
Alem Tena	59	106.2	47.2	8.6	32.37	3.34	38.61	66.7	5.9	6.5	R	MR	R

DH = days to heading; DM = days to maturity; GFP = grain filling period; AGB = aboveground biomass (t/ha); TSW = thousand seed weight (g); GY = grain yield (t/ha); HI = harvest index (%); PH = plant height (cm); SL = spike length (cm); NPTPP = number of productive tillers per plant; YR = yellow rust; LR = leaf rust; and SR = stem rust; R = resistant; MR = moderately resistant; R-MR = resistant to moderately resistant.

sulphuric acid [13]. The pH of the soil was determined according to the FAO [14] using 1 : 2.5 (weight/volume) soil sample to H_2O ratio using a glass electrode attached to a digital pH meter. To determine the cation exchange capacity (CEC), the soil sample was first leached using 1M ammonium acetate, washed with ethanol, and the adsorbed ammonium was replaced by sodium (Na). Then, the CEC was determined titrimetrically by the distillation of ammonia that was displaced by Na [15]. The available P was determined by Olsen's method [16]. The exchangeable bases mainly K and Na in the soil were determined from the leachate of 1M ammonium acetate (NH4OAc), and they were displaced with 1N NaOAc [17]. The available sulphur (mg/kg SO_4^{-2}) was determined by the ammonium acetate method [18]. The available B was determined using the hot water method [19].

2.4.2. Crop Data. Data on crop phenology parameters, viz., days to 50% heading and days to 90% physiological maturity, were recorded. Wheat plants were considered to have headed when 50% of the heads in a plot emerged from the boot. The plants were considered to have matured when the peduncle turned a golden colour. The height of the plants was measured from the base to the tip of the spike excluding awns. The length of the spike was estimated from a sample of 10 spikes randomly taken from the effective tillers and measured from the bottom of the spike to the tip of the spike by excluding the awns. The number of total tillers per plant and the number of productive tillers per square meter were also estimated by counting total tillers (both effective and non-effective) in $1\,m^2$ of land from each net plot area at maturity, and the number of kernels per spike and the thousand kernels' weight were collected. In addition, the aboveground dry biomass ($t{\cdot}ha^{-1}$) was estimated from the plants within the net area of $1.6\,m^2$ and harvested at the point where they are attached to the ground, sun-dried, and then weighed using a sensitive balance expressed in equivalent tons ha^{-1}. Similarly, grain yield was estimated after threshing the seed yield from the net plot area and converted to ton per hectare; straw yield was obtained by deducting the adjusted grain yield from the total aboveground dry biomass yield for the respective treatment and expressed in ton ha^{-1}. The harvest index was calculated as the ratio of grain yield to total aboveground dry biomass yield for each respective treatment.

(1) Disease Severity. Field response of the durum wheat genotypes to the 3 wheat rust diseases, leaf rust caused by *Puccinia triticina*, stem rust (*P. graminis* f.sp. *tritici*), and stripe (yellow) rust (*P. striiformis* f.sp. *tritici*), was visually estimated using a standard scale as described by [20]. This scale measures the severity of rust diseases using scores ranging from 1 to 9 (very resistant-very susceptible): <5%, resistant (R); 10%–15%, resistant to moderately resistant (R-MR); 20%–30%, moderately resistant (MR); 35%–45%, moderately resistant to moderately susceptible (MR-MS); 50%–60%, moderately susceptible (MS); 65%–75%, moderately susceptible to susceptible (MS-S); 80%–90%, susceptible; and 95%–100%, highly susceptible.

2.4.3. Partial Budget Analysis. The data collected for partial budget analysis were computed using the method outlined in CIMMYT [21]. All the costs incurred during the field trial period, which means the costs of inputs and labour starting from sowing to harvesting and seed processing, were calculated based on the prevailing market prices. All expenditures and incomes (including profits) were estimated on a hectare basis in Ethiopian Birr (ETB). The concepts used in the partial budget analysis were the mean grain yield of each treatment, the gross benefit (GB) ha^{-1} (the mean yield for each treatment), and the field price of fertilizers (the costs of NPSB and the application costs and transport cost). The benefit of straw yield was included in the calculation of the benefit. The net benefit (NB) was calculated as the difference between the gross field benefit and the total variable cost (TVC) using the formula NB = GFB -TVC, where GFB = gross field benefit and TVC = total variable cost. Actual grain yield and straw yield were adjusted downward by 10% to reflect the difference between the experimental yield and the yield farmers could expect from the same size field. For each pair of ranked treatments, a percentage marginal rate of return (MRR) was calculated using the following formula:

$$\mathrm{MRR}\,(\%) = \frac{\text{Change in NB}\left(\mathrm{NB}_b - \mathrm{NB}_a\right)}{\text{Change in TVC}\left(\mathrm{TVC}_b - \mathrm{TVC}_a\right)} \times 100, \quad (1)$$

where NB_a = NB with the immediate lower TVC, NB_b = NB with the next higher TVC, TVC_a = the immediate lower TVC, and TVC_b = the next highest TVC. The costs for each type of fertilizer were included in calculating the total variable cost (TVC) at the price of ETB $15.5\,kg^{-1}$ of NPSB

and a fixed price of ETB 14.5 kg^{-1} of N/urea during sowing time. The cost of straw was estimated as ETB 2.00 kg^{-1} for each kg of straw, and the average open price of durum wheat at Sodo Market was ETB 30.00 kg^{-1} in December 2021 during the time of harvesting.

