Evaluation of weed management practices and nitrogen fertilizer rates on growth, yield and yield components of bread wheat (*Triticum aestivum* L.) at Aneded District, Northwestern Ethiopia

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Abstract

Wheat is one of the most important cereal crops in north western Ethiopia. However, its production and productivity is low due to inefficient weed management practices and the use of inappropriate rate of nitrogen fertilizer applications. Therefore, the field experiment was conducted to evaluate the combined effects of weed management practices and nitrogen fertilizer rates on grain yields and yield attributes components of bread wheat. The treatments consisted of a factorial combination of four rates of nitrogen (46, 69, 92, and 115kg N per ha) and four weed management practices (no weeding as control, twice hand weeding, after 40 days hand weeding and herbicides) in randomized complete block design with three replications. Partial Budgets analysis was determined using gross benefit, total variable cost, net benefit and marginal rate of return. Growth, yield and yield related data were collected and analyzed using SAS software version 9.2. *Interaction of nitrogen fertilizer and weed management practices significantly affected spike length (8.23 cm), effective tiller number (49.5), grain yield (5.29 t ha^{-1}), thousand kernels weight (37.85 g) and straw yield (37.85 t ha^{-1}). However, no weeding with 46 kg N ha^{-1} recorded the lowest grain yield (2.69 t ha^{-1}) and biomass yield (8.13 t ha^{-1}). Similarly, the partial budget analysis revealed that herbicide with the applications of 115 kg N ha^{-1} fertilizer rate gave the highest net benefit (347760 Birr ha^{-1}) with acceptable MRR (105.14%). It can be concluded that 115 kg N ha^{-1} fertilizer rate with herbicide-treated treatments were found to be appropriate both agronomic and economically for enhancing wheat productivity in the study area.*

Keywords*:* Herbicide, nitrogen, wheat, weed management

1. Introduction

Bread wheat (*Triticum aestivum* L.) is a member of the *Poales* (*Glumiflorae*) order, *Poaceae* (*Gramineae*) family, *Triticeae* tribe, and *Triticum* genus (Giraldo *et al*., 2019). It has a short ligule and spikelet that are occasionally hairy, as well as a smooth, bald, typically hollow culm that is 0.7-1.6 meters tall (Tiwari and Shoran, 2010). Bread wheat is grown between 1500 and 3200 meters above sea level, 6-16^{0}N latitude and 35-42^{0}E longitude, but its optimal agro-ecological zones are between 1800 and 2700 meters above sea level (Little *et al.*, 2021;

Mekonnen, 2022).

Bread wheat is widely adapted and most important cereal crop throughout the world (Giraldo *et al*., 2019). In 2020, world wheat production was 761 million tones, led by China, India, and Russia collectively providing 38% of the world total production (Zenda *et al*., 2021). Its production in Ethiopia in 2021/22 was about 5.18 million tons harvested from 1.9 million ha (CSA 2022). In Amhara Region about 578,034.07 ha was covered by bread wheat to produce 16,117,841.44 q. In the same year about 3,976,853.24 q of bread wheat was produced from 578,034.07 ha of land (CSA, 2022).

Bread wheat is one of the most important cereal crops, responsible for the emergence and development of agriculture and has fed, and continues to feed, a large part of the world's population across many centuries (Ciudad-Mulero *et al*., 2021). Its consumption has climbed by 73 percent in emerging countries during the last ten years (Ciudad-Mulero *et al*., 2021). Wheat has a high nutritional value, containing 60-90 percent carbohydrate, 11-16.5 percent protein, 1.5-2 percent fat, 1.2-2 percent inorganic ions, and vitamins (Asres, 2019).

Weed infestation is the main problem for wheat production in Aneded District. Farmers are aware the problem of weeds. But often they could not manage its infestation during the peak period of competition due to the shortage of labor to give priority for other agricultural activities (Little *et al.,* 2012. Such ineffective weed management practices are considered one of the main factors for the low yield of bread wheat with an average yield loss ranges from 45% to 86% (GU *et al*., 2021).

