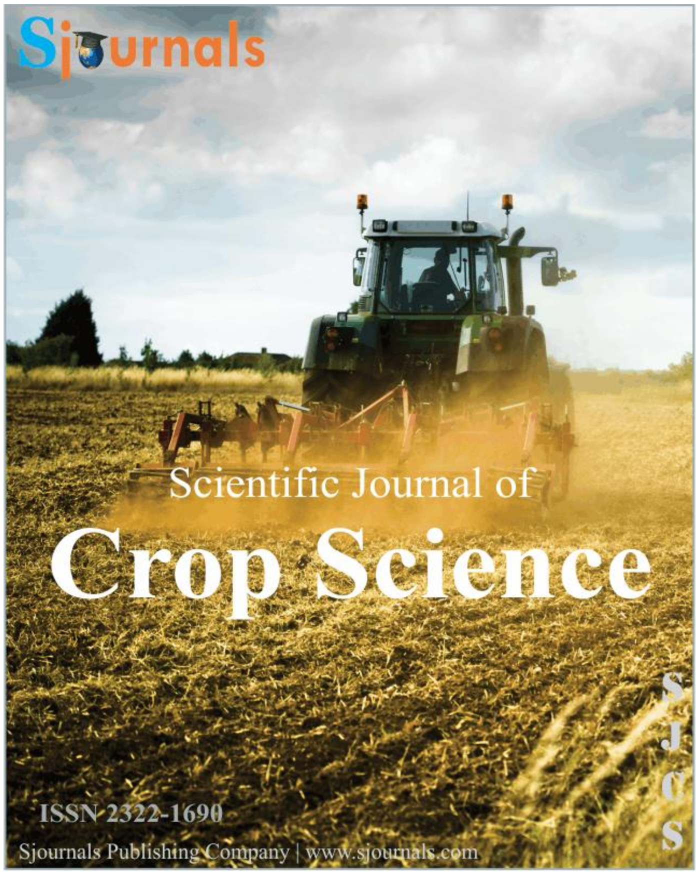
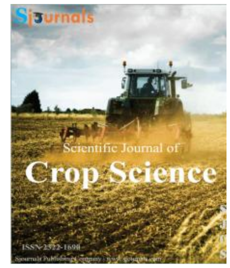

Sjournals
Scientific Journal of
Crop Science
ISSN 2322-1690
Sjournals Publishing Company | www.sjournals.com
SJCS

Sjournals
Scientific Journals
Scientific Journal of Crop Science (2018) 7(1) 280-284
ISSN 2322-1690
doi: 10.14196/sjcs.v7i1.2499

Contents lists available at Sjournals

Scientific Journal of **Crop Science**

Journal homepage: www.Sjournals.com



Original article

On-farm evaluation of the effects of crop rotation system on bread wheat in Bale highlands, south-eastern Ethiopia

Mengistu Bogale* and Girma Fana

Oromia Agricultural Research Institute, Sinana Agricultural Research Center, Bale-Robe, Ethiopia.

*Corresponding author: mbalemu@gmail.com

A R T I C L E I N F O

Article history,
Received 16 December 2017
Accepted 17 January 2018
Available online 24 January 2018
iThenticate screening 18 December 2017
English editing 16 January 2018
Quality control 23 January 2018

Keywords,
Wheat
Crop rotation
Precursor crops
Fertilizer rate

A B S T R A C T

A crop rotation experiment was initiated at Sinana on-farm and Adaba locations in 2001. At both locations, the precursor crops used were food barley (*Hordeum vulgare*), faba bean (*Vicia faba*), field pea (*Pisum sativum*) and lin seed (*Linum usitatissimum*). Fertilizer levels used, were 0-0, 9-23 and 41-46 kg N-P_2O_5 ha^{-1}. The experiment was laid out in randomized complete block design with three replications in factorial arrangement and it was conducted during the period from 2001 to 2010. Combined analysis of the results generated at each location during the period showed that rotation had a significant effect on wheat grain yield and most yield components of wheat both at Sinana and Adaba. At both locations, rotation with faba bean had a marked effect on the grain yield of wheat (4887.40 kg ha^{-1}) and (3624.80 kg ha^{-1}) at Sinana and Adaba, respectively. The next highest grain yield was recorded, wheat rotation with field pea at both locations. The lowest wheat grain yield was recorded, wheat rotation with barley (3945.00 kg ha^{-1}) and (2355.90 kg ha^{-1}) at Sinana and Adaba, respectively. Fertilizer rate had significant effect on most yield and yield components of Wheat at both locations. The highest fertilizer rate (41-46 kg N-P_2O_5 ha^{-1}) recorded the highest grain yield (4689.5 kg ha^{-1}) and (3397.1 kg ha^{-1}) at Sinana and Adaba, respectively. The lowest grain yield was recorded from control plots. In general, from this long-term on-farm rotation trial it is possible to conclude that faba bean and field pea are beneficial break crops in Bale highlands to alleviate wheat production constraints arising due to continuous cereal mono-cropping systems.