2.5. Data Analyses. The data collected on wheat phenology, growth, grain yield, and components of yield were statistically analyzed. Analysis of variance (ANOVA) was computed for each trait at each location following the standard procedure for ANOVA described in Gomez and Gomez [22] using SAS software version 9.1.3 (SAS, Institute, Cary, NC, 2001). Before computing the combined analysis of variance of the two locations, the test of homogeneity of variances of the two locations was conducted using the Bartlett test for homogeneity of variance and the test displayed a non-significant difference between the variances of the two locations for each treatment. A combined ANOVA was computed for most of the agronomic parameters that showed homogeneity of the variances of the two locations using the following statistical model:

$$Y_{ijkl} = \mu + E_i + R_j + G_k + EG_{ik} + F_l + EF_{il} + GF_{kl} + EGF_{ikl} + \varepsilon_{ijklm}, \quad (2)$$

where μ = general mean; E_i = effect due to i^{th} location; R_j = effects due to j^{th} replication in the i^{th} location; G_k = effects due to k^{th} genotype in the j^{th} replicate and i^{th} location; EG_{ik} = interaction effect due to i^{th} location and k^{th} genotype; F_l = effect due to l^{th} fertilizer rate; EF_{il} = interaction effect due to i^{th} location and l^{th} fertilizer rate; GF_{kl} = interaction effect due to k^{th} genotype and l^{th} fertilizer rate; EGF_{ikl} = interaction effect due to i^{th} location, k^{th} genotype, and l^{th} fertilizer rate; and ε_{ijklm} = effects due to random error.

Means were separated using the following least significant difference (LSD) formula whenever the main effects were significant at $P < 0.05$:

$$LSD_a = t_a \sqrt{\frac{2S^2}{n}}, \quad (3)$$

where t is the tabulated t value, s is the standard deviation of all the plots, and n is the number of observations in each variety [22].

The standard error of the mean was calculated using the following formula:

$$SE(m) = \sqrt{\frac{2S^2}{r}}, \quad (4)$$

where r is the number of replications that are common to both treatments in the pair and s^2 is the error mean square in the analysis of variance.

3. Results

3.1. Physicochemical Properties of Soil from Experimental Sites. Analysis of chemical and physical properties of soil from experimental sites indicated that the soil texture of the Adekoysha testing site, which had a pH of 5.83, was clay with a particle distribution of 45% clay, 32% sand, and 23% silt. In contrast, soil from the Kokate site with a prevailing pH of 5.48 had a clay loam type of soil texture with a particle distribution of 43% clay, 36% sand, and 21% silt (Table 2). The soil chemical analysis determined that the OC content was 1.365 for Adekoysha and 1.17 for Kokate testing sites. The CEC of experimental sites was 22.4 cmol (+) kg^{-1} in Adekoysha and 17.5 cmol (+) kg^{-1} in Kokate, which are grouped under the medium category. Total N content was 0.117663% in Adekoysha and 0.100854% in Kokate experimental soils. The available "P" content was determined to be 12.2 mg·kg^{-1} for Adekoysha and 9.83 mg·kg^{-1} for Kokate soil samples. The result also showed that the available S concentration was 16.3 mg·kg^{-1} for Adekoysha and 15.2 mg·kg^{-1} for Kokate. The available B was 0.79 mg kg^{-1} for Adekoysha and 0.61 mg·kg^{-1} for Kokate (Table 2).

3.2. Analysis of Variances. The result of the ANOVA revealed that the effects due to location, fertilizer rate, and genotypes were highly significantly ($P < 0.01$) different for phenology, growth, and grain yield and its components (Table 3). The genotype × environment interaction (G × E) effect was highly significant for the majority of parameters except days to 50% heading (DH) and plant height (PH). However, six of the agronomic traits, DH, PH, spike length (SL), number of kernels per spike (NKS), thousand seed weight (TSW), and harvest index (HI), were not affected significantly by the interaction effect of fertilizer by environment (F × E). Similarly, the phenological traits (DH and DPM), PH, NKS, HI, and severity of stem rust (SR) disease were not affected significantly by the interaction effect of genotypes by application rates of blended (NPSB) fertilizer (Table 3). Effects due to the G × E × F interaction were significant only for grain yield and the number of tillers (both total and productive).

3.2.1. Mean Performances of Agronomic and Disease Parameters. The mean performance values of the durum wheat genotypes for the agronomic traits and their level of resistance against the three rust diseases of wheat as influenced by locations and application rates of the blended NPSB fertilizer are depicted in Tables 4–7. Fertilizer applied at an equivalent rate of 225 kg·ha^{-1} minimized DH by twenty-four days compared with control (Table 4). The date of 50% heading varied between the genotypes, and it ranged from 59.1 (G2-222450) to 75.5 (Alem Tena) days. The number of days to 50% heading for durum wheat at Adekoysha hastens on average by 5.5 days compared with DH at Kokate. Genotype 222450 planted at Adekoysha matured earlier than the rest of the genotypes; it was 19 days earlier than that of genotype 214606 planted at Kokate that matured lately. Alem Tena matured within the same days in both places (Table 4). Planting durum wheat with an NPSB rate of 225 kgha^{-1} in both sites minimized the date of maturity by 24% compared with the control treatment.

Genotypes planted at Adekoysha had a 6 cm height increment compared with genotypes planted at Kokate (Table 4). The height difference between the tallest and

Table 2: Soil physicochemical properties of the soil from experimental sites.