Low soil fertility, in particular nitrogen deficiency, is one of the major problems limiting wheat production in Ethiopian highlands (Teklu and Hailemariam, 2009). Applied N fertilizer remains unavailable to a crop due to leaching, erosion, continuous monocropping, volatilization and denitrification. Thus, the use of appropriate rate and placement of nitrogen along with weed free fields increases production and productivity of the crop. However, little research has been done to evaluate the influence of weed management practices and N fertilizer application on the productivity of bread wheat. Hence, this study was conducted:

- To evaluate the combined effects of nitrogen fertilizer rates and weed management practices on yields and yield attributes of bread wheat.

- To identify economically optimum weed management practices and N rate for enhancing wheat production at Amber District

2. Materials and methods

2.1 Description of the study Area

The study was carried out at Debre Markos Agricultural Research Center on research fields East Gojjam Zone, Amhara Regional state in 2021/2022 main cropping season. The site is located 291 km Northwest of Addis Abeba and 274 km Southeast of Bahir Dar (Figure 1). The site had an elevation of 2300 - 2420 meters above sea level and was geographically located at10°14'N latitude and 37° 52'E longitude. The district is characterized by an average maximum temperature of 19.6 - 26.3 ^{o}C while a minimum temperature of 8.6 - 13.1^{o}C (Figure 1). The soil of the experimental site was black.

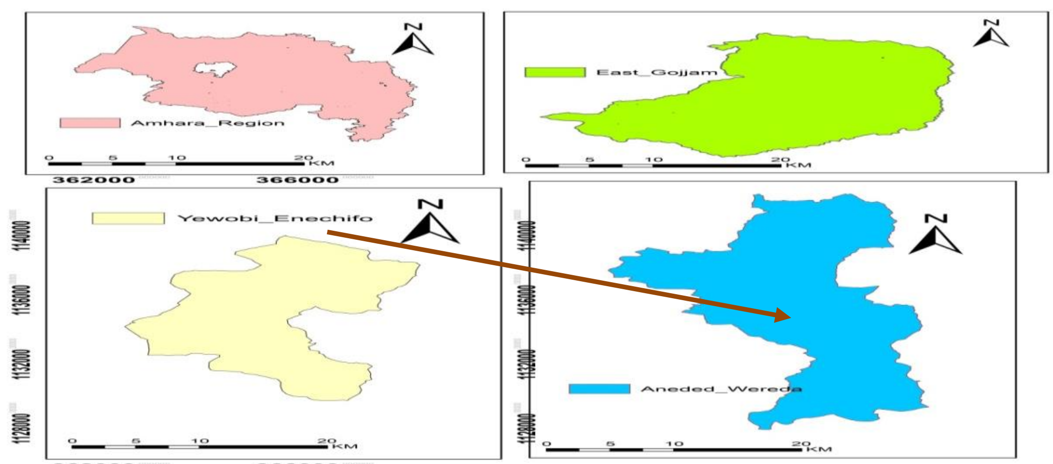

Figure 1. Map of Aneded District.

The major crops grown in the districts are teff (*Eragrostis abissinica*), wheat (*Triticum aestivum*), maize (*Zea mays*), bean (*Phaseolus vulgaris*), pea (*Pisum sativum*), potato (*Solanum tubersum*), barley (*Hordeum vulgare*) and respectively (Dereje and Eshetu, 2012).

2.2. Experimental Materials: Bread wheat variety 'Kakaba' was used as a test crop for this experiment. The variety was released by Kulumsa Agricultural Research Centre during 2010 The variety was selected based on its adaptability to agro-ecological zone of the study area, productivity, and resistant for disease. The variety requires 103 days to maturity. Herbicides (Pyroxsulam) was used as standard check to compare other treatments.

