INTERACTION EFFECT OF GREEN MANURING AND FERTILIZER-N IN RAPESEED MUSTARD CROPS

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INTRODUCTION

Farmers traditionally plow legume cover crops under as green manure, providing an important source of organic matter and introducing a significant portion of N into the soil through biological N-fixation. Besides, providing potential soil and water conservation benefits, decomposing green manuring legumes may be able to contribute a significant portion of required N to non-legumes.

Rapeseed and mustard crops respond markedly to fertilizer N. Virtually no yield is obtained without N when it is grown on coarse textured soils very low in organic matter in sub-tropical climatic conditions (Pasricha et al. 1987). To achieve the yield potential of the improved cultivars of Brassica oil crops, 60 to 100 kg N/ha is recommended (Pasricha et al. 1991); however, the recommended level of N is generally not applied by many farmers because of the unsure nature of the crop. Main season crop, sown in winter is subject to frost injury and severe insect pest attack.

Green manure is an attractive alternative to fertilizer N. It has been successfully tried in rice (Morris et al. 1986, 1989; Maskina et al. 1989) and corn (Rachhpal-Singh et al. 1982; Haichel 1987). Common green manuring crops like cowpea (Vigna unguiculata (L.) Walp.), mungbean (V. radiata (L.) Wilczek), guara (Cyamopsis tetragonoloba) or susbania (Susbania rostrata) accumulates 45 to 80 kg N/ha during 30-45 days growth. Rinaudo et al. (1983) calculated that in 52 d, S. rostrata fixed 267 kg N/ha under waterlogged conditions on 1-m^2 plots in Senegal. Thus, the green manuring crops tried for incorporation in rice or corn compare favourably with the most productive symbiotic N fixation systems of annual legumes (LaRue and Petterson 1981).

Green manuring of legume crop besides supplying N, also improves the soil productivity by favourably affecting the soil physical, chemical and biological characteristics. Increased water holding capacity, improved soil tilth and increase in soil organic carbon have been reported by a number of scientists (Power 1987). However, if fertilizer N is to be replaced with green manure N, then this crop should fit in the cropping system. In tropical Asia, where irrigation water facilities are available, the cropping intensity is as high as 175%. However, after the harvest of winter crop and before the sowing of rainy season crop, one 30 to 60-d period occurs when fields have limited alternative use. Another alternative is to grow green manure crop on a nearby field and transport loppings to the Brassica field for incorporation. This is also a traditional practice in many parts of tropical Asia and is termed as green leaf manuring.

Cowpea (V. unguiculata), a summer annual legume, has proven to be agronomically viable green manuring crop (Rachhpal-Singh et al 1982). When grown in the first week of July, it makes remarkable growth and accumulates substantial dry matter and N by the time toria (Brassica napus) is planted in mid-September. The portion of cowpea N derived from biological N fixation is

assumed to represent a significant input of N into the cropping system.

MATERIALS AND METHODS

The study site is located in Punjab Agricultural University, Ludhiana, India, on a Fatehpur loamy sand. Field experiments were done on toria (B. napus) and raya (B. juncea) grown in rotation with wheat and corn, respectively. Treatments included 0, 20, 40 and 60 kg N applied to toria with and without green manuring followed by wheat to see the residual effect of green manuring N. Similarly, raya was grown after corn which received 0, 60, 90 and 120 kg/ha of fertilizer N with and without green manuring. Cowpea was grown in situ as green manure crop for 45 days and disced into the plots before sowing of corn in July and toria in September. Residual effect of green manure was studied on the following raya and wheat crops. In another experiment conducted for two years, loppings of guara (C. tetragonoloba) were incorporated into the soil before sowing of raya (B. juncea) which received 0, 50, 100 and 150 kg N/ha. The soil had a pH of 8.15 (1:2 soil/water), 0.15% organic carbon (Walkley and Black 1934) and 80.6 kg/ha of alkaline per manganate extractable N (Subbiah and Asija 1956).