Parameters	Value		Rating		References
Physical	Adekoysha	Kokate	Adekoysha	Kokate	
Soil particle size and distribution					
Clay	45	43	High	High	Hazelton and Murphy [23]
Sand	32	36	Moderate	Moderate	
Silt	23	21	Low	Low	
Textural class	Clay	Clay loam	—	—	
Chemical	Adekoysha	Kokate	Adekoysha	Kokate	
pH	5.83	5.48	Moderately acidic	Strongly acidic	
Organic carbon	1.365	1.17	Low	Low	Landon [24]
Total nitrogen	0.117663	0.100854	Medium	Medium	Hazelton and Murphy [23]
Available phosphorus	12.2	9.83	Low	Low	Jones [25]
Available sulphur	16.3	15.2	Medium	Medium	Horneck et al. [26]
Available boron	0.79	0.61	Low	Low	Jones [25]
CEC	22.4	17.5	Medium	Medium	

CEC = cation exchange capacity.

shortest genotypes was 34 cm. The fertilizer application rate showed significant variation in plant height of the genotypes. The highest plant height was observed at a fertilizer rate of 225 kg·ha^{-1}, but the shortest was obtained from the control treatment. Plant height increased consistently with an increased blended NPSB fertilizer rate.

Genotype 213037 showed better performance in the number of total tillers (NTTs) than others with an equivalent NPSB fertilizer rate of 225 kgha^{-1} at Adekoysha (Table 5). Variety Alem Tena showed the least total number of tillers from the control treatment at Kokate. The value of NTT from fertilized plots is higher than that of unfertilized plots, showing that the trend of NTT increased consistently with an increase in blended NPSB application rates (Tables 4 and 5). The number of productive tillers (NPT) ranged from 445 to 117.67 for genotypes 213037 at an NPSB rate of 225 kg·ha^{-1} and Alem Tena at an NPSB rate of 0 kg·ha^{-1} at Adekoysha and Kokate, respectively, where the NPSB rate of 225 kg·ha^{-1} fertilized plot yielded 3.8-fold more tiller than the control plot (Tables 4 and 6). Each genotype responded differently to NPSB fertilizer on each site specifically.

The value of spike length from genotype 213037 at Adekoysha was statistically not different from the value of genotype 214606 at the same experimental site. The highest spike length was observed from these 2 genotypes. Genotype Alem Tena had the shortest spike length than others at both experimental sites (Table 4). Though the performance of genotypes increased with increasing rates of NPSB application, the scale of increment and overall performance for spike length observed on cultivar Alem Tena were very low.

Genotype 213037 scored the highest number of kernels per spike in both locations (Adekoysha and Kokate), but Adekoysha surpassed Kokate by 3.3% for the same genotype. Alem Tena had the highest number of kernels per spike at Adekoysha next to genotype 213037 (Table 4). Adekoysha was the preferred environment for most of the agronomic traits, which responded similarly for thousand seed weight. With regard to genotypic performance for TSW, genotype 213037 and Alem Tena performed best in Adekoysha, while genotypes 222450 and 214606 did better at Kokate. Location-wise, the highest mean value of thousand seed weight was recorded from genotype 213037, while the lowest mean of TSW was recorded at Kokate from cultivar Alem Tena, which was statistically at par with the mean value recorded at Damot Gale from selection 222450 (Table 4). Genotype 213037 showed the heaviest TSW from the fertilizer rate of 225 kgha^{-1}, while genotype 222450 had the lightest TSW score from the control treatment. The result indicated that an increased rate of NPSB fertilizer consistently increased TSW for every genotype of durum wheat investigated. This result showed the positive response of the genotypes for every rate of fertilizer application up to the maximum rate. However, the percentage increment of genotypes from zero application to the maximum rate of 225 kg·ha^{-1} was variable: 50% for 213037, 51.5% for 222450, 52.1% for 214606, and 55.1% for Alem Tena.

The ANOVA result of AGBM depicted the significance of genotypes (G), fertilizer application rates (F), location (E), and their interaction effect except G × F × E. Genotype 213037 was the best performer at both Adekoysha and Kokate testing sites, whereas cultivar Alem Tena was the least. The highest grand mean value exceeded the lowest grand mean by 86.8%. Blended NPSB fertilizer rate also interacted with location significantly; the highest grand mean value of aboveground biomass (13014 kg·ha^{-1}) was scored from Adekoysha with a fertilizer rate of 225 kg·ha^{-1}, whereas the lowest grand mean value (7997 kg·ha^{-1}) was scored from Kokate with a nil NPSB rate (Table 4). Genotypes interacted with NPSB blended fertilizer rates significantly, which means each genotype responded differently for each fertilizer level. Straw yield also followed a similar trend to AGBM (Tables 3 and 4).

The interaction between location, genotype, and NPSB fertilizer rates (G × F × E) was found to significantly ($P < 0.01$) affect grain yield (Table 7). This means that the effects of NPSB fertilizer rates on grain yield were influenced by genotypes and environment. Grain yield increased in response to the increasing rate of NPSB fertilizer across the 2 locations and for all the genotypes (Tables 4 and 7).

Table 3: Mean square values of phenology, growth, yield, and yield component parameters of durum wheat promising lines tested at two locations of the Wolaita Zone in 2021.