1. Introduction

Sustainable agriculture is the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources (TAC, 1988). The maintenance of long-term agricultural productivity depends on a number of biotic and abiotic factors, all of which are dynamic in response to human intervention. Conservation tillage and crop rotation are considered to be the major means of maintaining agricultural productivity globally (Lal, 1989). Crop rotation extremely beneficial in the peasant farming sector for several reasons: N fixation by legumes, the interruption of weed, disease and Insect cycles by dicotyledonous crops, crop diversification, improvement in soil tilt and a concomitant reduction in rainfall runoff and erosion. In the peasant farming system of south-eastern Ethiopia, cereals predominate, often occupying over 80% of the total cropped land (Chilot et al., 1992). The high proportion of wheat and barley in the highland cropping systems satisfies the short term subsistence objectives of peasant farmers, but may prove detrimental in the long-term due to the absence of the inherent advantages of crop rotational system. Most of the studies have also focused on the short-term agronomic benefits from break or precursor crop for wheat production (Hailu et al., 1989).

In Bale highlands, currently, monoculture of wheat or barely is dominant practice. Farmers practice rotation of cereals or application of small amount of fertilizer on low fertile soils. These practices have a significant negative effect on yield from time to time due to deterioration of soil fertility. Even though the farmers are conscious of the problem, they have no access to use proper fertilization. Hence, using leguminous crops as a favorable break crop may be one of the possible solutions for wheat production in the zone. Tanner et al. (1991) found that faba bean, field pea and lin seed in the order are the best beneficial break crops in wheat production. Therefore, a long-term crop rotation experiment was conducted on bread wheat to evaluate the effect of different break crops on the grain yield and yield components of bread wheat; and to determine the most beneficial precursor crop in wheat production.

2. Materials and methods

The experiment was conducted at two locations (Sinana and Adaba on-farm) for 10 years from 2001 to 2010 during main cropping season, to determine the relative importance of different precursor crops in the long-term rotation cycle to bread wheat in Bale highlands (Table 1).

Table 1
Treatments used in the long-term rotation experiment at Sinana and Adaba.

Treatments	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
BF0	B	W	B	W	B	W	B	W	B	W
BF1	B	W	B	W	B	W	B	W	B	W
BF2	B	W	B	W	B	W	B	W	B	W
FBF0	FB	W	FB	W	FB	W	FB	W	FB	W
FBF1	FB	W	FB	W	FB	W	FB	W	FB	W
FBF2	FB	W	FB	W	FB	W	FB	W	FB	W
FPF0	FP	W	FP	W	FP	W	FP	W	FP	W
FPF1	FP	W	FP	W	FP	W	FP	W	FP	W
FPF2	FP	W	FP	W	FP	W	FP	W	FP	W
LSF0	LS	W	LS	W	LS	W	LS	W	LS	W
LSF1	LS	W	LS	W	LS	W	LS	W	LS	W
LSF2	LS	W	LS	W	LS	W	LS	W	LS	W

B=Barley, FB=Faba bean, FP=Field pea, LS=Lin seed, F0=0-0 Kg N-P_2O_5 ha^{-1}, F1=9-23 Kg N-P_2O_5 ha^{-1}, F2=41-46 Kg N-P_2O_5 ha^{-1}

The experiment was laid out as a randomized complete block design (RCBD) in a factorial arrangement and replicated three times per treatment. The treatments were consist of four precursor crops (Barley, Faba bean, Field pea and Lin seed) and three fertilizer levels (0-0, 9-23 and 41-46 kg N-P_2O_5 ha^{-1}). The principal bread wheat variety "Sofumer" was sown at the recommended seeding rate of 150 kg ha^{-1} and fertilizer recommended for the area. Precursor crops were sown according to their recommended seeding rate and fertilizer rate. Tillage for this trial was based on ox-plough. The size of each plot was 5m x 5m ($25m^2$) and the distance between the plots and blocks were kept at 1m and 1.5m apart respectively. All the other recommended management practices were applied to the crop uniformly according to the standard practice in the area.

3. Results and discussion

3.1. Rotation effects on wheat grain yield

The result of the analysis of variance of the rotation experiment conducted at Sinana and Adaba combined over the period 2001 to 2010 are presented in Table 2, 3 and Fig 2, 3.