RESULTS AND DISCUSSION

The yield of toria without chemical N and without any green manure was only 217 kg/ha (Table 1). Application of successive levels of fertilizer N consistently increased their yield and an impressive five fold increase was obtained with recommended level of 60 kg N/ha. Green manuring alone i.e. without any fertilizer N increased the yield of toria by 831 kg/ha which was almost equal to that obtained with 60 kg N/ha treatment. The fertilizer N equivalent of an incorporated green manure legume crop preceding a non-legume that gives a grain yield equivalent to that obtained by preceding the non-legume by a green manuring legume crop. This method requires two assumptions: that the entire N effect is due to additions through symbiotic N_2 fixation and that fertilizer N and green manuring N is equally available (Heichel 1987). This indicates that green manuring supplied N equivalent to 60 kg N/ha but on the other hand, even with the recommended levels of fertilizer N, green manuring further increased the yield by 560 kg/ha demonstrating the beneficial effect of green manuring on overall yield potential of these crops. Thus, a combination of incorporation of 45-d cowpea crop and 60 kg/ha of fertilizer N has consistently resulted in greater toria yields all through 4 years (Table 1). Percent increase in the seed yield of toria as a result of green manuring ranged from 68.7 to 377.3 at different levels of applied fertilizer N. Maximum increase was where no fertilizer N was applied and it decreased with increase in the level of applied fertilizer N (Fig. 1a). The yield increases with green manuring are undoubtedly attributable to interaction of increased N fertility, and possibly improvements in other physical, chemical and biological factors.

Similarly, the grain yield of corn without any fertilizer N or green manuring was only 361 kg/ha (Table 2). Application of fertilizer N consistently increased the yield of corn. Green manuring alone resulted a yield increase of 603 kg/ha which was almost equal to that obtained with 60 kg/ha of fertilizer N. This again indicates that green manure supplied N equivalent to

60 kg N/ha. The recommended level of fertilizer N for corn is 120 kg/ha, even with this level of fertilizer N, green manuring further increased its yield by 901 kg/ha. Schimidt (1974) also reported that red clover Triticum pratense L.) used as green manure crop provides about 60 to 80 kg N/ha to corn. Like toria, percent increase in the seed yield of corn as a result was maximum when no fertilizer N was applied and decreased with increase in fertilizer N (Fig. 2a).

Since considerable area under Brassica oil crops is now under double cropping on irrigated lands, green manuring of one crop may also influence the yield of the succeeding crop in a cropping system. The residual effect of green manuring on raya (B. juncea L.) (sown after corn) and wheat (sown after toria) ranged from 112 to 200 kg/ha and 217 to 460 kg/ha, respectively (Table 1 and Table 2). Ladd et al. (1981) also observed similar residual effect of green manuring in wheat. Percent increase in yield as a result of residual effect of green manure was higher in wheat and ranged from 10.7 to 69 (Fig. 1b) as compared to that of raya in which it ranged from 10.0 to 26.5 (Fig. 2b). The atmospheric temperature during September October at the site of present experiment is quite low when green manure is incorporated before sowing of toria, as compared to that in June-July when corn is planted; hence decomposition of green manure and consequent mineralization of organic N and other nutrients was relatively slow in toria-wheat than in corn-raya cropping system. Thus, there is higher residual effect in wheat (average 369 kg/ha) as compared to raya (average 152 kg/ha).

Under environmental conditions of this study, a well adapted legume incorporated into soil can replace all the fertilizer N requirements of rapeseed mustard. Thus where green manuring with a legume crop is done, a question still remains on recommended N fertilization, should the farmers reduce the amount of fertilizer N or, conversely, apply optimum N and potentially produce higher yield with the legume incorporation.

In another experiment, where loppings of legume crop were incorporated into the soil, grain yield of raya increased at all levels of applied N (Fig. 3). Average percent increase in yield due to green manuring at different levels of applied N showed that the response to green manuring was maximum (83%) at 50 kg/ha of applied fertilizer N and it decreased with increase in level of applied fertilizer N.

Total N removed in grain and straw of raya at different levels of applied N was higher in green manured plots. Percent increase in the recovery of fertilizer N as influenced by green manuring increased with increase in fertilizer N up to 100 kg/ha of fertilizer N and decreased with further increase in applied N (Fig. 4). The uptake of total N was higher in green manured plots at all levels of fertilizer N. It is clear that green manuring helped in better utilization of fertilizer N. Average N uptake from fertilizer N determined by non-isotope method increased from 10.1 to 13.4 kg at 50 kg, from 25.2 to 37.9 kg at 100 kg and from 39.3 to 52.3 kg at 150 kg/hec level of fertilizer N respectively with green manuring in raya. Green manure incorporation on an average resulted in 6.6 to 12.7% greater recovery of fertilizer N than when no incorporation was done (Fig. 4). Thus total recovery of fertilizer N was higher at different levels of its application when applied in combination with legume N. The addition of legume N in combination with fertilizer N may decrease the fertilizer N immobilization. Thus, legume N added, along with fertilizer N, would improve the recovery of fertilizer N by diluting the pool of N from which

the soil microbes are immobilizing. Thus potential N losses through leaching may be lower with fertilizer N when applied in combination with legume N.