Sources of variation	DF	Mean squares											
		DH	DPM	PH(cm)	NTT	NPT	SL (cm)	NKS	TSW (gm)	AGBM (kg)	GY (kg)	SY (kg)	HI
Replication	2	7.2	21.1	14.8	184.0	188	0.4	5.5	1.8	221794.0	14748.0	230959.0	2.6
Location	1	765.0**	98.0**	921.3**	28566**	30317**	1.7**	157.6**	19.26**	4.48E + 07**	331045**	3.67E + 07**	17.6**
NPSB rate	3	2612.8**	2134.3**	1071.0**	253962**	252623**	25.3**	1464.3**	1182.84**	5.59E + 07**	4580843**	2.835E + 07**	21.2**
Genotype	3	1286.3**	1393.4**	4447.4**	15171**	15372**	104.7**	963.8**	429.79**	1.3E + 08**	3427648**	9.326E + 07**	337.989**
Location × NPSB	3	2.3NS	26.2**	5.27NS	2415**	2308**	0.3NS	951NS	0.37NS	860061**	16618*	664090**	1.402NS
Location × genotype	3	7.0NS	27.0**	6.18NS	7431**	8660**	3.2**	551.5**	183.70**	2510506**	596296**	5370448**	129.396**
NPSB × genotype	9	4.2NS	2.3NS	2.20NS	320**	340*	0.7**	4.8NS	2.18**	591722**	29735*	483877**	0.480NS
Location × NPSB × genotype	9	8.6NS	5.5NS	3.87NS	398**	401*	0.1NS	2.8NS	0.89NS	166314NS	15068**	183085NS	1.154NS
Error	62	14.24	3.2	3.58	144	149	0.12	4.94	0.81	142720	4994	151574	1.434
CV%		5.61	1.6	2.0	4.42	4.63	4.0	4.13	2.27	3.67	2.9	4.96	5.01

LSD = least significance difference at the 5% level; CV = coefficient of variance; * = significant; ** = highly significant; NS = nonsignificant; DF = degree of freedom; DM = number of days to 50% heading; DPM = number of days to 90% physiological maturity; PH = plant height; NTT = number of total tillers; NPT = number of productive tillers; SL = spike length; NKS = number of kernels per spike; TSW = thousand seed weight; AGBM = aboveground biomass; GY = grain yield; SY = straw yield; HI = harvest yield; YR = yellow rust; SR = stem rust; LR = leaf rust.

Table 4: Mean values of the main effects of the different (phenology, growth, grain yield, and its component traits) agronomic parameters and severity of the rust diseases of wheat.

Treatments	DH	DPM	PH	NTT	NPT	SL	NKP	TSW	AGB	GY	SY	HI	YR	SR	LR
G1-213037	63.50^{c}	106.00^{c}	111.15^{a}	306.92^{a}	299.33^{a}	10.375^{a}	62.250^{a}	45.583^{a}	13004^{a}	2985.0^{a}	9977.8^{a}	22.921^{b}	R-MR	R	R-MR
G2-222450	59.13^{d}	101.92^{d}	93.38^{c}	248.58^{d}	239.75^{c}	8.733^{c}	47.750^{d}	35.750^{d}	9528^{c}	2133.6^{d}	7394.0^{c}	21.592^{c}	R-MR	R-MR	MR
G3-214606	75.17^{a}	118.21^{a}	95.53^{b}	268.92^{b}	262.00^{b}	9.908^{b}	54.667^{b}	39.542^{b}	11033^{b}	2373.3^{b}	8676.0^{b}	21.608^{c}	R-MR	R	R-MR
Alem Tena	71.50^{b}	115.08^{b}	77.88^{d}	261.00^{c}	255.00^{b}	5.729^{d}	50.375^{c}	37.833^{c}	7610^{d}	2258.1^{c}	5352.0^{d}	29.442^{a}	R	R-MR	R
LSD (0.05)	2.178	1.0274	1.0921	6.9163	7.0514	0.2004	1.2825	0.5200	218.00	40.780	224.66	0.6909	—	—	—
F_1-0kgha^{-1}	79.67^{a}	121.21^{a}	86.50^{d}	155.79^{d}	149.04^{d}	7.4833^{d}	44.417^{d}	31.458^{d}	8557^{d}	1928.1^{d}	6628.4^{d}	22.692^{c}	R	R	R
F_2-75kgha^{-1}	71.17^{b}	114.08^{b}	92.26^{c}	224.04^{c}	216.54^{c}	8.2792^{c}	51.167^{c}	37.083^{c}	9638^{c}	2260.8^{c}	7380.9^{c}	23.633^{b}	R	R	R
F_3-150kgha^{-1}	63.00^{c}	106.54^{c}	97.02^{b}	314.79 b	307.12^{b}	9.1333^{b}	56.750^{b}	42.333^{b}	10912^{b}	2628.2^{b}	8246.3^{b}	24.421^{a}	R-MR	R-MR	R-MR
F_4-225kgha^{-1}	55.46^{d}	99.38^{d}	102.15^{a}	390.79^{a}	383.38^{a}	9.8500^{a}	62.708^{a}	47.833^{a}	12069^{a}	2933.0^{a}	9144.1^{a}	24.817^{a}	MR	MR	MR
LSD (0.05)	2.178	1.0274	1.0921	6.9163	7.0514	0.2004	1.2825	0.5200	218.00	40.780	224.66	0.6909	—	—	—
Adekoysha	64.50^{b}	109.29^{b}	97.58^{a}	288.60^{a}	281.79^{a}	8.8187^{a}	55.042^{a}	40.125^{a}	10977^{a}	2496.2^{a}	8467.9^{a}	23.463^{b}	R	R	R-MR
Kokate	70.15^{a}	111.31^{a}	91.383^{b}	254.10^{b}	246.25^{b}	8.5542^{b}	52.479^{b}	39.229^{b}	9611^{b}	2378.8^{b}	7231.9^{b}	24.319^{a}	MR	MR	R
LSD (0.05)	1.540	0.7265	0.7722	4.8905	4.9861	0.1417	0.9069	0.3677	154.15	28.836	158.86	0.4885	—	—	—
CV%		1.61		4.42	4.63	4.00	4.13	2.27	3.67	2.90	4.96	5.01			

N.B. = The letters "a," "b," "c," and "d" indicate mean values of treatments significantly different from each other at 5% level of significance for each agronomic parameter. Whereas, means that follow the same letter are statistically not different from each other at 5% level of significance.

