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Effect of green-manure crops on yield of barley (*Hordeum vulgare*) and maize (*Zea mays*) + cowpea (*Vigna unguiculata*) grown on alluvial sand deposits

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ABSTRACT

A field experiment was conducted for 3 years (1990–91 to 1992–93) to study the effect of different green-manure crops on the yield of barley (*Hordeum vulgare* L. sensu lato) grain and maize (*Zea mays* L.) + cowpea [*Vigna unguiculata* (L.) Walp.] fodder under rainfed condition. Maximum yield of barley grain was found after green-manuring with sannhemp (*Crotalaria juncea* L.), followed by *dhaincha* or prickly sesban [*Sesbania cannabina* (Retz.) Pers.; Syn. *S. aculeata* Pers.] and was 93 and 73% higher than the yield after fallow. Significant response of N up to 60 and 120 kg N/ha was found in the grain yield of barley and yield of fodder maize + cowpea respectively on sandy soils having very low available nitrogen.

Alluvial sand deposits along the river Beas are sandy in texture, poor in available plant nutrients. Maize (*Zea mays* L.) crop is not successful due to excess moisture during the rainy season. There is a need to improve the texture of such soils (Ustipsamments), through organic manures. Since the availability of farmyard manure is limited, green-manuring is the alternative. However, farmers in this valley are following this practice. The objective was to study which green-manure crop is more successful. After green-manuring, barley (*Hordeum vulgare* L. sensu lato) crop was taken, as it is an important cereal crop of high hills and also can grow well on low-fertility soils.

MATERIALS AND METHODS

The experiment was conducted in a split-plot design (3 replications) with green-manure crop and fallow in the main plots and 3 levels of nitrogen (20, 40 and 60 kg/ha) applied to barley in subplots during 1990–91 to 1992–93, at Regional Research Station, Bajaura. The green-manure crops tested were *dhaincha or* prickly sesban [*Sesbania cannabina* (Retz.) Pers.], sannhemp (*Crotalaria juncea* L.), cowpea [*Vigna unguiculata* (L.) Walp.] and *guar or* clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.]. Nitrogen and phosphorus respectively at 20 and 40 kg/ha were applied to the green-manure crops as basal dose. The green-manure crops were sown in the second week of June in 1990 and 1991 and in first week of May in 1992 and harvested in the third week of August during the first 2 years and in the first week of August in 1992. These were buried in the same plots after recording green weight. During 1990–91 and 1991–92 barley ('HPL 36') was grown after green-manuring in subplots with a basal dose of 30 kg P_2O_5/ha. Maize + cowpea (2 : 1) fodder was sown in the first

week of August in subplots after green-manuring during 1992–93 with 40, 80 and 120 kg/N/ha along basal dose of 60 kg P_2O_5/ha and harvested on 17 October, after which barley was sown on 20 October similar to the previous 2 years and harvested on 12 May 1993.

The soils at the start of the experiment was sandy in texture having pH 8.0 and organic carbon 0.22% (low). The available N, P and K (kg/ha) was 41 (low), 5.5 (low) and 67 (low) respectively. After 1992–93 soil samples from all the plots of the experiment were analysed for organic carbon. The soil was analysed (Chopra and Kanwar, 1976). The mean, rainfall during May–July, August–October and November –April was 215, 200 and 542 mm respectively.

RESULTS AND DISCUSSION

Yield of green-manure crops

The biomass of a sannhemp and *dhaincha or* prickly sesban was maximum and almost similar, but was higher by 113% (mean value) during 1990 and 1991 compared with the green matter of cowpea (Table 1). In the year 1992 the biomass of cowpea was found maximum, but was only 16–19% higher than that of sannhemp and prickly sesban. The performance of *guar or* clusterbean was poor during all the years.