2.3 Treatments and Experimental Design:- About Sixteen treatments consisted of four levels of nitrogen (46, 69, 92, and 115 kg N a^{-1}) and four weed management practices (No weeding, hand weeding on 20 and 35 days, hand weeding on 45 days and herbicides at 30 days). The treatments were laid out in factorial randomized complete block design with three replications. The gross plot size was323.2m^2. Each plot was 2 m × 1.8 m (3.6m^2) with 20 cm row spacing. A total of 9 rows with a gap of 0.5 m and 1 m between adjacent plots and blocks respectively were used. The net plot size of 1.6 m × 1 m (1.6 m^2) was used.

2.4. **Experimental Procedures**:- The land was cleared and oxen plough three times before planting of the crop to make the land suitable for the crop. The recommended rates of NPSB fertilizer (100 kg ha^{-1}) and seed were applied at the time of sowing, while Urea was applied in three splits: a third of N fertilizer was applied within the rows at sowing, and the remaining two-thirds of N in the form of urea was top-dressed in two equal splits at the tillering and panicle initiation stages after 40 and 72 days of sowing respectively. About 150 Kg ha^{-1} bread wheat variety (Kakaba) was hand drilled at 20 cm apart in rows.

The herbicide (Pyroxsulam as standard check) was applied using a hand sprayer as directed in the allocated plots 30 days after emergence, using 250 l ha^{-1}water as a carrier. Weeds in weed-free plots were pulled out by hand frequently to keep the plots free from weeds. Harvesting was done on each plot and the crop was sun dried for eight days to make threshing easier.

2.5. Data collected

2.5.1. Growth Parameters

Plant height (PH): The average heights of 10 randomly selected plants from the net plot area of each plot, ignoring owns at maturity, were measured in cm from the ground to the top of the spike, and average values were calculated.

Effective Tiller number (ETN): The number of effective tillers bearing spikes was counted at physiological maturity by counting all spikes from two randomly taken rows of 0.5 m in length from the net plot area was considered.

Spike length (SL): The spike length was measured in centimeters from ten randomly selected plants in the two inner rows, and the mean length was recorded for each plot. Excluding owns, it was measured from the base to the top of the spike.

2.5.2. Yield and Yield Related Parameters

Kernel number (KN): Ten randomly selected plants from the two inner rows of each plot were counted for the number of kernels per spike, and the mean kernel number was used..

Biomass yield (BY): The sun-dried total aboveground plant biomass (straw + grain) from the net plot area was weighed and converted to tone ha^{-1} to determine total biomass yield.

Grain yield (GY): The weight of the grains threshed from the net plot area was used to calculate grain yield, which was then converted to tone ha^{-1} after the grain moisture content was adjusted by 12.5%.

Straw Yield (SY): Straw yield was determined by subtracting grain yield from total above-ground biomass (Meena *et al*., 2019).

$$\text{Straw Yield} = \text{Total Above Groung Biomass Yield} - \text{Grain yield}$$

Harvest Index (HI): The division of grain yield (GY) to the above-ground biological yield (BY) and multiplying by 100 was considered as the harvest index (Meena *et al*., 2019).

$$\text{Harvest Index} = \frac{\text{Grain yield}}{\text{Total above ground biomass yield}} * 100$$

2.5.3. Weed control efficiency: Any weed management treatment's % reduction in weed dry matter in contrast to the weedy check plots was done using the formula (Meena *et al*., 2019).

$$\text{WCE} = \frac{\text{Dry matter of unweeded plot} - \text{Dry matter of treated plot}}{\text{Dry matter of weed in the treated plot}} * 100$$

2.6. Data Analysis: - The data were subjected to analysis of variance (ANOVA) using SAS version 9.2 software, and the significant difference between individual means was determined by using the least significance difference (LSD) at a 5% or 1% significance level. Simple correlation coefficients between growth, yields and yield components and weed parameters were calculated for correlation analysis.

