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Full Length Research Paper

Determination of optimum seed and fertilizer rate for fodder oat in Bale Highland Southeastern Ethiopia

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The experiment was conducted from 2011 to 2012 for two years at Sinana on-station and on farms (Selka and Agarfa) with the objective to determine optimum seed rate and fertilizer level for herbage and grain production. The trial was carried out in factorial RCBD with three replications. Seed rates of 60, 70, 80 and 90 kg/ha were used as main plot treatments where as fertilizer rates of 0, 25kg UREA and 50 kg DAP, 50kg UREA and 100 kg DAP and 75kg UREA and 150 kg DAP were used as sub plot treatments. DM yield, seed yield, plant height and standing percentage and leaf to stem ration were significantly (P<0.05) varied among different seed rate and fertilizer rate combination. The DM yield of fodder oat increased with increasing level of fertilizer. The highest value (15.0 t/ha) was obtained at seed rate of 80kg/ha and at the higher fertilizer level. This could be due to the more competitiveness of oats with weeds at the higher seeding rate. Moreover, these fertilizers promote vigorous plant growth and a larger leaf area that contribute to the dry matter yield of the fodder oat. At the higher levels of fertilizer application, the DM contents did not increase significantly. It indicated that there is no significant difference in DM yield of fertilizer application of 50kg UREA and 100 kg DAP and the highest level which is 75kg UREA and 150 kg DAP. However, seeding rate and application of fertilizers above optimum level often produce no additional yield increase. Moreover, higher fertilizer rates could result in higher lodging of oats. Hence, there is no need to go for higher seed rate and fertilizer level. The highest seed yield (44.8Q/ha) was obtained at seed rate of 70kg/ha and fertilizer rate of 50kg UREA and 100 kg DAP, while the lowest seed yield 36.8Q/ha was obtained at seed rate of 80kg/ha without fertilizer. A modest increase in seed yield occurred with an increased seeding rate up to 70kg/ha with fertilizer level of 50kg UREA and 100 kg DAP. The increasing seeding rates above 70kg/ha are more likely to reduce size and quality of seed. The highest plant height (134.2cm) was recorded at the higher fertilizer level with seed rate of 80 and 90 kg/ha respectively. The lowest plant height (124.3 cm) was recorded at seed rate (80kg/ha) without fertilizer application. This study also indicated that application of fertilizer showed significantly (P<0.05) higher plant height than group having no fertilizer. Generally, the study indicated that seeding rates and fertilizer application at different level have an impact on yield and agronomic parameters of fodder oat. So it is found to be very important to have the optimum seed rate and fertilizer level for producing reasonable DM and seed yield of fodder oats. Hence, the optimum seed rate and fertilizer level to get reasonable DM yield will be at seed rate of 80 kg/ha and at fertilizer level of 50kg UREA and 100 kg DAP. While if the target is for forage seed production, seed rate of 70kg/ha with fertilizer rate of 50kg UREA and 100 kg DAP is very optimum to farmers in order to obtain reasonable yield.

Keywords: Fodder oats, Avena sativa, Bale highland

INTRODUCTION

The use of cultivated forage crops has received considerable attention for complementing the conventional feed resources especially in areas where high producing crossbred dairy cows are owned in the Ethiopian highlands (Daniel, 1990). The very nature of the integrated crop-livestock production systems in the Ethiopian highlands requires multipurpose forage species suitable for feed and food or feed and natural resource conservation thereby to address the multi-faceted problems of the farming community. Due to its

short life cycle, suitability in crop rotations and better performance on marginal lands, oats is the most important species for integration into the existing farming system. Oats appears to be the main forage crop grown at very high altitudes (up to 3000 m) or on heavy soils (vertisols) where temperate grasses such as ryegrass, cocksfoot or tall fescue are difficult to establish (Lulseged, 1981). The species owes its reputation to its versatility as it can be grown for grain, hay, silage or direct grazing and is being used as feed for dairy cattle, young stock, sheep and hogs (Kipps, 1970; Boonman, 1993). Moreover, it has superior recovery after grazing and is highly useful for overcoming critical periods of feed shortage or for finishing animals for market when permanent pastures are of poor quality (Lovett and Scott, 1997).

As other any food crop, seed rate has to be determined and recommended for forage crops including oat varieties. Seeding rate had been previously recommended for oat varieties in Ethiopian highlands (Astatke Haile, 1979). Seeding rate can be influenced by the type and fertility of the soil, climate, establishment methods (condition of seed bed and seeding method) and the like. Using higher and lower seed rate could have a negative impact on herbage and seed yield of forage crops.