Table 5: Interaction effects of location, genotype, and blended NPSB fertilizer rate on the number of total tillers (NTT) per unit area.

Location	Fertilizer (kg·ha^{-1})	Genotypes			
		213037	222450	214606	Alem Tena
Adekoysha	0	199.33^{m}	141.00^{op}	146.33^{o}	176.00^{n}
	75	281.67^{i}	203.00^{m}	206.67^{lm}	235.00^{jk}
	150	383.00^{de}	290.67^{hi}	326.00^{g}	370.33^{ef}
	225	452.33^{a}	382.67^{de}	401.33^{cd}	422.33^{b}
Kokate	0	176.67^{n}	133.67^{op}	147.00^{o}	126.33^{p}
	75	251.67^{j}	200.67^{m}	225.00^{kl}	188.67^{mn}
	150	306.67^{gh}	277.00^{i}	319.67^{g}	245.00^{j}
	225	404.00^{bc}	360.00^{f}	379.33^{ef}	324.33^{g}
LSD (5%)		19.562			
CV%		4.42			

LSD = least significance difference at the 5% level; CV = coefficient of variance; means followed by the same letter show a nonsignificant difference at the 5% probability level.

Table 6: Interaction effects of location, genotype, and blended NPSB fertilizer rate on the number of productive tillers (NPT).

Location	Fertilizer (kg·ha^{-1})	Genotypes			
		213037	222450	214606	Alem Tena
Adekoysha	0	192.67^{lm}	133.33^{op}	140.00^{o}	173.33^{mn}
	75	275.33^{i}	193.67^{l}	198.33^{l}	231.00^{jk}
	150	376.67^{cde}	278.00^{i}	319.00^{g}	366.00^{ef}
	225	445.00^{a}	375.00^{de}	392.67^{cd}	418.67^{b}
Kokate	0	167.67^{n}	125.67^{op}	142.00^{o}	117.67^{p}
	75	243.00^{j}	192.33^{lm}	218.67^{k}	180.00^{lmn}
	150	298.33^{h}	269.00^{i}	312.33^{gh}	237.67^{jk}
	225	396.00^{c}	351.00^{f}	373.00^{de}	315.67^{gh}
LSD (5%)		19.94			
CV%		4.63			

LSD = least significance difference at the 5% level; CV = coefficient of variance; means followed by the same letter show a nonsignificant difference at the 5% probability level.

Table 7: Main effects of location, genotype, and blended fertilizer rate (NPSB) on grain yield.

Location	Fertilizer (kg·ha^{-1})	Genotypes			
		213037	222450	214606	Alem Tena
Adekoysha	0	2389.8^{ijk}	1575.3^{r}	1926.4^{op}	2021.8^{no}
	75	2765.5^{ef}	1867.7^{pq}	2215.7^{lm}	2331.5^{jk}
	150	3177.2^{cd}	2333.3^{jk}	2463.9^{hi}	2755.5^{ef}
	225	3689.3^{a}	2550.0^{gh}	2789.5^{ef}	3087.3^{d}
Kokate	0	2388.7^{ijk}	1790.3^{q}	1837.7^{pq}	1495.0^{r}
	75	2733.7^{f}	2100.7^{mn}	2288.3^{kl}	1783.0^{q}
	150	3225.0^{c}	2316.0^{kl}	2607.7^{g}	2146.7^{m}
	225	3511.0^{b}	2535.3^{gh}	2857.3^{e}	2444.3^{hij}
LSD (5%)		115.34			
CV%		2.90			

LSD = least significance difference at the 5% level; CV = coefficient of variance; the same letter in a column of each factor shows a nonsignificant difference at the 5% probability level.

Thus, the highest grain yield was recorded at the interaction of 225 kg·ha^{-1} NPSB with genotype 213037 at Adekoysha, which is 2.5-fold higher than the nil NPSB application on Alem Tena at Kokate. Grain yield significantly increased with an increasing NPSB fertilizer rate.

The highest ratio of grain yield to biomass yield (HI) was obtained from Alem Tena at Adekoysha with a ratio of 32.45%, and the lowest ratio was recorded from genotype 214606 at the same experimental site with a ratio of 19.508% (Table 4). The ratio of 19.508% from genotype 214606 and the ratio of 20.200% from genotype 222450 were statistically at par. The highest HI percentage of Alem Tena might be due to the lowest number of total tillers and plant height, resulting in less competition among the plants. Blended NPSB fertilizer significantly influenced the harvest index. The highest percentage of harvest index was recorded from

a fertilizer rate of 225 kg·ha^{-1} (24.817%), and the lowest percentage was recorded from the control treatment (22.692%).