Results of present study clearly demonstrated that green manuring with legume crops not only partially substitute the fertilizer N requirements of crops but also increases their overall potential. Thus to harness, the higher yields of brassica oil crops on coarse textured soils poor in inherent fertility and organic carbon content, inclusion of green manuring in their fertilizer management is of great importance.

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Table 1. Interaction effect of fertilizer N and green manure on the seed yield of toria (Brassica napus L.) and its residual effect on the following wheat

N-applied (kg N/ha)	Yield (kg/ha) 1985-86 GM No	1985-86 GM Yes	1986-87 GM No	1986-87 GM Yes	1987-88 GM No	1987-88 GM Yes	1988-89 GM No	1988-89 GM Yes
			Toria (Brassica napus L.)					
0	150	1100	220	960	240	1080	240	1040
20	400	1380	440	1380	480	1440	450	1470
40	670	1550	770	1600	810	1720	810	1840
60	701	1610	970	1560	1020	1680	970	1830
Mean	480	1410	500	1375	627	1480	618	1545
			Wheat (Triticum aestivum L.)					
0	660	1160	650	1040	720	1250	820	1350
60	1780	1970	1770	2020	1820	2080	1900	2300
90	1950	2580	2100	2390	2640	2960	2830	3150
120	2470	2800	2340	2700	2750	2970	2940	3120
Mean	1715	2128	1890	2028	1983	2315	2122	2480

Table 2. Interaction effect of fertilizer N and green manure on the seed yield of corn and its residual effect on the following raya crop (Brassica juncea)
(Av. of 3 years data)

N-applied (kg/ha)	Yield (kg/ha) Without GM	With GM	Response to green manure
	Corn (Zea mays)		
0	361	964	603
60	1029	2121	1092
90	1357	2542	1185
120	1710	2611	901
Mean	1114	2060	
	Raya (Brassica juncea)		
0	423	535	112
60	857	1057	200
90	1153	1302	149
120	1458	1604	146
Mean	973	1125	