On the other hand fertilizer use is one of the important factors, which contribute to the yield of any crop. Most soils very in nutrients require by the plants such as nitrogen and phosphorous fertilizers. These conditions vary greatly across the agro-ecological areas. The response of fertilizer is very high in soil with very poor soil and as the level of available soil nutrient increased the need for fertilizer decreases. On the other hand as stored soil moisture increases or growing season precipitation increases, the need for additional fertilizer increases. Fertilizer is not only contributes towards yield and growth of forage but also quality. Higher fodder yield with fertilizer application is due to their favorable effects on plant water relations, light absorption, crop density, plant height, leaf area and nutrient utilizations. The applications of fertilizer improve the dry matter, seed yield and quality of forage. However, the optimum rate of fertilizer application is required to improve yields of the crops. Hence, there is a need to determine an appropriate level of fertilizer application especially in soils deficient in the major macronutrients, nitrogen and phosphorus. Therefore, this study was aimed to determine optimum seed and fertilizer rate for fodder oat varieties in Bale highlands.

MATERIALS AND METHODS

Experimental sites

The experiment was carried out from 20011 to 2012 at three locations *via,* Sinana Agricultural Research Center (SARC), Sinana on-farm (Selka) and Agarfa of Bale highlands. Sinana Agricultural Research Center is found at an altitude of 2400 m.a.s.l. The mean annual rainfall is 563-1018 mm with minimum and maximum temperature of 7.9 and 24.3°C, respectively. The other experimental sites Selka and Agarfa were with an altitude of 2400 – 2600 m.a.s.l, respectively. The farming systems of the area are classified as a mixed cereal-livestock production system. The soil types of the study area are mainly clay in texture (dark brown Vertisols) with slightly acidic reaction (SARC, 2008). There are two distinct seasons '*Ganna*' (extending from March to July) and '*Bona*' (extending from July to December) which are allows double cropping. Bimodal rainfall condition is a common phenomenon, especially in the study sites.

Experimental arrangement

Oat variety (*Bonsa*) which was recently released from Sinana Agricultura Research Center was used for the trial. The trial was carried in factorial RCBD with three replications with seed rates of 60, 70, 80 and 90 kg/ha as main plot treatments and fertilizer rates of 0, 23, 46 and 69 kg/ha of N and P_2O_5 as sub plot treatments. Sowing was made by drilling the seeds in rows on 1.8 m x 2 m plots spaced 0.5 m apart. All the plots were hand weeded once a month after sowing and thereafter as required based on occurrence of weeds.

Data collection

The variety was closely examined beginning from the early vegetative growth and a reliable record such as disease occurrence, stand percentage, plant height, forage biomass yield, leaf to stem ratio and seed yield was taken.

Statistical analysis

Analysis of variance was performed using the statistical analysis system (SAS) software (SAS, 2001) in order to determine the agronomic difference between different level of seed and fertilizer rate and mean separation was carried out using Least Significant different (LSD) test.

RESULTS AND DISCUSSION

The combined statistical analysis showed that differences in seed and fertilizer level had significant ($P<0.05$) effect on considered agronomic and yield parameters. DM yield, seed yield, plant height and standing percentage and leave to stem ration were significantly ($P<0.05$) varied among different seed rate and fertilizer rate combination.

Table 1: Mean agronomic and yield performance of fodder oat under different seed and fertilizer rate combined over locations from 2011 to 2012

Treatments		PH (cm)	SP (%)	leaf to stem ratio	DM (t/ha)	SY (Q/ha)
Seed rate (kg/ha)	**Fertilizer rate (kg/ha)**					
	0	125.55^{cd}	81.94^{bc}	0.43^{b}	11.4^{b}	38.8^{ab}
60	25kg UREA and 50 kg DAP	125.94^{bc}	81.50^{bc}	0.5^{ab}	12.5^{ab}	39.9^{ab}
	50kg UREA and 100 kg DAP	128.78^{ab}	80.22^{cd}	0.53^{ab}	12.7^{ab}	41.3^{ab}
	75kg UREA and 150 kg DAP	134.05^{a}	83.39^{ab}	0.56^{ab}	12.7^{ab}	44.2^{a}
	0	129.50^{ab}	82.5^{bcd}	0.50^{ab}	12.3^{ab}	38.0^{ab}
70	25kg UREA and 50 kg DAP	128.67^{ab}	81.94^{bc}	0.53^{ab}	12.7^{ab}	39.9^{ab}
	50kg UREA and 100 kg DAP	129.55^{ab}	83.55^{ab}	0.61^{ab}	13.9^{ab}	44.8^{a}
	75kg UREA and 150 kg DAP	130.22^{ab}	84.39^{ab}	0.65^{a}	13.5^{ab}	44.3^{a}
	0	124.33^{d}	79.33^{d}	0.60^{ab}	12.7^{ab}	36.8^{b}
80	25kg UREA and 50 kg DAP	131.05^{ab}	83.72^{ab}	0.53^{ab}	12.9^{ab}	40.1^{ab}
	50kg UREA and 100 kg DAP	134.00^{a}	84.67^{ab}	0.6^{ab}	14.8^{a}	43.7^{ab}
	75kg UREA and 150 kg DAP	132.78^{ab}	87.50^{a}	0.63^{a}	15.0^{a}	44.1^{a}
	0	126.17^{bc}	83.28^{ab}	0.5^{ab}	12.3^{ab}	38.5^{ab}
90	25kg UREA and 50 kg DAP	128.44^{ab}	84.55^{ab}	0.53^{ab}	13.7^{ab}	43.5^{ab}
	50kg UREA and 100 kg DAP	131.72^{ab}	85.72^{ab}	0.5^{ab}	13.7^{ab}	43.5^{ab}
	75kg UREA and 150 kg DAP	134.22^{a}	86.22^{a}	0.66^{a}	14.8^{a}	43.9^{a}
Mean		129.62	83.34	0.55	13.1	41.7
CV		8.25	8.53	18.2	21.17	25.6
Lsd		7.03	4.68	0.16	1.82	6.66