All 3 factors significantly influenced the severity of the rust diseases in durum wheat plants. The highest mean value of yellow rust occurrence was recorded from genotype 213037 at Kokate; it was 14.37%, and the lowest value of 1% was obtained from the Alem Tena cultivar at Adekoysha (data not shown). The interaction effect of genotypes and NPSB fertilizer also influenced the occurrence of stripe rust on durum wheat, in which the highest mean value of 16.25% was recorded from genotype 213037 with an NPSB fertilizer rate of 225 kg·ha^{-1}, while the lowest value of 1.25% was recorded from the variety Alem Tena from the control treatment. The severity of stem rust increases with an increasing rate of fertilizer. The highest value of 25% was recorded from Alem Tena cultivar at Kokate with a fertilizer rate of 225 kg·ha^{-1}, and the lowest value of 1% was recorded from the same variety at Adekoysha for all treatments (data not shown). Fertilizer rates also affected the occurrence of leaf rust. Increasing the fertilizer rate creates favourable environment for sporulation. The highest mean value of 28.33% was obtained from genotype 222450 at Adekoysha with a fertilizer rate of 225 kg·ha^{-1}, and the lowest mean value of 1% was obtained from Alem Tena cultivar at the same experimental site for all treatments. All the genotypes demonstrated an acceptable level of field resistance to all three wheat rust diseases (Table 4).

3.3. Partial Budget Analysis. Partial budget analysis showed that genotype 213037 at the application of NPSB 225 kg·ha^{-1} gave the maximum economic benefit of 112986.5 birr·ha^{-1} with a marginal rate of return of 1356.4%, while the lowest net benefit was 55525.8 birr·ha^{-1} from the Alem Tena variety with no application of NPSB fertilizer (Table 8). The highest economic benefit for the above treatments might be due to the highest grain and straw yields produced by the genotypes at a rate of 225 kg·ha^{-1} NPSB fertilizer rate (Table 8).

4. Discussion

4.1. Soil Analysis. The soil physicochemical analysis result indicated that both soils are suitable for wheat production. The pH test for Adekoysha and Kokate was rated as moderately acidic (5.5–6.5) and strongly acidic (<5.5), respectively [23]. CEC and total N contents were categorized under medium level (0.075–0.15) [23]. The concentration of available phosphorus was categorized under low level [25], indicating the necessity of application of phosphorus-containing fertilizer for both experimental sites. The available sulphur (S) fell under the category of medium for both experimental sites [26]. The amount of boron (B) was categorized under low level for both sites [25]. Hence, the maintenance application of boron for the experimental sites is needed.

4.2. The Mean Performance of the Main Effects on the Agronomic and Disease Parameters. The findings of this study showed that increasing the rate of blended NPSB fertilizer hastens DH, while a decreased rate delays DH. Genotype 222450 headed twelve days earlier than genotype 214606, while Alem Tena and genotype 213037 showed intermediate results, implying that this observed difference might be due to the genetic variation present between the genotypes (Table 4). Such differences in average days to the heading of durum wheat location-wise could be attributed to the variation in agroecological conditions. This result is in line with Tesfaye et al. [27], who stated that increasing levels of the NPS fertilizer shortened DH from 74.6 days (150 kg·ha^{-1} NPS) to 59.5 days (unfertilized plot). Similarly, Abebe and Abebe [28] reported that increasing levels of the N fertilizer shortened DH. This variation observed between genotypes could be due to the genetic difference that existed among the genotypes, the agroecological variation of the experimental sites, and the response of each genotype for the specific agroecological characteristics (G × E effect) as displayed in the significant effect of G × E [29].

In this study, the increased rate of fertilizer hastened DPM, while a decreased rate delayed DPM that corresponded with the effects of fertilizer on DH. This result is in line with Woldetsadik et al. [30], who reported that the blended fertilizer resulted in a significantly reduced number of days to attain maturity compared with the control treatment. One of the reasons for the earliness of fertilized plots compared with the control treatment could be the addition of B that has the potential for earliness in DPM as previous studies on boron indicated [31]. Regarding plant height, genotype 214606 exceeded genotype 222450 by 2 cm only; this difference was minimum compared with the gap between genotype 213037 and the check variety Alem Tena. This difference could be largely due to the genetic difference in the genotypes, in which case modern (improved) cultivars such as Alem Tena might have the semidwarfing genes introduced to wheat and rice core germplasms during green evolution from alien species [32]. Plant height increased consistently with an increased blended NPSB fertilizer rate. This response to fertilizer application rate could be attributed to the addition of sufficient nitrogen. The increase in plant height with an increasing rate of nitrogen levels has been appraised by several researchers; for instance, Diriba Shiferaw et al. [33] reported significant increments in plant height due to the application of a high nitrogen rate. Kumar et al. [34] reported that sulphur-deficient plants exhibited reduced plant height and stunted growth, reduced tillers, spikelets, and delayed maturity.

The check variety Alem Tena with an NPSB rate of 225 kg·ha^{-1} at Adekoysha had 30.2% more tiller than Alem Tena planted at Kokate with an NPSB rate of 225 kg·ha^{-1}; this indicates how much the environment affected the performance of tillering. The genotype-by-environment interaction effect (GEI) is the main cause of the differential performance of genotypes across locations, which influences the selection and recommendation of varieties [35]. The highest number of total tillers at the highest rates of NPSB might be due to the increase in the number and size of growing cells, ultimately resulting in an increased number of tillers [36]. This indicates that the application of blended fertilizer was important to increase the number of total

Table 8: Economic feasibility analysis computed for each genotype, fertilizer rate and its corresponding grain yield of durum wheat.

