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Sustainable Wheat Based Crop Rotation System in Tropical

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Abstract

Cropping systems in the Ethiopian highlands consist primarily of cereals in rotation with grain legume and oilseed crops. Bread Wheat (*Triticumaestivum L.*) is the dominant crop in wheat belt of Ethiopia and its production is mainly challenged by continuous wheat cropping year after year. Verification of wheat based crop rotation was conducted in Aris zone during 2014 and 2015 cropping seasons. The objective was to break down wheat monoculture and thereby enhance productivity and sustainability of wheat-based farming systems. Rotational crops included rapeseed (*Brassica carinata L.*), faba bean (*Vicia faba* L.) and continuous wheat. In second trail, the aforementioned three rotations were arranged with three levels of N fertilizer viz. recommended N, 75 and 50% of the recommended N in split plot design with three replications. Recommended rate of phosphorus fertilizer was applied for all treatments. Results indicated that faba bean and rapeseed wheat rotation increased wheat grain yield by 80% and 84 % cf. continuous wheat cropping, respectively. Rapeseed has been found better in controlling grass weed than faba bean. Demonstration of faba bean in the rotation enabled small-scale wheat farmers to use *Rhizobium* inoculants with appropriate inoculation techniques. Results of faba bean wheat rotation and fertilizer rate study indicated that there was no significant difference between wheat yields obtained from 100% and 75% recommended N fertilizer application. Hence, when faba bean wheat rotation is practiced 25% of the N fertilizer can be saved.

Keywords: Bread wheat; Crop rotation; Faba bean; Ethiopian mustard; Grain yield

Introduction

Cropping systems in the Ethiopian highlands consist primarily of cereals in rotation with grain legume and oilseed crops. Bread Wheat (*Triticumaestivum*L.) is the dominant crop in wheat belt of Ethiopia and its production is mainly challenged by continuous wheat cropping year after year. Crop rotation is one of the oldest and most fundamental agronomical practices, and is thought to have great impact on increasing crop yield. Crop rotation means changing the type of crop grown on a particular piece of land from year to year. 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 [1]. Rotations primarily help in weed control, improve soil fertility, and increase wheat grain yield when compared to mono-cropping [2]. 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. Hence, choice of appropriate precursor crop to wheat planting for rotation can affect wheat yield.

In Ethiopia, the high rates of nitrogen (N) applied to bread wheat plots in single season on farm fertilizer trials had repercussions on soil pH levels, severity of wheat foliar disease, and weed incidence and competition [3]. However, there are no reports available on the long-term effects of repeated N and phosphorus (P) fertiliser application at the rates recommended for cereal production. In the peasant farming systems of southeastern Ethiopia, cereals predominate, often occupying over 80% of the total cropped land each season [4]. In the highland zones, bread wheat *(Triticum aestivum)* and barley are the most common cereals in production, while faba bean *(Vicia faba)* and rapeseed *(Brassica carinata)* are common grain legume and oilseed crops, respectively.

The high proportion of wheat and barley in the highland cropping systems satisfies the shortterm subsistence objectives of peasant farmers, but may prove disadvantageous in the long-term due to the absence of the inherent advantages of crop rotational systems. Several of the well-known benefits of crop rotation could be extremely valuable in the peasant farming sector: N fixation by legumes (Hargrove *et al.*,); the interruption of weed [5], disease (Cook, 1984) and insect cycles by dicotyledonous crops; crop diversification [6]; improvement in soil tilth and a concomitant reduction in rainfall runoff and erosion [7]. Several short-term studies in the Ethiopian highlands have examined the beneficial effects of break crops on bread wheat production. In one study, a faba bean break crop increased wheat grain yield by 1100 kg ha^-1, or 69% of the yield of second year continuous wheat [8]; in a second study, faba bean increased wheat yield by 1000 kg ha^-1, or 44% of. the yield of continuous wheat [9]. Verification of wheat based crop rotation was conducted in Aris zone during 2014 and 2015 cropping seasons. The objective was to break down wheat monoculture and thereby enhance productivity and sustainability of wheat-based farming systems.

Materials and Methods

Description of the Study Site

This Experiment was conducted on farmers field at Gedeb Asasa in Arsi zone of Ethiopia during 2014 and 2015. Experimental site is located in an altitude of 2340 meters above sea level (masl). The long term average annual rainfall is 620mm and soil type is Gleysol.

Experimental Treatments, Design and Procedures

The activity was done one site used different precursor crop which was faba bean, Ethiopian mustard and wheat. In second trail, the aforementioned three rotations were arranged with three levels of N fertilizer viz. recommended N, 75 and 50% of the recommended N in split plot design with three replications. Recommended rate of phosphorus fertilizer was applied for all treatments.

Data Collection

Agronomic data on grain yield and yield components grain and biomass yields were collected at the recommended time. Analysis of variance was carried out for each of the measured or computed parameters following the method described by Gomez & Gomez (1984). All yield, yield component data were subjected to analysis of variance using PROC GLM of SAS version 9.0 (SAS Institute, 2008) statistical software.

Results and Discussion

Results indicated that faba bean and rapeseed wheat rotation increased wheat grain yield by 80% and 84 % of continuous wheat cropping, respectively. Rapeseed has been found better in controlling grass weed than faba bean. Demonstration of faba bean in the rotation enabled small-scale wheat farmers to use *Rhizobium* inoculants with appropriate inoculation techniques. Results of faba bean wheat rotation and fertilizer rate study indicated that there was no significant difference between wheat yields obtained from 100% and 75% recommended N fertilizer application. Hence, when faba bean wheat rotation is practiced 25% of the N fertilizer can be saved.

Rotations	N rates	GY (Kg/ha)
Wheat-Wheat	100 % N	4092^{bc}
	75 % N	4173 ^{bc}
	50 % N	4054^{bc}
Rapeseed-wheat	100 % N	4612^{a}
	75 % N	4330^{ab}
	50 % N	3770^{bc}
Faba bean-wheat	100 % N	4093^{bc}
	75 % N	4330^{ab}
	50 % N	3669^{c}

Table 1: Trial of Crop rotation viz N Fertilizer rates.

Conclusion

Rotation with dicotyledonous 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. Ethiopian mustard

precursor also resulted in important grain yield increments in a succeeding wheat crop. The low yields obtained from the continuous cereal rotations at kulumsa indicate the need to encourage the adoption of appropriate crop rotations by peasant in Ethiopia.

In particular, the proportion of legumes should be increased in the currently cereal-dominated cropping systems. Crop rotation provided effects on wheat response to applied N nutrients: rotation with faba bean minimized wheat response to fertilizer N; crop rotation. The use of the N2 fixing leguminous crop faba bean in rotation with wheat in the present experiment clearly demonstrated the importance of legume-cereal rotation systems in sustaining wheat production and reducing the consumption of costly imported inorganic N fertilizer.

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