2.7. Economic Analysis:- It was done to determine the economic feasibility of the treatments. The economic analysis was done using the method of CIMMYT partial budget analysis (CIMMYT, 1988). Normally, costs of labor, fertilizer, hand weeding and herbicide application were considered to estimate the variable cost while the prices of kakaba seed and straw were identified to compute the field benefit of the treatments. The price of fertilizer and herbicide were 40 birr/kg and 150 birr/g, respectively. The labor cost for harvesting, threshing and winnowing was estimated 100 birr/100 kg seed yield. The cost of seed packing material and transportation was 25 birr/100 kg seed while the cost of straw packaging and transporting was 15 birr/25 kg. It takes into account the examination of gross benefit (GB), total variable cost (TVC), net benefit (NB), and marginal rate of return (MRR) were done accordingly. To narrow the grain and straw yield gap between experimental plots and farmers' fields, the mean grain and straw yield data was reduced by 10%. The economic benefits of the treatment were computed by estimated seed price of 60 birr/kg and straw price by 2 birr/kg. Then the dominance analysis undertaken to select the most profitable treatment, thus treatments were arranged in ascending order of total variable cost from the lowest to the highest cost. Moreover, the net benefit of each treatment was computed through a difference of the gross field benefit to total cost.

$$\mathrm{GB} = (\mathrm{GY} * \mathrm{PGY} + \mathrm{SY} * \mathrm{PSY})$$

$$\mathrm{NB} = \mathrm{GB} - \mathrm{TVC}$$

Where; GB = Gross Benefit, GY = Grain Yield, PGY = Price of Grain Yields, SY = Straw Yield, and PSY = Prices of Straw Yield. NB = net benefit, GB = Gross Benefit.

Dominated (designated as "D") treatment has a higher total variable cost but the lowest net benefit than the treatment before it. To select potentially profitable treatments from the range that was tested, the dominance analysis procedure was described due to larger yields don't always mean better net benefits. The dominated and nominated treatments were the rejected and selected treatments, respectively. Changing net benefit by changed total variable cost, the marginal rate of return was calculated: (Kassa *et al.*, 2018)

$$MRR = \frac{\Delta NB}{\Delta TVC} * 100$$

Where; MRR = marginal rate of return, ΔNB = change in net benefit, and ΔTVC = change in total variable cost.

3. Results and discussions

3.1. Growth Parameters

3.1.1 Plant height:- The analysis of variance showed that main effect of nitrogen fertilizer rate and weed management Practices on bread wheat height were highly significant ($P<0.01$) on plant height. Weedy treatments achieved the shortest plant height (74.38cm) while the tallest plant height (80.9cm) was recorded on herbicides treated treatments (Table 3.1). Similar findings were reported by Rani (2019), who found that in a weedy check, the wheat crop invested photosynthetic power in shading weeds to attain vegetative superiority. Unlike competition for nutrients and moisture, once weeds shade a crop plant, cannot benefit from the increased light intensity (Rani, 2019).

Table 3.1. The main effect of weed management practices and nitrogen fertilizer rates on plant height (cm) of bread wheat at Aneded District in 2021 cropping season.

Weed Management Methods	Plant Height
No weeding	74.37^{c}
Twice hand weeding (on 20 and 35 days)	79.87^{ab}
Hand weeding after 45 days	77.96^{b}
Herbicide (Pyroxsulam)	80.29^{a}
LSD (0.05)	1.9
CV (%)	9.86
Nitrogen fertilizer ($kgha^{-1}$)	
46	76.14^{b}
69	77.59^{ab}
92	79.35^{a}
115	79.42^{a}
LSD (0.05)	1.9
CV (%)	7.42

LSD= least significant difference, CV= coefficient of variation. Means in the same columns followed by the same letter(s) are not significantly different at 5% level of significance.

3.1.2 Effective tiller number:- Both main and interaction effects of N fertilizer rate and weed management methods showed highly significant (P<0.01) influence on the effective tiller number of bread wheat. The highest effective tiller numbers (49.5) were recorded from twice hand weddings with 115 kg N ha^{-1}, while the lowest effective tiller numbers (30.5) were confirmed from weedy treatments with 46kg N ha^{-1} (Table 3.2). The applications of optimum N rates and better weed control practices may have enhanced the photosynthetic rate, assimilate translocation, and cell division, and increased the number of tillers per plant (Bogale, 2020). Similarly, Al-Khafji *et al*. (2020) found varied weed management strategies with higher nitrogen fertilizer could be obtained more tillers. Bogale (2020) showed similar results when weeds and crops competed for resources, resulting in low productive tillers. According to Al-Khafji *et al*. (2020) reported an increase in many fertile productive tillers leads to better weed control.