Grain yield of barley

The overall yield of barley grain (Table 2) under different green-manure crops during 1991–92 was 67% higher compared with the yield during 1990–91, though the yield under fallow remained almost the same. This may be due to poor nodule formation during the first year if such crops are grown without proper legume culture. The sandy soils lack other nutrients such as calcium and molybdenum which are essential for nitrogen fixation for certain leguminous crops (Russell, 1963). The yield of barley grain during 1992–93 was again low because during this year 1 extra crop of fodder was taken that had depleted the nitrogen fixed and mineralized by the green-manure crops. Another reason is that there was no rainfall in December during this year, whereas this month had 111 and 31 mm rainfall during 1990 and 1991 respectively.

Table 1. Yield of green-manure crops (q/ha)

Crop	1990	1991	1992
Cowpea	72.87	232.49	302.58
Prickly sesban	328.11	324.79	254.00
Clusterbean	62.07	93.69	31.92
Sannhemp	303.08	342.14	261.94

Effect of green-manures on grain yield of barley

The effect of green-manure crops on the yield of barley grain was significantly superior during 1990–91 and 1991–92, and on the average gave 66% higher grain yield than fallow. Shekhawat *et al.* (1989) and Giri and De (1981) also found 26 and 34% higher yield of barley after the legume than after no-legume fodder. On an average the maximum yield of barley grain was found after green-manuring with sannhemp, which was statistically at par with yield after prickly sesban but was significantly higher by 25 and 29% than the grain yield of barley obtained after green-manuring with cowpea and clusterbean respectively. During 1992-93 the effect of green-manure crops was not found significant on the grain yield of barley, because nitrogen fixed and mineralized by these crops was utilized by

Table 2. Effect of green-manure crops and nitrogen on yield of barley grain and maize + cowpea fodder

Treatment	Grain yield of barley (q/ha)			Fodder yield (q/ha)
	1990–91	1991–92	1992–93	
Green-manure crop				
Fallow	14.24	14.81	13.36	106.44
Cowpea	16.38	28.08	17.44	315.22
Prickly sesban	20.89	29.22	17.73	224.19
Clusterbean	17.84	25.31	12.71	191.76
Sannhemp	17.72	37.88	17.54	212.93
CD (P = 0.05)	3.07	8.76	NS	88.29
N (kg/ha)[Ψ]				
N_1	13.17	24.64	13.48	181.75
N_2	17.79	26.42	15.99	215.25
N_3	21.28	30.10	17.80	233.30
CD (P = 0.05)	2.22	4.08	1.50	24.64

[Ψ]20, 40 and 60 kg N/ha to barley, and 40, 80 and 120 kg N/ha to fodder

the fodder crop which was grown just after green-manuring.

Effect of green-manures on fodder yield

The yield of fodder was significantly superior to fallow after the green-manure crop except in clusterbean which was statistically at par with fallow. This is because that under early-sown condition during 1992 the clusterbean could not tolerate the heat of sandy soils which caused burning of leaves. The poor crop of clusterbean may be responsibile for less nodule formation and thus adverselly affecting the nitrogen fixation. The maximum yield of fodder was obtained after green-manuring with cowpea, which was significantly better by 41 and 48% than the fodder yield after prickly sesban and sannhemp respectively. Grobbelaar *et al.* (1989) obtained higher yields of maize fodder with legumes as green-manure than as a fodder crop.

Effect of N on grain yield of barley and fodder

The response to nitrogen was significant on barley grain as well as fodder crop. On an average (1990–91 and 1991–92) 40 and 60 kg N/ha increased the grain yield of barley by 17 and 36% and by 19 and 32% during 1992–93 compared with the yield obtained with 20 kg N/ha. The addition of 80 and 120 kg/ha increased the yield of fodder by 18 and 28% respectively compared with the yield of fodder at 40 kg N/ha.

Effect of green-manures on organic carbon in soil

The soil samples after 1992–93 showed no build-up of organic carbon (%) due to these green-manure crops compared to fallow. However, there was a significant improvement (24%) in organic carbon. Green-manuring does not usually increase

the organic matter content of the soil and in this respect differ from farmyard manure (Russell, 1963). The reason is that immature green plant tissue decomposes more rapidly leaving less residue than farmyard manure. In the present experiment the green-manure crops at the time of harvesting and burying in the plots had 75–82% moisture, indicating that these were very succulent and easy to decompose.

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