Treatments		AGY (kg ha^{-1})	ASY (kg ha^{-1})	Income (ETB ha^{-1})		GFB (ETB ha^{-1})	TVC (ETB ha^{-1})	NB (ETB ha^{-1})	MRR (%)
Genotypes	Fertilizers			Grain	Straw				
213037	0	2150.4	7716.6	64512	15433.2	79945.2	0	79945.2	
213037	75	2474.6	8407.8	74238	16815.6	91053.6	3027.5	88026.1	266.9
213037	150	2881	9324	86430	18648	105078	4265	100813	1033.3
213037	225	3240.2	10471.5	97206	20943	118149	5162.5	112986.5	1356.4
222450	0	1514.5	5394.6	45435	10789.2	56224.2	0	56224.2	1099.5
222450	75	1785.8	6084	53574	12168	65742	3027.5	62714.5	214.4
222450	150	2092.2	7170.3	62766	14340.6	77106.6	4265	72841.6	818.4
222450	225	2288.4	7969.5	68652	15939	84591	5162.5	79428.5	733.9
214606	0	1693.8	6727.5	50814	13455	64269	0	64269	293.6
214606	75	2026.8	7518.6	60804	15037.2	75841.2	3027.5	72813.7	282.2
214606	150	2282.2	8066.7	68466	16133.4	84599.4	4265	80334.4	607.7
214606	225	2541.2	8921.7	76236	17843.4	94079.4	5162.5	88916.9	956.3
Alem Tena	0	1582.6	4023.9	47478	8047.8	55525.8	0	55525.8	646.8
Alem Tena	75	1851.5	4561.2	55545	9122.4	64667.4	3027.5	61639.9	201.9
Alem Tena	150	2206	5126.4	66180	10252.8	76432.8	4265	72167.8	850.7
Alem Tena	225	2489.2	5555.7	74676	11111.4	85787.4	5162.5	80624.9	942.3

NPSB cost = 15.5 birr kg^{-1}; urea cost = 14.5 birr kg-^{1}; sale price of durum wheat grain = 30 birr kg^{-1}; sale price of durum wheat straw = 2 birr kg^{-1}; AGY = average grain yield; ASY = adjusted straw yield by 10% downward; GFB = gross field benefit; TVC = total variable cost; MRR = marginal rate of return; NB = net benefit.

tillers, which contributes to the increment in yield. The improvement in the total number of tillers with NPSB application might be due to the role of P found in NPSB in emerging radicle and seminal roots during seedling establishment [36]. This result is in agreement with Tilahun and Tamado [37], who reported a significant increase in the number of tillers of durum wheat, where they found that the highest number of tillers (343.3 per m^2) at 150 kg NPS·ha^{-1} and 92 kg·N·ha^{-1} supplemented, while the lowest total number of tillers (158.3 per m^2) was recorded at 100 kg NPS·ha^{-1} with nil N supplemented. This variation also could happen due to the synergetic effect of the soil nutrient boron and increasing nitrogen use efficiency on genotype 213037. Tahir et al. [38] reported that boron is an essential micronutrient to decrease the accumulation of toxic aluminum and increase the utilization of other nutrients. The reduction in aluminum toxicity might decrease phosphorus fixation to some extent. However, the application of sulphur (NPSB) reduced the number of unproductive tillers and increased the number of years per unit area by 10–70% [39].

The performance of genotypes for spike length indicated the presence of genetic variation within the genotypes that enabled them to respond differently to the effects of environments. Furthermore, the response of the genotypes was significantly different from the application of NPSB fertilizer rates. This was displayed in the data (Table 4) that the landrace selections responded abundantly compared with smaller values of cultivar Alem Tena. Such a differential response of genotypes to experimental treatments is not uncommon. The shortest spike length from Alem Tena with no NPSB application was statistically at par with the value of Alem Tena with NPSB 75 kg·ha^{-1}. However, the other three genotypes demonstrated a consistent increment for every NPSB application rate (Table 4). Shiferaw et al. [33] reported an increase in SL with increasing levels of blended NPSB fertilizer applications.

The durum wheat genotypes responded differently to environments. In most cases, the number of kernels per spike was strongly associated with spike length. According to Irfan Ullah et al. [40], the number of kernels per spike has a positive association with spike length and the number of spikelets. As the genotypes are different in their genetic makeup, their capacity to bear grain is also different. The differential performance of genotypes in TSW to the influences of the environment demonstrated the need to evaluate genotypes of durum wheat across locations in order to select superior genotypes for either specific adaptability or wider adaptability. Abera et al. [36] reported that Mangudo had the highest thousand kernel weight (44.7 g) with no significant difference with varieties Ude and Utuba, while variety Alem Tena displayed significantly the lowest TSW of 36.6 g. Similarly, in this experiment, Alem Tena was significantly exceeded by genotype 213037. The increase in TSW with increased rates of NPSB might be due to the synergistic effect of the four soil nutrients by providing adequate and balanced nutrients, which enhanced the accumulation of assimilates in the grains, resulting in good grain filling and the development of bigger kernels. Considering the individual contribution of each nutrient, sulphur has a great role in increasing grain weight as it is one of the building blocks of protein and a key ingredient in the formation of chlorophyll [41].