Table 3.2. Interaction effect of weeds management practices and nitrogen rates on the effective tiller of bread wheat at Aneded District in 2021 cropping season.

Weed Management Methods	Nitrogen Fertilizer (Kg N ha^{-1})			
	46	69	92	115
No weeding	30.5^{i}	34^{h}	37.16^{g}	40.66^{ef}
Twice hand weeding (on 20 and 35 days)	42.66^{de}	42.83^{de}	49.16^{a}	49.50^{a}
Hand weeding after 45 days	40^{f}	40.16^{f}	42.66^{de}	43.33^{cd}
Herbicide (Pyroxsulam)	44.16^{bcd}	44.33^{bcd}	45.50^{bc}	46.50^{b}
LSD(0.05)	2.41			
CV (%)	3.44			

LSD= least significant difference, CV= coefficient of variation. Means in the same columns followed by the same letter(s) are not significantly different at a 5% level of significance

3.1.3. **Spike length**

The main effect of weed management method and nitrogen fertilizer rate had highly significant (p<0.01) influence and their interaction had significant (p<0.05) effect on spike length. The longest spike length (8.23cm) was recorded from herbicides with 115 kg N ha^{-1}, while the shortest (6.05cm) recorded from weedy with 46 kg N ha^{-1} (Table 3.3). Bogale (2020) further claims that an increase in spike length is due to less crop-weed competition in treated plots and higher nitrogen availability. The additive influence on vegetative development, increased wheat output encourages tillering, which in turn encourages the formation of additional spikes per plant (Al-Khafji *et al*., 2020).

Table 3.3. Interactions of weed management practices and nitrogen fertilizer rates on spike length (cm) of bread wheat At Aneded District.

Weed Management Methods	Nitrogen Fertilizer (Kg N ha^{-1})			
	46	69	92	115
No weeding	6.06^{j}	6.30^{hij}	6.60^{fgh}	7.10^{bcd}
Twice hand weeding (on 20 and 35 days)	6.20^{ij}	6.60^{fgh}	6.8^{defg}	7.16^{bc}
Hand weeding after 45 days	6.50^{ghi}	6.66^{fg}	6.83^{def}	7.03^{cde}
Herbicides (Pyroxsulam)	6.76^{efg}	7.33^{bc}	7.36^{b}	8.23^{a}
LSD(0.05)	0.32			
CV (%)	8.34			

LSD= least significant difference, CV= coefficient of variation. Means in the same columns followed by the same letter(s) are not significantly different at a 5% level of significance

3.2 Yield and Yield Component

3.2.1 **Biomass yield:-** The interaction effect of weed management methods and nitrogen fertilizer rate had a highly significant ($p<0.01$) influence on biomass production. The highest biomass yield (15.83 tha^{-1}) was recorded in twice hand weeding plots with a nitrogen fertilizer rate of 115kg N ha^{-1}, whereas the lowest biomass yield (8.13tha^{-1}) was registered in weedy check plots with a nitrogen fertilizer rate of 46 kg N ha^{-1} (Table 3.4).

Table 3.4. Interaction of weed management practices and N fertilizer rates on Biomass yield (t ha^{-1}) of Bread wheat at Aneded District.

