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Yield and Economics of Maize as Influenced by Cropping Sequences, Rates and Frequency of FYM Application

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ABSTRACT

A field experiment was conducted at agronomy farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar. The experiment comprising of three factors viz., cropping sequences (S_1 =maize-lentil, S_2 =maize-oats, S_3 =maize-brown sarson and S_4 =maize- fallow), three FYM rates (R_1 =10 t ha^{-1}, R_2 =20 t ha^{-1} and R_3 =30 t ha^{-1}) and three FYM frequencies (F_1 =FYM application in kharif and rabi season),(F_2=FYM application in Kharif season only) and (F3=FYM application in rabi season only) was laid out in a split plot design (cropping sequences in main plot and FYM rates and frequencies in sub plot) replicated thrice. Highest maize equivalent yield was recorded in maize-oats sequence with application of 30 t FYM ha^{-1} during kharif and rabi. Highest net returns and benefit cost ratio were realized when maize was followed by oats supplied with 10 t FYM ha^{-1} during kharif and rabi.

Key words: *Maize, Cropping sequence, FYM, Maize equivalent yield, Economics.*

INTRODUCTION

Maize is one of the most important cereal crops grown all over the globe and has relatively higher production potential, wider adaptability and multifarious uses. It is a rich source of carbohydrates and has also higher percentage of proteins than other cereals. Maize yields are stagnant in recent years and this situation cannot coup to solve the food problems of ever increasing population. It is necessary to continuously increase the production to meet the demands of people which can be achieved by supplying plant nutrients in adequate amount and in developing countries these nutrients can be supplied through organic manures and by inclusion of a legume in the cropping system. In Jammu & Kashmir, maize is followed by *rabi* crops such as oats, brown sarson, pulses, berseem etc., Lentil in the maize based cropping system can maintain soil fertility and sustain crop productivity, but keeping in view the need for providing nutritious fodder for increased livestock population and also the need for edible oil for domestic consumption, maize-oats and maize-brown sarson cropping system have gained much popularity amongst the farming community.

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Such a scenario demands addition of plant nutrients to soil in excess than their removal by the cropping system for maintaining the soil health. The alternative can be met through the use of organic fertilizer; there is also a need for identifying the time of FYM application. Hence the present study entitled "Yield and economics of maize as influenced by cropping sequences, rates and frequency of FYM application was undertaken.

MATERIAL AND METHODS

The experiment was carried out at Agronomy farm of Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar, Srinagar during *Kharif* and *rabi* seasons of 2008-2009 and 2009-2010 on silty clay loam soil. The available N, P and K in soil were 272.61, 14.83 and 59.00 kg ha^{-1}, respectively with pH of 6.74. The experiment was laid out in spilt plot design with three replications, comprising of 3 factors Viz., four cropping sequences (S_1 =maize-lentil, S_2 =maize-oats, S_3 =maize-brown sarson and S_4 =maize-fallow), three FYM rates (R_1 =10 t ha^{-1}, R_2 =20 t ha^{-1} and R_3 =30 t ha^{-1}) and three frequencies (F_1 =FYM application in *Kharif* and *rabi*, F_2 =FYM application in *Kharif* and F_3 =FYM application in *rabi*). Maize was sown on 15th of May and 23rd of May during 2008-2009 and 2009-2010, respectively while lentil, oats, brown sarson were sown on 27th of April during both the seasons. Well decomposed FYM was applied as per the treatments for maize and half dose of nitrogen (45 Kg N ha^{-1}) and full doses of phosphorus (60 kg P_2O_5 ha^{-1}), potassium (40 kg K_2O ha^{-1})and Zinc (20 Kg Zn ha^{-1}) was applied uniformly to each plot through urea, diammonium phosphate, muriate of potash and Zinc sulphate, respectively, in lentil whole recommended dose of nitrogen (40 kg ha^{-1}), phosphorus (60 kg ha^{-1}) and potassium (20 kg ha^{-1}) was band placed just before sowing. In fodder oats, half dose of nitrogen (75 kg ha^{-1}) and full dose of phosphorus (60 kg ha^{-1}) and potassium (20 kg ha^{-1}) was applied as basal and the remaining half dose of nitrogen was top dressed in two equal splits, one each at knee high stage and 20 days before flowering. In case of brown sarson, half dose of nitrogen and full dose of phosphorus and potassium was applied as basal and remaining half dose of nitrogen in two equal spilt one each at flowering and pod initiation stage.