Table 2
Main effect of precursor crops and N-P fertilizers on grain yield, yield components and other agronomic parameters of bread wheat at Sinana on-farm (2001-2010).

Treatments	SCH/m^2	Plant	Spike	Grain	Bio-mass	Harvest	TKW
Precursor crops	**(no.)**	**height(cm)**	**length(cm)**	**yield(kg/ha)**	**yield(kg)**	**index(%)**	**(gm)**
Barley	442.53	101.87	7.86	3945.00	8175.20	0.48	37.71
Faba bean	478.22	105.10	8.17	4887.40	9923.60	0.49	37.73
Field pea	476.31	105.97	8.15	4613.20	9589.60	0.48	38.51
Lin seed	428.40	102.71	8.13	4245.50	8787.00	0.48	38.77
LSD(5%)	36.32	2.16	0.18	239.37	657.65	ns	0.98
N-P Fertilizer levels ($N-P_2O_5$ kg/ha)							
0-0	440.63	98.40	7.79	3929.30	7827.90	0.50	38.78
9-23	455.67	105.15	8.12	4424.60	9313.60	0.47	38.30
41-46	472.80	108.18	8.34	4689.50	10215.10	0.45	37.46
LSD(5%)	31.45	1.87	0.16	207.30	569.54	0.01	0.85
CV%	19.12	4.98	5.40	17.18	17.32	18.86	6.16

SCH=Stand count at harvest; LSD(5%)=Least significant difference; CV(%)=Coefficient of variation.

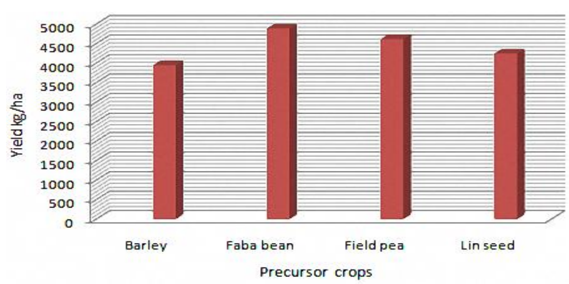


Fig. 1. Effects of precursor crops on grain yield of bread wheat (Sinana on-farm).

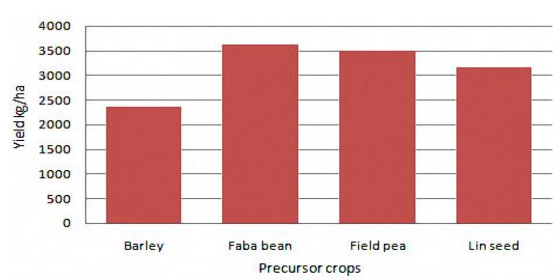


Fig. 2. Effects of precursor crops on grain yield of bread wheat (Adaba).

The result revealed that rotation had significant effects on wheat grain yield and majority of yield components at both locations. Dicot precursor crops resulted in higher grain yield of subsequent wheat crop relative to the continuous cereal cropping system. At both locations, faba bean had the most dramatic effect on the grain yield of a succeeding wheat crop. The next highest yield was recorded from plots treated with field pea precursor crop and the lowest was from barley precursor crop (Table 2 and 3). The superior performance of faba bean and field pea precursor treatments suggests that the growth and the development of succeeding wheat crop is probably benefiting from atmospheric N_2 fixed by faba bean and field pea and available soil mineral N spared by the legume. The benefit of pulses in this finding agrees with the findings of Tanner et al. (1991 and 1998) and Mooleki and Siwale (1998). The analysis also revealed that fertilizer rate had a significant effect on wheat grain yield. Application of 41-46 kg N-P_2O_5 ha^{-1} gave yield advantage of 16% and 5% over 0-0 and 9-23 N-P_2O_5 ha^{-1} at Sinana and 13% and 7% over 0-0 and 9-23 N-P_2O_5 ha^{-1} at Adaba, respectively.

Table 3
Main effects of precursor crops and N-P fertilizers on grain yield, yield components and other agronomic parameters of bread wheat at Adaba on-farm (2001-2010).