Weed Management Methods	Nitrogen Fertilizer (Kg N ha^{-1})			
	46	69	92	115
No weeding	8.13^{i}	8.73^{h}	9.40^{g}	11.89^{f}
Twice hand weeding (on 20 and 35 days)	15.31^{bc}	15.31^{bc}	15.50^{ab}	15.83^{a}
Hand weeding after 45 days	11.56^{f}	11.77^{f}	14.06^{d}	14.27^{d}
Herbicide (Pyroxsulam)	13.33^{e}	13.34^{e}	15.00^{c}	15.01^{c}
LSD(0.05)	0.47			
CV (%)	9.7			

LSD= least significant difference, CV= coefficient of variation. Means in the same columns followed by the same letter(s) are not significantly different at a 5% level of significance

Bogale (2020) reported similar results, explaining that decreased biological yield in bread wheat could be related to weed competition as a result of weed depletion of nutrient availability and water, resulting in reduced crop plant growth, seed, and straw yields. Weed management improved wheat biological yield while decreasing weed infestation. The use of grassy and broadleaf herbicides boosted wheat grain production and yield components (Bogale, 2020). At Kulumusa, Ethiopia, 60 kg N ha^{-1} and hand weeding considerably enhanced the maximum values of yield components and grain yield of wheat (Zenda *et al*., 2021).

3.2.2 Grain Yield:- Grain yield was highly significant ($p<0.01$) influenced by their interaction effect on the main effect of nitrogen fertilizer rate and weed management methods. The highest grain yield (5.29tha^{-1}) was recorded from the herbicides treated treatment and 115 kg N ha^{-1}, whereas the lowest grain yield (2.69tha^{-1}) was achieved from weedy check treatment and 46 kg N ha^{-1} (Table 3.5). The Pyroxsulam application had significant influence on weed species. When no Pyroxsulam was used, the yield was drastically reduced. Effective weed control was observed from herbicide-treated plots, since less competition for the resources. These findings are supported by Zenda *et al*. (2021), greatest grain yield was recorded from herbicide treated treatments due to lower weed population, greater fertilizer and water usage efficiency, but minimum grain production was confirmed at the control.

Table 3.5. Interaction effect of weed management and N fertilizer rates on wheat grain yield

Weed Management Methods	Nitrogen Fertilizer (Kg N ha^{-1})			
	46	69	92	115
No weeding	2.69 ^{j}	3.23^{i}	3.52 ^{h}	3.81^{g}
Twice hand weeding (on 20 and 35 days)	4.00^{fg}	4.21^{ef}	5.04^{ab}	5.12^{a}
Hand weeding after 45 days	3.75^{gh}	4.14^{bc}	4.50^{cd}	4.77^{bc}
Herbicide (Pyroxsulam)	4.33^{de}	5.04^{ab}	5.25^{a}	5.29^{a}
LSD(0.05)	0.28			
CV (%)	8.18			

LSD= least significant difference, CV= coefficient of variation. Means in the same columns followed by the same letter(s) are not significantly different at 5% level of significance

3.3.3 Straw yield:- The main effect of weed management method, nitrogen fertilizer rate, and their interaction were highly significantly ($p<0.01$) influenced on the straw yield. The highest straw yield (9.72 tha^{-1}) was recorded at 115 kg N ha^{-1} application with Pyroxsulam treatment, while the lowest straw yield (5.44 tha^{-1}) was recorded from weedy check at 46 kg N ha^{-1} (Table 3.6).

Table 3.6. Interaction effect of weed management practices and nitrogen fertilizer rates on straw yield (tha^{-1}) of bread wheat at Aneded District.

Weed Management Methods	Nitrogen Fertilizer (Kg Nha^{-1})			
	46	69	92	115
No weeding	5.44^{h}	5.50^{h}	5.88^{h}	8.08^{fg}
Twice hand weeding (on 20 and 35 days)	11.31^{a}	11.16^{ab}	10.70^{bc}	10.35^{c}
Hand weeding after 45 days	7.79^{fg}	7.56^{g}	9.56^{d}	9.50^{de}
Herbicide (Pyroxsulam)	9.00^{e}	8.30^{f}	9.75^{d}	37.85^{d}
LSD(0.05)	3.05			
CV (%)	4.23			

LSD= least significant difference, CV= coefficient of variation. Means in the same columns followed by the same letter(s) are not significantly different at a 5% level of significance

The straw yield varied from 5.44 to 37.85 t ha^{-1}. The smallest straw yield was recorded from no weeding treatment with 46 kg N $ha^{-1}$and the highest from herbicides with 115 kg N ha^{-1}. In a similar study, Meena *et al*. (2019) reported that the combined effect of nitrogen fertilizer application and weed management practices contributed to higher straw yield production compared to the control. The use of grassy and broadleaf herbicides with weed management boosted wheat grain production and yield components (Geddes and Gulden, 2021).

