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TILLAGE OPTIONS AND ITS EFFECT ON PRODUCTIVITY, PROFITABILITY AND QUALITY OF FORAGE UNDER FEED/ FOOD-FODDER BASED CROPPING SYSTEM IN MOLLISOLS

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SUMMARY

Field experiment was conducted during 2009-10 and 2010-11 at Instructional Dairy Farm, G. B. Pant University of Agriculture & Technology, Pantnagar to study the effect of tillage options on growth, forage yield and forage quality of berseem. The experimental site was silty loam in texture with 0.84% organic carbon and neutral in soil reaction (soil pH 7.1). The available N, P_20_5 and K_20 was 365, 36, 145 and kg/ha, respectively. The experiment consisted of 8 tillage options i.e. $T_{1,}$ Conventional tillage with 3 cultivation (one disc harrow+2 cultivator), $T_{2,}$ 2 Cultivation (1 disc harrow+1 cultivator), $T_{3,}$ 2 cultivation with Rotavator, $T_{4,}$ 1 cultivation with disc harrow, $T_{5,}$ 1 cultivation with Rotavator, $T_{6,}$ Broadcast seed before T_3, $T_{7,}$ Broadcast Seed before T_5, and $T_{8,}$ Zero tillage. The existing cropping system of the region i.e. '*Sorghum-Wheat-Maize+Cowpea'* was grown with all recommended agro-techniques of all crops of the system. The conventional tillage gave highest green fodder yield equivalents, dry fodder yield, crude protein, net profit as well as B:C ratio followed by reduced tillage with broadcasting of seed before 2 cultivation with rotavator with respect of net profit and B:C ratio. Therefore conventional tillage or two pass of rotavator may be recommended for higher productivity, profitability and quality fodder production in Molliusols.

Key words : Crude protein, net return, productivity, profitability, tillage options

India ranks first in livestock population, hence there is tremendous pressure on the limited feed and fodder resources. At present, only 5.4 per cent (around 7.8 million hectares) of total cultivable land is engaged in fodder production in the country that has one of the world's largest livestock population. If the current situation continues then India's green fodder shortage will reach 66 per cent and dry fodder will reach 25 per cent by 2030. Even the feed industry will not fulfil this deficit, so fixing the problems is imperative. Again the drastic outcomes of climate change may worsen the fodder scenario of the country in years to come. Therefore the option to increase the fodder production is to grow fodder crops in different existing cropping systems as well to improve the natural grasslands. Presently the tillage options like zero and reduced tillage have proved its utility to reduce the cost of cultivation with equal or more crop productivity. The reduced or zero tillage also help to minimize the gas emission. The existing potential food-fodder based cropping systems like rice-berseem-maize+cowpea, sorghum-wheat-maize+cowpea, baby corn-wheat-baby corn,Maize-berseem+oat-maize+cowpea etc. are prevalent in the *Tarai* region of Uttarakhand. Therefore sorghum(F)-wheat-maize+cowpea (F) was grown under different tillage options to find out the best tillage with higher productivity and profitability in the region.

MATERIALS AND METHODS

Field experiment was conducted during 2009-10 and 2010-11 at Instructional Dairy Farm, G. B. Pant University of Agriculture& Technology,Pantnagar to study the effect of tillage options on growth, forage yield and forage quality of Berseem. The experimental site was silty loam in texture with 0.84% organic carbon and neutral in soil reaction (soil pH 7.1). The available N, $P_20_5$and K_2O was 365, 36, 145 and kg/ha, respectively. The experiment consisted of 8 tillage

options i.e.$T_{1,}$Conventional tillage with 3 cultivation (one disc harrow+2 cultivator), $T_{2,}$ 2 Cultivation (1 disc harrow+1 cultivator), $T_{3,}$ 2 cultivation with Rotavator,$T_{4,}$ 1 cultivation with disc harrow, $T_{5,}$ 1 cultivation with Rotavator, $T_{6,}$ Broadcast seed before T_3,T_7, Broadcast Seed before T_5, and$T_{8,}$ Zero tillage. The existing cropping system of the region i.e. '*Sorghum-Wheat-Maize+Cowpea'*was grown with all recommended agro-techniques of all crops of the system. The tillage options were practiced only in the beginning of experiment in ***Kharif*** season 2009 and later ai other seasons like Rabi and Summer, the crops were grown under conventional tillage in all treatments. The green and dry fodder yield of all crops were recorded and later green fodder yield equivalents of the system was calculated based on green fodder yield of all crops of the cropping system. Similarly the crude protein, net profit as well as B:C ratio of all the treatments were estimated.