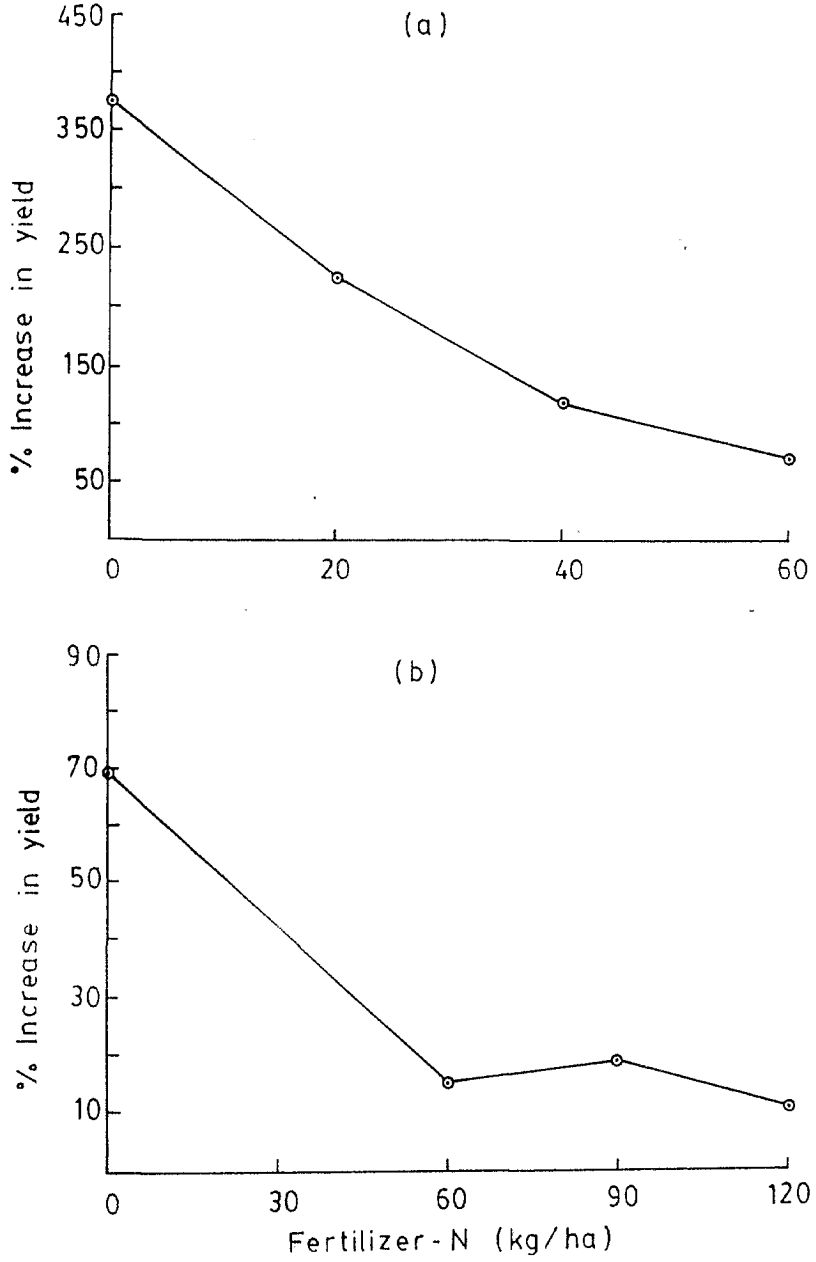

Fig. 1 Percent increase in the seed yield of toria (a) as influenced by green manuring and its residual effect on wheat (b) at different fertilizer N levels. (Av. of four years)

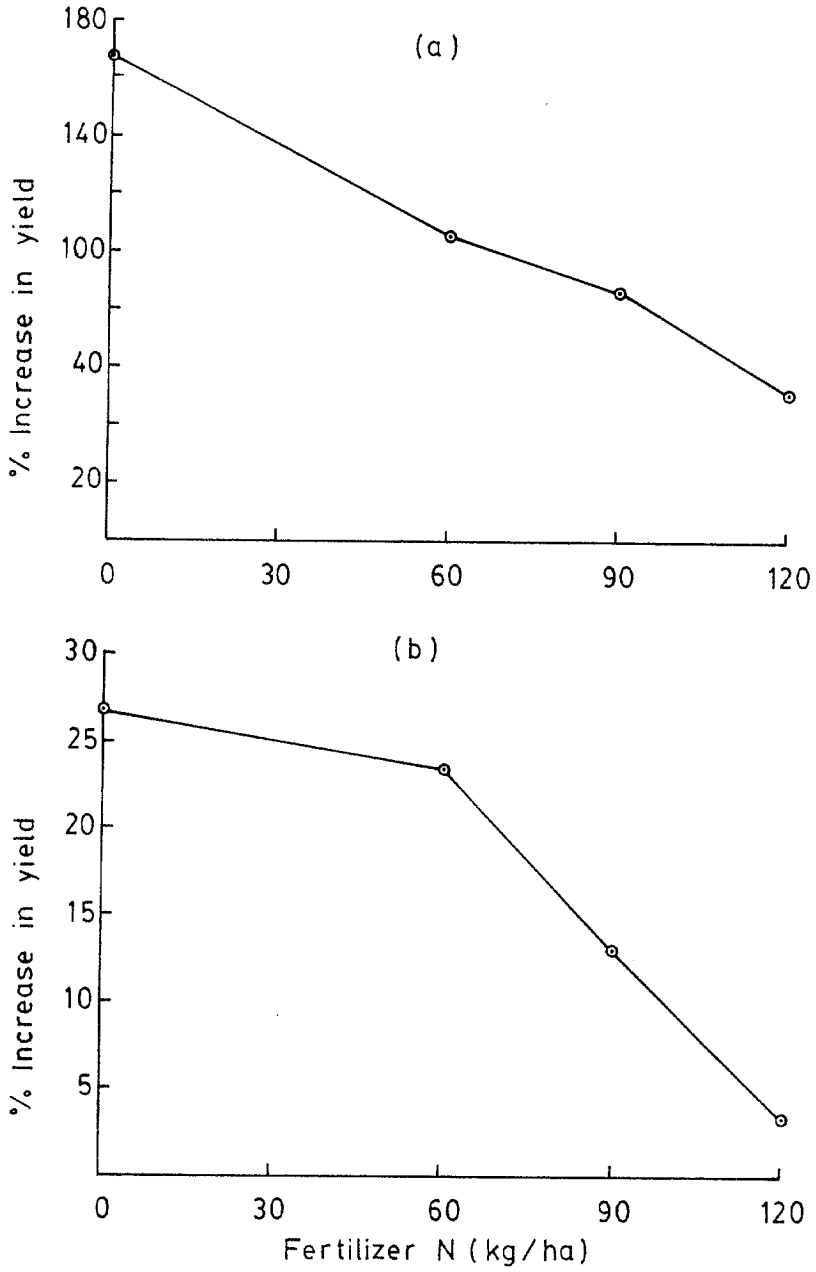

Fig.2 Percent increase in the seed yield of corn (a) as influenced by green manuring and its residual effect on raya (b) at different fertilizer N levels. (Av. of three yrs.)