3.3.4. Harvest index:- The analysis of variance revealed that the harvest index was significantly ($p<0.01$) influenced by the main effect of weed management methods, nitrogen fertilizer rate, and their interaction effect. Herbicides treated plot combined with 115 kg N ha^{-1} had the highest harvest index (35.59%), while twice hand wedding-treated plot along with 46 kg N ha^{-1}gave the lowest harvest index (26.12 %) (Table 3.7). Bogale (2020) observed similar findings that the harvest index increased as weed competition decreased. Meena *et al*. (2019 also reported that weed management practices and higher nitrogen fertilizer rate caused considerable variation in the wheat harvest index.

Table 3.7. Interaction effect of weed management practices and nitrogen fertilizer rates on harvest index of bread wheat at Aneded District.

Weed Management Methods	Nitrogen Fertilizer ($Kgha^{-1}$)			
	46	69	92	115
No weeding	33.09[de]	36.99[abc]	38.77[a]	32.05[e]
Twice hand weeding (on 20 and 35 days)	26.12[f]	27.08[f]	32.74[e]	32.38[e]
Hand weeding after 45 days	32.48[e]	35.78[bc]	32.01[e]	33.42[de]
Herbicide (Pyroxsulam)	32.53[e]	37.81[ab]	35.04[cd]	35.29[cd]
LSD(0.05)	2.27			
CV (%)	4.08			

LSD= least significant difference, CV= coefficient of variation. Means in the same columns followed by the same letter(s) are not significantly different at a 5% level of significance.

3.4. Weed control efficiency: - The present result of analysis of variances indicated that the main and interaction effect of nitrogen fertilizer rate and weed management practices had highly significant ($p<0.01$) influence on weed control efficiency. Pyroxsulam had the highest weed control efficiency ranged from 92 – 94%, whereas no weeding treatment had the lowest weed control efficiency (27.03%) (Table 3.8). The present findings are similar to those of others who found that broad-spectrum herbicides were more effective at controlling weeds than untreated control. The high control efficiency indicated that the weed was controlled when it was young or before it accumulated more dry matter by competing with the crop plants (Menia *et al*., 2021).

Table 3.8. Interaction effect of weed management methods and nitrogen fertilizer rates on weed control efficiency (%) of bread wheat at Aneded District.

Weed Management Methods	Nitrogen Fertilizer ($Kgha^{-1}$)			
	46	69	92	115
No weeding	27.03[g]	19.02[b]	15.65[i]	3.84[j]
Twice hand weeding (on 20 and 35 days)	77.05[b]	75.08[b]	75.54[b]	60.35[d]
Hand weeding after 45 days	70.06[c]	55.71[e]	53.61[e]	46.86[f]
Herbicide (Pyroxsulam)	92[a]	94[a]	94[a]	93[a]
LSD(0.05)	2.72			
CV (%)	9.95			

LSD= least significant difference, CV= coefficient of variation. Means in the same columns followed by the same letter(s) are not significantly different at a 5% level of significance

3.5. Economic Analysis:- **3.5. Economic Analysis**. :- An economic analysis result using the partial budget procedure (CIMMYT, 1988) was done due to grain yield being significantly influenced by weed management practices and N fertilizer rate. In the evaluation of weed management methods and N fertilizer rate, the costs that are directly associated with the decision to use or not were the costs for the herbicides, Urea, and the labor for the application of the input (CIMMYT, 1988). Fixed costs were not considered in this study, and the highest total variable cost (12830 ETB ha^{1}) and net return (347,760 ETB ha^{-1}) with MRR of 105.14% were recorded from herbicide-treated plots with 115 kg N ha^{-1} (Table 3.9). According to Kassa *et al.* (2018), yield alone does not tell much about production efficiency; hence the efficiency of production has been studied using partial budget analysis. As Chacko *et al.* (2021) reported that, herbicide combinations and N fertilizer levels efficiently controlled weed infestation on bread wheat, resulting in greater yields that were directly associated with the high relative net return. The net benefit of all interactions of weed management measures and N fertilizer rates was higher than the weedy check.