Treatments Precursor crops	SCH/m^2 (no.)	Plant height(cm)	Spike length(cm)	Grain yield(kg/ha)	Bio-mass yield(kg)	Harvest index(%)	TKW (gm)
Barley	267.56	84.21	6.89	2355.90	4024.00	0.59	32.86
Faba bean	350.36	88.91	7.32	3624.80	7197.00	0.50	33.64
Field pea	341.47	88.69	7.32	3498.00	7265.40	0.48	33.92
Lin seed	341.78	87.42	7.36	3165.50	6291.70	0.50	32.98
LSD(5%)	33.73	3.10	0.26	261.27	700.12	0.02	0.80
N-P Fertilizer levels (N-P_2O_5 kg/ha)							
0-0	295.47	82.77	6.95	2948.00	5519.50	0.53	33.26
9-23	327.10	87.73	7.22	3138.10	6161.00	0.51	33.23
41-46	353.30	91.42	7.43	3397.1	6903.8	0.49	33.57
LSD(5%)	29.21	2.69	0.22	226.27	606.33	ns	ns
CV%	14.90	8.54	8.59	19.04	17.15	14.76	15.75

SCH=Stand count at harvest; LSD(5%)=Least significant difference; CV(%)=Coefficient of variation.

3.2. Rotation effect on wheat yield components

The results of the analysis of variance for rotation effect on wheat yield components are presented in Table 2 and 3. Except harvest index at Sinana and harvest index and thousand kernel weights at Adaba all agronomic parameters measured were significantly influenced by rotation systems at both locations. The maximum number of stand count m^{-2} recorded from plots treated with faba bean precursor crops at both locations, indicating that seedlings and tillers developing during the early vegetative stage were more vigorous in wheat following faba bean, presumably because of a surplus supply from different sources (i.e fertilizer, fixed N, soil N). Wheat plant height also significantly increased in faba bean rotation at both locations. The continuous cereal rotation resulted in relatively shorter wheat plants, reflecting the positive contribution of faba bean as an N source for the enhanced growth of the wheat crop.

4. Conclusion

The long-term data set generated by this experiment revealed that wheat following faba bean precursor crop rotation resulted in superior grain yield in both environments. A field pea precursor also resulted in significant grain yield increments in a succeeding wheat crop. The low yield was recorded from barley precursor crop. The low yield obtained from the continuous cereal rotation at both locations indicates the need to encourage the adoption of appropriate crop rotation by peasant farmers in Bale highlands. In particular, the proportions of legumes should be increased in the currently cereal-dominated cropping systems of Bale highlands. The use of the N_2 fixing leguminous crop faba bean and field pea 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 the inorganic N fertilizer. Therefore, from this long-term on-farm rotation trial it is possible to conclude that faba bean and field pea are beneficial break crops in Bale highlands to alleviate wheat production constraints arising due to continuous cereal mono-cropping systems.

Acknowledgements

The authors are grateful to all staff of the Sinana Agricultural Research Centre, especially those in the Agronomy and Crop physiology division for valuable contributions in data collection. Oromia Agricultural Research Institute is acknowledged for financing the experiment.

References

Chilot, Y., Hayilu, B., Lemma, Z., Tanner, D.G., 992. Farming systems of the Kulumsa area. In: Research with farmers-lessons from Ethiopia, Franzel, S., van Houten, H. (eds.). CAB International, Wallingford, U.K. 145-157.

Hailu, G., Amsal, T., Endale, A., 1989. Beneficial break crops for wheat production. Ethiop. J. Agr. Sci., 11, 15-24.

Lal, R., 1989. Conservation tillage for sustainable agriculture: Tropics versus temperate environments. Adv. Agron., 42, 85-197.

Mooleki, P., Siwale, J., 1998. The impact of crop rotation on the grain yield of rainfed wheat in northern Zambia. In: The tenth regional wheat workshop for eastern, central and southern Africa. CIMMYT, Addis Ababa, Ethiopia. 350-356.

Tanner, D.G., Amanuel, G., Kasahun, Z., 1991. Wheat agronomy research in Ethiopia. In: Wheat research in Ethiopia: Historical perspective, Hailu, G., Mariam, D.G., Tannar, Mengistu, H. (eds.). IAR/CIMMYT, Addis Ababa, Ethiopia. 101pp.

Tanner, D.G., Verkujil, H., Asefa, T., Regassa, E., 1998. An agronomic and economic analysis of a long-term wheat based crop rotation trail in Ethiopia. In: The tenth regional wheat workshop for eastern, central and southern Africa. CIMMYT, Addis Ababa, Ethiopia. 213-248.

TCA, 1988. Sustainable agricultural production: Implications for international agricultural research. FAO, TCA, Secretariat, Rome. 45pp.

How to cite this article: Bogale, M., Fana, G., 2018. On-farm evaluation of the effects of crop rotation system on bread wheat in Bale highlands, south-eastern Ethiopia. Scientific Journal of Crop Science, 7(1), 280-284.