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ORIGINAL ARTICLE

Effect of crop rotation on grain yield and yield components of bread wheat (*Triticum aestivum* L.) in the central highlands of Southern Ethiopia

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Cropping systems in the Ethiopian highlands consist primarily of cereals in rotation with grain legume and oilseed crops. Bread wheat (*Triticum aestivum* L.) is the dominant crop in wheat belt of Ethiopia and its production is mainly challenged by continuous wheat cropping year after year. Wheat based crop rotation was conducted in Silte zone, Allicho-wuriro district during 2019, 2020 and 2021 cropping seasons. The objective was to break down wheat monoculture and thereby enhance productivity and sustainability of wheat based farming systems. Rotational crops include potato, food barley, faba bean, field pea, lentils and continuous wheat were laid down in randomized complete design with three replications. Results indicated that faba bean and field pea wheat rotation increased wheat grain yield by 6.6% and 5.45 % of continuous wheat cropping, respectively. Demonstration of faba bean in the rotation enabled small-scale wheat farmers to use rhizobium inoculants with appropriate inoculation techniques. Their fore, small scale farmers in the study area and similar agro ecologies can increase wheat grain yield by using faba bean as a rotation crop.
Keywords: Bread wheat, Precursor crop, Leguminous crop, Rhizobium, *Triticum aestivum*

Introduction

Bread wheat (*Triticum aestivum* L.) is one of the most important cereal crops of the world and is a staple food for about one third of the world's population (Hussain, et al., 2022). It is one of the major cereal crops grown in the highlands of Ethiopia and the country is regarded as the largest wheat producer in Sub-Saharan Africa (Efrem, et al., 2000). Out of the total grain crop area, wheat ranked 4th after tef (*Eragrostis tef*), maize (*Zea mays*) and sorghum (*Sorghum bicolor*), while third in total production after maize and tef (CSA, 2020). Despite the long history of wheat cultivation and its importance to the Ethiopian agriculture, its average yield is still very low, not exeeding 2.4 tha^{-1} CSA, which is below the world's average of 3.4 tha^{-1} (Castellazzi, et al., 2008). The low yield of wheat in the country may be due to the use of low yielding varieties, inadequate and erratic rainfall, diseases and low soil fertility due to continuous cropping without rotation.

Crop rotation is one of the oldest and most fundamental agronomical practices, and is thought to have great impact on increasing crop yield. It is primarily a management decision based on a desire to optimize financial, agricultural or environmental objectives through profit and yield maximizations as well as through minimized pesticide use (Harris, et al., 2007).

Rotations primarily help in weed control, improve soil fertility, and increase wheat grain yield when compared to mono-cropping (Yirga, et al., 1992). A well planned rotation reduces weed pressure by eliminating the constant niche that mono cropping provides.

A leguminous crop usually precedes cereals for the aim of improving soil fertility. Therefore, the benefits of rotations could arise from increased nitrogen supply, soil organic matter, and improvement in soil structure, and decreased pests, disease or weed competition. The farming systems of southern Ethiopia, cereals predominate, often occupying over 80% of the total cropped land each season (Admasu, et al., 2020).

In the highland zones, bread wheat and barley are the most common cereals in production, while faba bean is common grain legume crop. Though the high proportion of wheat and barley in the highland cropping systems not satisfies the short term subsistence objectives of farmers, and also, may prove disadvantageous in the long term due to the absence of the inherent advantages of crop rotational systems. Hence, choice of appropriate precursor crop to wheat planting for rotation can affect wheat yield.

Materials and Methods

Description of the study site

The study was conducted for three consecutive years from July to December during the 2019 to 2021 main cropping seasons in the Silte zone, Allicho-wuriro district at the Kedkedo experimental field station. The site is located at 7°58'N latitude and 37°29'E longitude at an altitude of 2984 meters above sea level. This area is typical of the rain fed wheat growing regions of Ethiopia with average annual rainfall of 825 mm.

Treatments and experimental design

In the first year all plots were received wheat with recommended agronomic package to make the experimental units homogenous. In the second year crop grown potentially in the district were used as precursor crop which was food barley, potato, field pea, lentils, faba bean and wheat. The precursor crops were arranged in randomized complete block design with three replications. The plot size for planting was 2.4 m × 3.0 m accommodating 12 rows spaced 20 cm apart. Eight central rows were used for data collection and measurement. The distance between the plots and blocks were kept at 0.5 m and 1 m apart, respectively.

Data collected

In the first and second year only yield data was collected. However, in the third year (last year) Agronomic data like plant height, tiller per plant, spike length, biomass, grain yield and thousand seed weight were recorded.

Data analysis

After verifying the homogeneity of error variances, analysis of variance was done using the procedure of SAS. Mean comparisons were done by Least Significant Difference (LSD) at the 5% level of significance.

Results and Discussion

In the first year wheat was sawn on all plots, and the average grain yield was 7100 kg/ha. In the second year the wheat was reduced in to 5810 kg/ha and in the third year the wheat yield was reduced in to 4008 kg/ha. This indicates continuous wheat cropping in small scale farmers significantly reduce bread wheat yield due to no host break for soil born disease and different pests. The remaining precursor crop yield described below in Table 1.

Table 1. The yield of rotation crops in 2020 cropping seasons.

Crops	Wheat	Food barley	Potato	Faba bean	Field pea	Lentil
Yield(kg/ha)	5810	5031	35230	3200	2181	1812

Precursor crops were significantly ($p<0.05$) affect plant height, number of tillers, spike length, biomass, grain yield and thousand seed weight. The maximum values of the above traits were obtained wheat following faba bean which increase the wheat grain yield by 6.6% compared to continuous wheat cropping but not significantly different from wheat following field pea. While, the minimum values were recorded from continuous cropping (Table 2). A similar result was reported by Admasu, et al. This could be due to the improvement in soil fertility with different crops compared to continuous wheat. The higher yield of wheat in crop rotation with legumes is due to nitrogen fixation and the change in spatial and temporal difference of crops. In addition, variation in root structure and depth is the other benefits of crop rotation for change in soil fertility and can influence yield of crops by altering the physical and morphological properties of the soil.

Table 2. Effect of rotation on wheat yield and yield components.

	Parameters					
Precursor crops	**PH (cm)**	**TN**	**SL (cm)**	**BM (kg/ha)**	**GY (kg/ha)**	**TSW (g)**
Wheat	80.3	2.3	5.83	5.3	3742	2071

Food barley	82.3	3c	6.27	5.76	3758	2470
Faba bean	92	6.3	9.5	11.5	4008	6034
Field pea	89.3	5b	8.6	10.7	3958	5572
Lentil	84.67	4.83	8.17	9.17	3900	5030
Potato	83.66	2.67	7.03	7.23	3908	4400
LSD (0.05)	3.32	1.28	1.54	0.82	63	540
CV (%)	7.5	17.51	11.18	5.43	6.89	6.96

PH: Plant Height; TN: Tiller Numbers; SL: Spike Length; BM: Biomass; GY: Grain Yield and TSW: Thousand Seed Weight.

Conclusion

Rotation with pulse crop species, particularly the faba bean grain legume crop, increased wheat grain yield in succeeding crops. This experiment revealed that the first wheat following a faba bean precursor crop in rotation resulted in superior grain yields. The low yields obtained from the continuous cereal rotations at Allicho-wuriro district. The result indicates the need to encourage the adoption of appropriate crop rotations by peasant in the high lands of Silte zone and similar agro ecologies.

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