PH=Plant Height, **SP**= Stand Percentage, **DM**= Dry Matter, **SY**= Seed Yield, **CV**= Coefficient of Variation, **LSD**=Least Significance Difference. Figures with the same letters in columns are not significantly different (P>0.05).

The DM yield of fodder oat increased with increasing level of fertilizer. The highest value (15.0 t/ha) was obtained at seed rate of 80kg/ha and at the higher fertilizer level. This could be due to the more competitiveness of oats with weeds at the higher seeding rate. Moreover, these fertilizers promote vigorous plant growth and a larger leaf area that contribute to the dry matter yield of the fodder oat. Similarly, the increasing trend of green forage yield in response to increasing level of N fertilization was also observed by many other workers (Sultana *et al.,* 2005; Khan *et al.,* 1996). However, the DM yield is not significantly differ at seed rate of 80 and 90 kg/ha. At the higher levels of fertilizer application, the DM contents did not increase significantly. It indicated that there is no significant difference in DM yield of fertilizer application of 50kg UREA and 100 kg DAP and the highest level which is 75kg UREA and 150 kg DAP. However, seeding rate and application of fertilizer above optimum level often produce no additional yield. Moreover, higher fertilizer rates result in higher lodging. Hence, there is no need to go for higher seed rate and fertilizer level.

The highest seed yield (44.8Q/ha) was obtained at seed rate of 70kg/ha and fertilizer rate of 50kg UREA and 100 kg DAP, while the lowest seed yield 36.8Q/ha was obtained at seed rate of 80kg/ha without fertilizer. A modest increase in seed yield occurred with an increased seeding rate up to 70kg/ha with fertilizer level of 50kg UREA and 100 kg DAP. The increasing seeding rates above 70kg/ha are more likely to reduce size and quality of seed. The highest plant height (134.2cm) was recorded at the higher fertilizer level with seed rate of 80 and 90 kg/ha respectively. The lowest plant height (124.3 cm) was recorded at seed rate (80kg/ha) without fertilizer application. Similar studies also indicated that plant height increased with increasing seeding rate indicating competition for light (Reddy and Reddi, 1992). The better plant height might have contributed for better forage yield of fodder oats. A crop provided enough of plant nutrients to meet out its requirements is expected to perform better than crop provided less than its requirements. This study also indicated that application of fertilizer showed significantly (P<0.05) higher plant height than group having no fertilizer. Similarly, there were significant differences with regards to standing percentages and leaf to stem ratio among evaluated

seed and fertilizer rates. The maximum number of leaf to stem ratio (0.65) was recorded for seed rate of 70 kg/ha and the maximum fertilizer rate application. Even though there are no very large differences among the different treatments, leaf to stem ratio was increased for treatments received fertilizer as compared to treatments without fertilizer. This indicate that fertilizer contribute for the increment of leaf area of fodder oats. On the other hands, there is no significant differences in leaf to stem ratio among the different seeding rate treatment that received fertilizer. While, the least leaf to stem ratio was recorded for the treatment with lower seed rate and without fertilizer application (Table 1).

CONCLUSION

It is recognized that the level of fertilizer required depends on the status of soil fertility, mineralization up potential of the soil, stored soil moisture, previous cropping and manuring history of soil. Hence, the need for fertilizing soil is very high in a continuous cereal cropping like Bale highlands. As observed from the result seeding rates and addition of fertilizer at different levels have great impact on the yield and agronomic parameters of fodder oats. However, seeding rate and application of fertilizer above optimum level often produce no additional yield. Therefore, it is important to have the optimum seed rate and fertilizer level for producing reasonable DM and seed yield of fodder oats. Hence, the optimum seed rate and fertilizer level to get reasonable DM yield will be at seed rate of 80 kg/ha and at fertilizer level of 50kg UREA and 100 kg DAP. While if the target is for forage seed production, seed rate of 70kg/ha with fertilizer rate of 50kg UREA and 100 kg DAP is very optimum to farmers in order to obtain maximum forage production.

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