Table 3.9. Economic analysis of weed management and nitrogen fertilizer rates on Bread Wheat at Aneded district

Treatment				Income (ETBha-)					
Weed management	Kg N ha^{-1}	AGY (Q ha^{-1})	ASY (Q ha^{-1})	Grain	Straw	GFB ($ETBha^{-1}$)	TVC ($ETBha^{-1}$)	NB ($ETBha^{-1}$)	MRR (%)
No weeding	46	7.21	48.96	40376	2448	42834	9730	33094	
After 45 days hand weeding	46	23.75	70.11	132888	3505.5	136393.5	10150	126243.5	22178.7
Herbicides	46	38.97	81	218232	4050	222,282	10430	211852	25536.6
No weeding	69	12.07	49.5	67562	2475	70067	10530	59537	D
Twice hand weeding (on 20 and 35 days)	46	26	101.79	145600	5089.5	150689.5	10570	140119.5	D
After 45 days hand weeding	69	37.26	68.4	104328	3420	107748	10950	96798	D
Herbicides	69	45.36	74.7	127008	3735	130743	11230	119513	7108.2
No weeding	92	22.68	52.92	88704	2646	91350	11330	80020	D
Twice hand weeding (on 20 and 35 days)	69	37.89	100.44	206855	5022	213678	11370	202308	D
After 45 days hand weeding	92	40.5	86.04	226800	4302	231102	11750	211352	D
Herbicides	92	47.25	87.75	264600	4387.5	268987.5	12157.5	124657.5	3771.9
No weeding	115	24.29	72.72	136024	3636	139660	12130	127530	D
Twice hand weeding (on 20 and 35 days)	115	55.36	96.3	310016	4815	314831	12170	313614	D
After 45 days hand weeding	115	42.93	85.5	240408	4275	244683	12550	233133	D
herbicide	115	63.61	87.48	356216	4374	360590	12830	347760	105.14
Twice hand weeding	115	56.08	93.15	317048	4657.5	318705.5	12970	305735.5	D

AGY= Adjusted Grain Yield, ASY= Adjusted Straw Yield, GFB= Gross Field Benefit, TVC= Total variable cost, NB= Net Benefit, and MRR=Marginal Rates of Return.

4. CONCLUSION

The analysis of variance showed that the spike length and grain yields were significantly ($p<0.05$) affected by the interaction effects of weed management and the application of Nitrogen fertilizer rate. Similarly, biomass yield (1.62***), straw yield (1.93***), harvest index and weed control efficiency were highly significantly ($p<0.01$) affected by interaction effects of weed management and application of Nitrogen fertilizer rate. Among the studied treatments, the combined application of 115 kg N ha^{-1} nitrogen fertilizer combined with herbicides gave the highest grain yield advantage of 105.14% as compared to the control.
347,760 ETB ha^{-1}) with MRR of 105.14%

The use of 115 kg N ha^{-1} nitrogen fertilizer combined with herbicides provided the greatest net benefit (347,760 ETB ha^{-1}) and was both agronomically and economically feasible and recommended in the study area. Since this research was only done for one season, it would be important to repeat the trial to make sound and reliable recommendations.

5. RECOMMENDATION

The combined effect of timely hand weeding and optimum level of N fertilizer along with Herbicide (Pyroxsulam) application may advisable for better production and productivity of bread wheat. About 115 Kg N fertilizer added to Herbicide (Pyroxsulam) gave promising yield advantage of bread wheat than other treatments.

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