RESULT AND DISCUSSION

Effect of cropping sequences

Yield attributes and Yield

The study reveals that the yield contributing characters viz., number of cobs $plant^{-1}$, cob length and grains per row were significantly higher with S_1 as compared to other sequences except S_4, during 2009-10, whereas during 2008-09 there was no effect of cropping sequences on the yield contributing characters (Table 1). The nutrient rich soil under lentil crop and the fallow during *rabi* 2008-09 might have provided nutrients to the maize resulting in the improvement of yield contributing characters. However during 2007 the experiment field was under oats crop and all the experimental plots of maize experienced similar soil fertility that resulted in non-significant effects of cropping sequences. Earlier[1] have also reported significant increase in yield contributing characters of maize in maize based cropping system.

The cropping sequence S_1 and S_4 recorded significant increase in maize grain and stover yield over S_2 and S_3 during 2009-10, where during 2008-09 the cropping sequences were no significant (Table 2). Higher yield of maize realized under S_1 and S_4 is the reflection of the effects of S_1 and S_4 on the cobs $plants^{-1}$, cob length and grain row^{-1} (Table 1).The non significant influence of cropping sequence on the yield during 2008-09 could be attributed to the facts that the experimental plot was under oats crop during *rabi* 2007 and all the plots of maize received similar fertility during *Kharif* 2008. S_1 marked yield superiority of 5.4 & 6.9 percent over S_2 & S_3 while S_4 marked superiority of 4.8 and 6.3 percent over S_2 and S_3, respectively, during 2009-10. Higher yield of maize under maize-wheat sequence followed by maize-toria–gobhi sarson cropping sequence has also been reported by [2]. The Stover yield also followed similar trend as that of grain yield.

Maize equivalent yield

The study revealed that the maize equivalent yield during 2008-09 and 2009-10 was significantly higher with S_2 compared to all other cropping sequences. The pooled yield also followed the similar trend (Table 2). For the pooled yield, S_2 recorded a yield superiority of 13.5, 10.4 and 68.5 percent over S_1, S_3 and S_4 cropping sequences. This may be attributed to the significantly higher maize-equivalent yield of oats than other *rabi* crops. [3] recorded significantly higher maize equivalent yield in maize- Indian mustard -green fodder cropping sequences whereas, [2] reported significantly higher maize equivalent yield in maize-wheat sequence.

Effects of FYM

Yield attributes and yield

The data (table 1) inferred that number of cobs per plant and cob length showed significant and consistent increase with increase in FYM rate up to 30 t ha^{-1}, whereas, grain rows cob^{-1} ,grains row^{-1} and 100 grain weight recorded significant increase up to 20 t ha^{-1} during both years of 2008-2009 and 2009-2010. FYM releases all macro and micro nutrients essential for plant growth as well as encourages microbial population and improves physical condition of soil there by effects yield contributing characters. The results are in accordance with the findings of [4,5]. F_1 and F_2 recorded significant increase in all the yield contributing characters over F_3 during 2008-09, whereas F_3 and F_1 recoded higher yield contributing characters during 2009-10 (Table 1). The availability of macro and micronutrients to *kharif* maize through FYM may have contributed to beneficial effects on the yield contributing characters during 2008-09, whereas during 2009-10, significantly higher yield contributing characters recorded with F_3 and F_1 than F_2 could be attributed to the residual effects of FYM applied to the *rabi* crops.

Data (Table 2) inferred that there was a significant increase in the grain yield of maize with increase in FYM rate upto 20 t ha^{-1} during both the years. 30 t FYM did not cause any significant increase over 20 t FYM ha^{-1}. The superiority of grain yield recorded with 20 t FYM ha^{-1} was to the tune of 12.3 and 10.7 percent over 10 t FYM ha^{-1} during 2008-09 and 2009-10, respectively. Higher grain yield obtained at higher FYM rate was mainly due to positive effect of FYM on yield contributing characters. Earlier [6,7,8] have also reported significant increase in grain yield of maize with increase in FYM rate upto 20 t ha^{-1}. It can also be inferred from the Table 2 that during 2008-09, F_1 and F_2 recorded significantly higher grain yield of maize over F_3, whereas during 2009-10, F_3 and F_1 recorded significantly higher grain yield over F_2, Infact the applied FYM released the nutrients in adequate amount in the fallowing season and very less quantity in the season in which it is applied. Due to lower temperatures in winter, the mineralization of FYM is very less but in the following *kharif* season, the mineralization is very fast due to higher temperatures and as such during 2009-10, F_3 and F_1 recorded significantly higher grain yield than F_2.