RESULTS AND DISCUSSION

Fodder yield

The green fodder yield equivalents and dry fodder yield were influenced significantly by tillage options during both years except dry fodder yield in 2009-10 (Table.1). The conventional tillage produced significantly highest green fodder yield equivalents during both years followed by 2 Cultivation (1 disc harrow+1 cultivator, 1cultivation with disc harrow and2 cultivation with rotavator from the Sorghum-Wheat-Maize+Cowpea cropping system in 2009-10. In 2010-11, the conventional tillage produced significantly higher green fodder yield equivalents that remained significantly equal to 2 cultivation (1 disc harrow+1 cultivator) followed by 2 cultivation with rotatvator. The T_7, broadcasting of seed before one cultivation with rotavator and T_8, zero tillage produced the lowest green fodder yield equivalents of the system with 14.7 % lower green fodder than conventional tillage but were at par with all other tillage options except conventional tillage in 2009-10. Similarly in 2010-11, the zero tillage gave the lowest green fodder yield equivalents with 44% lower than conventional tillage, however it was statistically equal to T_4, T_5, T_6 and T_7 treatments where reduced tillage either one disc harrow or rotavator was adopted. An average values indicate that conventional tillage was best with highest green fodder yield followed by T_2, 2 cultivation (1 disc harrow+1 cultivator) and T_3, 2 cultivation with rotavator that gave 8.9 and 10.8% lower green fodder yield than conventional tillage, respectively. The zero tillage produced the lowest green fodder yield equivalents i.e. 20.8% lower than conventional tillage.

The dry fodder yield did not influenced by tillage options in 2019-10 but the highest dry fodder yield was recorded under conventional tillage followed by 1 cultivation with rotatvator and two cultivation with rotatvator. The zero tillage hadthe lowest dry fodder yield. In 2010-11. The highest dry fodder yield was recorded under conventional tillage but it was significantly at par with T_2, 2 cultivation (1 disc harrow+1 cultivator). The zero tillage had the lowest value but was significantly at par with T4, T_5 and T_7 treatments. Two year average values indicate that conventional tillage had the highest dry fodder yield followed by T2 and T3 treatments having 2

TABLE 1

Effect of tillage options on green fodder yield equivalents and dry fodder yield of a feed/food-fodder cropping systems in Tari region of Uttarakhand during 2009-10 to 2010-11

Treatment	Green forage yield equivalent (q/ha)			Dry matter yield (q/ha)		
	2009-10	2010-11	Average	2009-10	2010-11	Average
T_1–Conventional tillage with 3 cultivation (one disc harrow+2 cultivator)	2545	2080	2313	390	341	366
T_2–2 Cultivation (1 disc harrow+1 cultivator)	2325	1889	2107	368	317	343
T_3–2 cultivation with Rotavator	2304	1824	2064	377	306	342
T_4–1 cultivation with disc harrow	2324	1606	1965	371	283	327
T_5–1 cultivation with Rotavator	2299	1489	1894	378	266	322
T_6–Broadcast seed before T_3	2311	1608	1960	366	290	328
T_7–Broadcast seed before T_5	2217	1596	1907	372	263	318
T_8–Zero tillage	2219	1444	1832	344	255	300
C. D. (P=0.05)	143	194	-	NS	29	-

cultivations. The results indicated that zero and one tillage are not suitable for fodder crops, however cultivation with rotavator twice may be sufficient for fodder crops. Deva *et al.* (2014) observed that conventional tillage produced higher green and dry fodder of oat. Kumar and Karmakar (2015) also reported that conventional tillage recorded higher green (354.6 q/ha) and dry fodder (78.7 q/ha) yield of oat over zero and minimal tillage. But Munsif *et al.* (2011) also reported at Peshawar (Pakistan) that reduced tillage produced taller plants (211 cm), more leaves per plant (9.3) and higher fresh and dry fodder yield of maize (130.5 & 48 t per ha). Similarly, reduced tillage resulted in higher gross income (Rs.65250) and net income (Rs. 63250). Higher value cost ratio (31.6) was recorded for reduced tillage followed by no-tillage (24.8). Gathala *et al.* (2015) found that, the average maize and system yield was greater by 9.1% and 6.1%, under reduced tillage and strip tillage compared to conventional tillage, respectively.