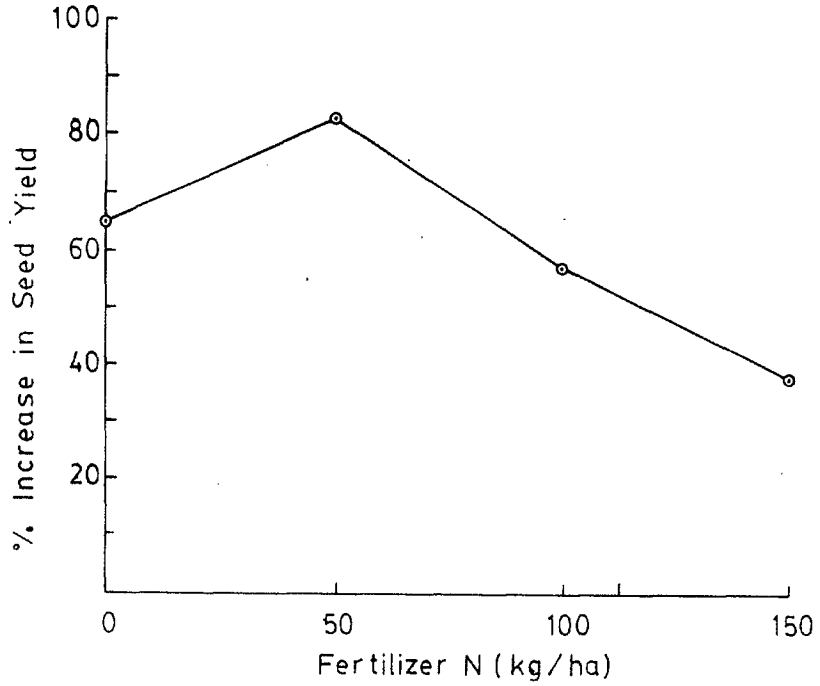

Fig.3 Percent increase in the seed yield of raya as influenced by green manuring at different fertilizer N (Av. of two years data)

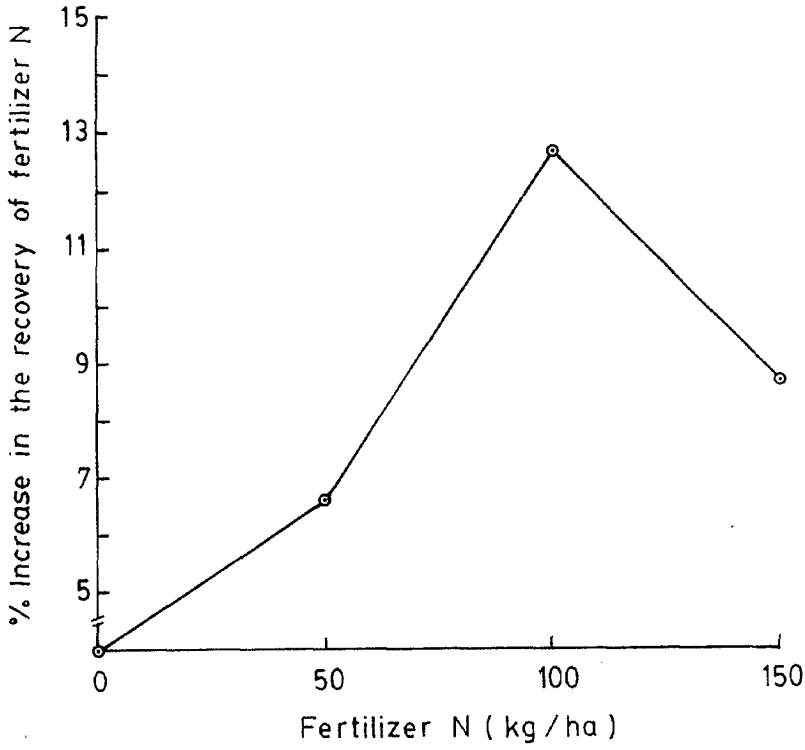

Fig. 4. Percent increase in the recovery of fertilizer N by raya as influenced by green manuring at different fertilizer N levels (Av. of two yrs.)