The stover yield showed a significant improvement with increase in FYM application up to 30 t ha^{-1} (Table-2). This could be attributed to the significant improvement in the plant height and dry matter accumulation of maize. Earlier [8,9,10,11] also reported significant increase in stover yield with application of FYM up to 30 t ha^{-1}. Further significant increase in the stover yield recorded with F_1 and F_2 over F_3 (Table 2) during 2008-09 and F_3 and F_1 over F_2 during 2009-10 could be the reflection of the effect of these treatments on the plant height and dry matter production of the crop.

ECONOMICS

The efficiency of a treatment is finally decided in terms of the economics (benefit:cost ratio) of that treatment. The present investigation revealed (Table 3) that during the two years of cropping system, benefit:cost ratio remained highest (1.76) with treatment combination $S_2R_1F_1$ which was closely followed by $S_2R_2F_3$ (1.74). The gross returns were highest with

$S_2R_2F_3$, whereas net returns were highest with $S_2R_1F_1$, indicating there by that both net returns and benefit cost ratio in maize based cropping system was realized with maize-oats supplied with 10 t FYM ha^{-1} during *kharif* and *rabi* season.

Table 1: Yield contributing characters of maize as influenced by cropping sequences, rates and frequencies of FYM

Treatments	Cobs plant^{-1}		Cob length (cm)		Grain rows cob^{-1}		Grains row^{-1}		100 Grain wt. (g)	
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Cropping sequences										
Maize-Lentil (S_1)	1.09	1.17	17.86	18.65	12.36	12.86	23.50	24.77	20.73	20.83
Maize-Oats (S_2)	1.11	1.12	17.34	17.22	12.38	12.68	23.45	23.75	20.61	20.62
Maize-B.Sarson (S_3)	1.11	1.12	17.70	17.18	12.19	12.70	23.42	23.77	20.64	20.64
Maize-Fallow (S_4)	1.10	1.15	17.78	18.15	12.35	12.85	23.32	24.66	20.67	20.68
SEm±	0.017	0.011	0.193	0.173	0.329	0.42	0.410	0.233	0.268	0.216
CD (p=0.05)	NS	0.04	NS	0.60	NS	NS	NS	0.81	NS	NS
FYM rates (tha^{-1})										
10 (R_1)	1.06	1.09	15.95	16.10	11.46	11.61	22.70	23.65	19.96	20.38
20 (R_2)	1.13	1.15	18.05	18.13	12.48	13.34	23.75	24.48	21.09	21.00
30 (R_3)	1.16	1.16	19.01	19.17	13.01	13.36	23.84	24.55	21.25	21.04
SEm±	0.011	0.007	0.099	0.074	0.208	0.265	0.053	0.044	0.166	0.191
CD (p=0.05)	0.03	0.02	0.28	0.21	0.89	0.75	0.15	0.14	0.47	0.54
FYM frequencies										
FYM in Kharif &Rabi (F_1)	1.10	1.17	18.85	18.17	12.77	13.39	23.65	24.43	20.91	20.42
FYM in Kharif (F_2)	1.10	1.16	18.10	16.94	12.70	11.48	23.49	23.65	20.87	20.21
FYM in Rabi (F_3)	1.09	1.18	16.66	18.29	11.49	13.36	23.18	24.59	20.31	20.98
SEm±	0.011	0.007	0.099	0.074	0.208	0.265	0.053	0.049	0.166	0.191
CD (P=0.05)	NS	0.02	0.28	0.21	0.89	0.75	0.15	0.14	0.47	0.54

Table 2: Grain and Stover yield (q ha^{-1}) and yield equivalent of maize (q ha^{-1}) as influenced by cropping sequences rates and frequencies of FYM