Quality of fodder

The crude protein production was affected significantly by tillage options during both years (Table 2). The crude protein production was found significantly highest under conventional tillage followed by T_3, 2 cultivations with rotavator during both years.. The lowest crude protein production was found under zero tillage that was significantly similar to T_6 and T_7 treatments in 2009-10 and T_7 in 2010-11. It is clear from two years data that the T_1, conventional tillage and T_3, 2 cultivations with rotavator had nearly 16 and 10% higher crude protein production than zero tillage. 16.2% and 10.0% higher crude protein production, respectively.

Economics

The tillage options had significant effect on net profit during both years and B:C ratio in 2010-11 (Table.2). In 2009-10, significantly maximum net profit was recorded under conventional tillage followed by one cultivation with rotavator, seed broadcast before 2 cultivation with rotavator. The lowest net profit was recorded under T_7, seed broadcasting before only one cultivation with rotatvtor and followed by zero tillage. In 2010-11, the conventional tillage had significantly higher net profit hat was significantly equal to T_2 and T_3 treatments. The zero tillage had the lowest net profit and it was significant same with T7 treatment. It is evident from the data that conventional tillage and zero tillage had the highest and the lowest net profit. The B:C ratio also followed the same trend as net profit. The higher net profit and B:C ratio was the result of high green fodder yield equivalents under conventional tillage. Deva *et al.* (2011) stated that highest net returns and B:C ratio was under plots treated with conventional tillage. Kumar and Karmakar (2015) found that reduced tillage gave higher gross returns (Rs. 79,689/ha), energy output (142985 MJ/ha) net energy returns (129471 MJ/ha) and energy use efficiency (11.7) over zero and minimal tillage. However, Munsif *et al.(*2011) concluded that reduced tillage resulted in higher gross income (Rs.65250) and net income (Rs. 63250). Higher value cost ratio (31.6) was recorded for

TABLE 2

Effect of tillage options on crude protein, net retuns and B : C ratio of a feed/food-fodder cropping systemsin Tari region of Uttarakhand during 2009-10 and 2010-11

Treatment	Crude protein yield (q/ha/year)			Net return (Rs./ha/year)			B : C ratio		
	2009-10	2010-11	Average	2009-10	2010-11	Average	2009-10	2010-11	Average
T_1–Conventional tillage with 3 cultivations (one disc harrow+2 cultivator)	33.7	33.6	33.7	105810	74663	90237	2.52	1.80	2.16
T_2–2 cultivation (1 disc harrow+1 cultivator)	30.9	30.9	30.9	93132	68863	80998	2.24	1.68	1.96
T_3–2 cultivation with Rotavator	31.7	31.6	31.7	91880	63610	77745	2.21	1.55	1.88
T_4–1 cultivation with disc harrow	31.4	31.4	31.4	94395	51377	72886	2.31	1.30	1.81
T_5–1 cultivation with Rotavator	31.3	31.3	31.3	92837	41957	67397	2.32	1.06	1.69
T_6–Broadcast seed before T_3	30.5	30.5	30.5	93687	53390	73539	2.34	1.35	1.85
T_7–Broadcast Seed before T_5	30.3	30.1	30.2	88062	52987	70525	2.20	1.34	1.77
T_8–Zero tillage	29.0	29.0	29.0	89240	45430	67335	2.29	1.16	1.73
C. D. (P=0.05)	1.5	1.4	-	8613	11508	-	NS	0.30	-

reduced tillage followed by no-tillage (24.8). The profitability was consistently greatest and significantly different (P≤0.001) under permanent raised beds compared to all other treatments (Gathala *et al.*, 2015). Reddy *et al* (2015) also reported that highest net return was obtained from fodder maize under zero tillage followed by conventional and the lowest minimum under minimum tillage.

CONCLUSION

The experimental results indicated that the conventional tillage or two pass of rotavator may be recommended for higher productivity, profitability and quality fodder production under feed/food-fodder based cropping systems in Molliusols.

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