The fact that all the main effects and their interaction significantly influenced AGBM indicated the differential response of genotypes towards environment (location effect) and fertilizer rates. It is known that AGBM is constituted from several traits and genes, such as PH, NTT, leaf number and size, GY, and SY, implying the involvement of many

genes that contributed to its manifestation. Therefore, it is expected that this trait will be highly influenced by environmental effects and display a differential response of genotypes. This finding is similar to Melkamu et al. [42], who reported that increasing the blended NPSB rate increased AGBM on wheat. Desta and Almayehu [43] also found that the highest total AGBM (17,383 kg·ha^{-1}) was recorded from plants supplied with blended fertilizer of 150 kg NPSBha^{-1} and the lowest total AGBM (7,025 kg·ha^{-1}) was obtained from the unfertilized plot. Quite similar to AGBM, the NPSB fertilizer rate of 225 kg·ha^{-1} on genotype 213037 maximized straw yield by 2.6-fold compared with the unfertilized plot of Alem Tena (Table 4). An increase in NPSB fertilizer rate from 0 to 225 kg·ha^{-1} significantly increased straw yield. This result is similar to the finding of Tesfaye et al. [27], who reported the highest straw yield (5130 kg·ha^{-1}) that was recorded from 150 kg·ha^{-1} NPS and 50 kg·ha^{-1} KCl as compared to the lowest straw yield (640 kg·ha^{-1}) observed from unfertilized plots.

Nearly similar to the result of AGBM, the main effects and all the interaction effects between them significantly influenced the grain yield of the durum wheat genotypes. This might be due to the genetic variation within genotypes and the heterogeneity of environments. There was also variation in climatic and edaphic factors across locations, which influenced the metabolic process of the plant. The temperature at Adekoysha is significantly warmer than that of Kokate; the warmer area has a greater number of degree days, which is more suitable for metabolism (photosynthesis and respiration). Our finding indicated that using the blended nutrient with supplementary nitrogen is more effective than using a single element as fertilizer in order to get much grain yield. For instance, Hrivna et al. [39] stated that sulphur deficiency reduces the efficiency of nitrogen fertilization, increases losses of nitrate, and reduces the number of grains per year; this indicates that nitrogen and sulphur have a positive relationship.

The results of the ANOVA on harvest index can lead to the conclusion that the increased rate of blended NPSB fertilizer can increase the ratio of harvest index, which indicates a higher production of grain yield. This result is similar to that of Tahir et al. [38] who articulated that a high transfer of assimilates to the grain would maximize the harvest index and reduce the proportion of dry matter produced. The mean value of the data showed that the harvest index ranged from 31.1 to 38.8%, and the maximum 38.8% harvest index was obtained from plots treated with 250 NPSB [42].

The severity of durum wheat genotypes to the rust diseases indicated that with increasing fertilizer rate, the severity of disease occurrence increases. This might be due to the great role of nitrogen as a nutrient with supplementary nitrogen in the form of urea. It highly initiates vegetative growth in plants, helps to produce a large number of tillers, and increases the density of the canopy, which creates favourable environment for the development and spread of fungal diseases. This result is similar to that of Luo et al. [44] who reported that at the N3 level, wheat stripe rust disease was the most serious compared with the unfertilized plot, and the N1–N3 treatments increased the incidence of wheat stripe rust. Blended NPSB rate also significantly influenced stripe rust; the highest value of 17.92% was scored at a fertilizer level of 225 kg·ha^{-1} at Kokate (Table 4). This finding is in line with Hoffland et al. [45] who stated that the increased disease severity of powdery mildews and rusts in grain crops by the application of nitrogenous fertilizers is attributed to enhanced crop canopy development, which increases the humidity favourable for disease development. Apart from nitrogenous fertilizers, environment and genetics also influenced disease severity in wheat rusts. For instance, the highest mean value of 28.33% was obtained from genotype 222450 at Adekoysha with a fertilizer rate of 225kgha^{-1} and the lowest mean value of 1% was obtained from the Alem Tena cultivar at the same experimental site for all treatments (data not shown). This is due to the variation in the genetic ability of genotypes to resist the disease and the influence of the agroecology where they are planted. According to Bariana et al.'s [20] scale, the obtained results show that genotype 222450 was moderately resistant and Alem Tena was highly resistant to leaf rust. The result indicates that the humid environment is more favourable than the cold environment. Relative humidity and leaf wetness variables were more strongly correlated with infection events, while precipitation was poorly correlated with ambient treatment to leaf rust infection events [46].

4.3. Economic Analysis. The partial budget analysis showed that the net benefit obtained from the top yielder genotype at the maximum NPSB application rate was twofold from the treatment with no fertilizer application (Table 8). Similarly, Abera et al. [36] reported that the maximum economic benefit of 44625.51 and 44614.25 birr·ha^{-1} with a marginal rate of return of 1354.61% and 1321.21%, respectively, was obtained with a fertilizer rate of 183 kg·ha^{-1} NPSB, while the lowest net benefit (13552.44 birr · ha^{-1}) was obtained from the variety Mangudo with no application of NPSB fertilizer. Thus, 225 kg·ha^{-1} NPSB fertilizer application on genotype 213037 is suggested for a higher mean net benefit for wheat-growing farmers.

5. Conclusion

The result showed that the highest grain yield (3689.3 kg · ha^{-1}) was obtained from genotype 213037 with an NPSB rate of 225 kg·ha^{-1} at Adekoysha. This genotype had better performance as compared to others. In addition, the net benefit (80584.5 $birr \cdot ha^{-1}$) with a marginal rate of return (956.2%) was obtained from genotype 213037 with an NPSB rate of 225 kg·ha^{-1}. Individually for each genotype, the highest net benefit with the highest marginal rate of return was obtained from an NPSB rate of 225 kg·ha^{-1}, so the use of genotype 213037 with an NPSB rate of 225 kg·ha^{-1} is economically feasible and recommended for the seed multiplication of durum wheat for both locations, Adekoysha and Kokate, and other areas with the same agroecology. Further investigation is needed until the optimum level of blended NPSB fertilizer is obtained.

Data Availability

All the data related to this manuscript are included in the manuscript. Additional information is available upon request to the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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