Treatments	Grain yield (qha^{-1})		Stover yield (qha^{-1})		Yield equivalent		Pooled
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	
Cropping sequences							
Maize-Lentil (S_1)	48.66	52.76	63.21	68.28	93.21	97.85	95.53
Maize-Oats (S_2)	48.50	50.05	62.50	64.89	107.78	109.11	108.44
Maize-B.Sarson (S_3)	48.35	49.35	62.56	63.90	96.39	100.03	98.21
Maize-Fallow (S_4)	48.38	52.48	62.60	67.93	62.26	66.48	64.37
SEm±	0.733	0.604	0.672	0.857	2.27	2.26	2.26
CD (p=0.05)	NS	2.37	NS	2.97	7.86	7.83	7.84
FYM rates (tha^{-1})							
10 (R_1)	46.81	49.15	59.97	63.07	85.52	88.75	87.12
20 (R_2)	49.31	52.10	62.06	65.24	91.16	94.77	92.96
30 (R_3)	49.31	52.19	66.11	70.02	93.04	96.61	94.82
SEm±	0.40	0.47	0.926	0.976	0.75	0.89	0.82
CD (p=0.05)	1.13	1.32	2.62	2.76	2.13	2.52	2.32
FYM frequencies							
FYM in Kharif &Rabi (F_1)	49.17	52.28	64.13	67.58	93.03	95.86	94.45
FYM in Kharif (F_2)	49.39	49.39	63.91	64.08	93.87	90.36	92.11
FYM in Rabi (F_3)	46.86	51.81	60.11	67.07	82.82	93.89	88.35
SEm±	0.40	0.47	0.926	0.976	0.75	0.89	0.82
CD (p=0.05)	1.13	1.32	2.62	2.76	2.13	2.52	2.32

Table 3: Relative economics (pooled) of maize based cropping system as influenced by cropping sequences, rates and frequencies of FYM

Treatment combination	Gross returns (Rs./ha)	Cost of cultivation (Rs./ha)	Net returns (Rs./ha)	Benefit: cost ratio
S1R1F1	85500.00	33889.20	51610.80	1.52
S1R1F2	84798.00	33889.20	60809.80	1.50
S1R1F3	83673.00	33889.20	49783.80	1.47
S1R2F1	87255.00	33889.20	48365.80	1.24
S1R2F2	86553.00	33889.20	47663.80	1.22
S1R2F3	85428.00	33889.20	46538.80	1.20
S1R3F1	87516.00	43889.20	43626.80	0.99
S1R3F2	87111.00	43889.20	43221.80	0.98
S1R3F3	85986.00	43889.20	42096.80	0.96
S2R1F1	97092.00	35209.40	61882.60	1.76
S2R1F2	96390.00	35209.40	61180.60	1.74
S2R1F3	95256.00	35209.40	60046.60	1.70
S2R2F1	98838.00	40209.40	58628.60	1.46
S2R2F2	98136.00	40209.40	57926.60	1.44
S2R2F3	97011.00	40209.40	56801.60	1.41
S2R3F1	99396.00	45209.40	54186.60	1.20
S2R3F2	98694.00	45209.40	53484.60	1.18
S2R3F3	97569.00	45209.40	52359.60	1.16
S3R1F1	87885.00	32849.60	55035.40	1.67
S3R1F2	87183.00	32849.60	54333.40	1.65
S3R1F3	86049.00	32849.60	53199.40	1.62
S3R2F1	89631.00	37849.60	51781.40	1.37
S3R2F2	88929.00	37849.60	51079.40	1.35
S3R2F3	87804.00	37849.60	49954.40	1.32
S3R3F1	90189.00	42849.60	47339.40	1.10
S3R3F2	89487.00	42849.60	46637.40	1.09
S3R3F3	88362.00	42849.60	45512.40	1.06
S4R1F1	57429.00	24843.10	32585.90	1.31
S4R1F2	56727.00	24843.10	31883.90	1.28
S4R1F3	55593.00	24843.10	30749.90	1.24
S4R2F1	59175.00	29843.10	29331.90	0.98
S4R2F2	58473.00	29843.10	28629.90	0.96
S4R2F3	57348.00	29843.10	27504.90	0.92
S4R3F1	59733.00	34843.10	24889.90	0.71
S4R3F2	59031.00	34843.10	24187.90	0.69
S4R3F3	57906.00	34843.10	23062.90	0.66

CONCLUSION

The maize–lentil cropping sequence recorded significantly higher grain yields of maize, where as maize –oats cropping sequence gave significantly highest yield of oats. Application of 20 t FYM ha^{-1} in *kharif* and *rabi* or *rabi* alone recorded significantly higher grain yield of maize. However, maize–oats cropping sequences supplied with 10 t FYM ha^{-1} in *kharif* and *rabi* recorded significantly higher maize equivalent yield than other cropping sequences and rates and frequencies of FYM. It also realized higher net returns and benefit cost ratio. Thus the results of two years study lead to the conclusion that for realizing higher grain yield of maize based cropping system under Kashmir valley conditions, rates and frequency of FYM for maize-oats cropping system must centre around 10 t FYM ha^{-1} to be applied in *kharif* and *rabi* along with recommended package of NPK for both maize and oats.

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