Effect of Preceding Crops and Nitrogen Rates on Post Harvest Attributes Of Winter Hybrid Maize (Zea Mays L)

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***Abstract*—*A field experiment was conducted at Agronomy research farm of IAAS, Rampur, chitwan, Nepal during summer and winter season 2010 and 2011 to study the effect of crop sequence and nitrogen rates on hybrid maize. There were thirty treatment combination consisting of six crop sequences, maize-maize, fallow-maize, greengram-maize, cowpea-maize, blackgram-maize, clusterbean-maize in main plots and five nitrogen rates 0, 50, 100, 150, 200 kg/ha in subplots with three replication.The research finding revealed that grain yield of maize was higher after summer legumes than after maize, fallow and clusterbean. Maximum grain yield of maize (4840 kg/ha in 2010 and 5230 kg/ha in 2011) was recorded under greengram-maize sequence followed by cowpea-maize, whereas the lowest grain yield was noted under maize-maize during both the years. Grain yield recorded with 200kg N/ha was maximum (6250 kg/ha in 2010 and 6548 kg/ha in 2011) while lowest yield (2296 kg/ha in 2010 and 2570 kg/ha in 2011) was under no nitrogen application. Maximum cob diameter (3.72 cm in 2010 and 3.85 cm in 2011) was recorded under greengram-maize sequence and it was minimum under maize-maize sequence. Cob diameter was maximum (3.78 cm in 2010 and 3.99 cm in 2011) with 200 kg N/ha while it was minimum at no nitrogen application. Cob length noted under cowpea-maize sequence was maximum (12.2 cm in 2010 and 12.8 cm in 2011) which was comparable to greengram – maize. While cob length was minimum under maize-maize sequences. Maximum cob length (12.5 cm in 2010 and 13.3 in 2011) was recorded with 200 kg N/ha and it was minimum under control. Maximum grain number per cob (334.6 in 2010 and 338.5 in 2011) was noted under greengram– maize sequences and minimum under fallow – maize in 2010 and under maize – maize in 2011. Grain number per cob was maximum 359.0 in 2010 and 364.0 in 2011) noted with 200 kg N/ha while it was minimum with no nitrogen during both the years . Maximum grain weight per cob (64. 5 g in 2010 and 65 .9 g in 2011) was recorded under cowpea– maize sequences which was comparable to greengram– maize sequences, while it was minimum under maize– maize. Grain weight per cob was maximum (80.0 g in 2010 and 82.0 g in 2011) recorded with 200 kg N/ha and it was minimum under no nitrogen application.Maximum 1000 grain weight (191.5 g in 2010 and 193.0 g in 2011) was recorded under greengram– maize sequence. While it was minimum under maize-maize sequence. 1000 grain weight was maximum (206.5 g in 2010 and 208 .0 g in 2011) with 200 kg N/ha and it was minimum with no nitrogen application. Stover yield was maximum (10504 kg/ha in 2010 and 11050 kg /ha in 2011) under greengram – maize sequences while it was minimum under maize– maize sequences. Maximum Stover yield (11922 kg /ha in 2010 and 12700 kg /ha in 2011) was recorded with 200 kg N/ha while it was minimum with no nitrogen application.*

***Keywords*—Preceding crop, nitrogen rates, summer legumes, crop sequence, yield attributes.**

I. INTRODUCTION

Winter maize has got highest production potential among the crop plants and due to wide variability in plant morphology; it has extremely wider adaptability also. It is more efficient than rice, wheat, barley. It is a heavy feeder of fertilizer nutrients particularly nitrogen, its effect being manifested quickly on plant growth and productivity. Among cereals, Maize is an important food and feed crops which rank second after rice and then wheat where as in global context it ranks third after wheat and rice. It is the second most important staple food crop both in terms of area and production after rice in Nepal. It is grown in 8, 70,166 hectare of land with an average yield of 2159 kg/ha. It occupies about 28.15% of the total cultivated agricultural land. Winter maize has an important place amongst the winter crops of the country and the other crops are wheat, gram, lentil, pea etc, under upland rainfed condition summer maize, green gram, black gram, cowpea, cluster bean are grown in rainy season and after the harvest of these crops during winter wheat, lentil, gram, mustard and winter maize are grown. The history of hybrid maize development is not very old in Nepal (Sherchan, *et al*., 2004). Research work on hybrid maize was initiated by National Maize Research Program (NMRP) during 1987 and the systematic work was done and expanded to different research stations of National Agricultural Research Council (NARC) both in terai and hill research stations to develop conventional hybrids (Gurung *et al.*, 2007).

Maize being C_4 plant is called photosynthetically most efficient plant in general among cereal and among three season of maize i.e winter, spring season and rainy season. Winter maize is physiologically, biotic and abiotic point of view is most efficient. Hence, from maximum production point of view winter maize is top most among winter season crops i.e. wheat, barley and others. Although maize is grown in all seasons i.e. spring, rainy and winter season, the productivity of winter maize is much higher than other season maize (Sherchan et al 2004) For many crop plants of temperate zone, optimum temperature for photosynthesis is lower than that for respiration, This has been suggested as one of the reasons for the higher yields of starchy crops such as maize and potatoes in cool climates as constrained with the yield of these crops in warmer region. Inner terai winter season temperature is favourable for photosynthesis than respiration during period of winter maize. For best growth, mean day temperature is 24 ^{o}C which is likely to be available for maize in winter season rather than other season i.e. spring and rainy season.

Maize-wheat and Maize-toria is widely adopted crop sequence and more popular under upland conditions. Besides the higher production potential for grain, higher amount of feed and fodder is also obtained under this sequence. But the continuous adoption of this sequence on same piece of land may have adverse effect on physical, chemical and biological properties of soil as continuous cropping of cereals impoverish yield of succeeding crops but inclusion of legumes in the rotation benefits the succeeding crops (Bains 1962).

Singh *et al.* (1982) observed that maize followed by cowpea for fodder resulted better yield attributes , grain and stover yields than after greengram, cowpea for grain, , maize for fodder, maize + cowpea for fodder and fallow. Nafzigar *et al.* (1984) reported that corn responded less to N when grown after leguminous crops than when grown after a grain crop or fallow. When grown without fertilizer N, corn following soybeans, oats, alfalfa and fallow produced yields equivalents to continuous corn fertilized with 65, 28,108 and 57 1b N/acre respectively. Sharma (1984) observed that grain and stover yields of maize were significantly higher when grown after peas than grown after wheat. . Reddy *et al.* (1999) observed that nitrogen application increased the yield attributing characters to the extent of 60 percent in length of cob, 8.2 percent in growth of cob, 153 percent in numbers of grains per cob and 32 percent in 1000 grain weight. Similarly, Alam *et al.* (2003) observed that application of nitrogen significantly affected all the yield attributes like cob length, cob weight, grains per cob and 1000 grain weight. Roy and Singh (1986) explained that various yield attributes viz., cob length and diameter, 1000 grains weight, number of grains per cob increased with the increasing level of nitrogenous fertilizers. Singh (2000) also reported the increase in various yield attributes viz., 1000 grain weight , cob length and diameter, thousand grain weight and shelling percentage with 90 kg N/ha while these were minimum with no nitrogen application

Application of nitrogen above 150 kg /ha was found to increase the stover yield of maize (Gautam and Khere, 1969) Krishnamoorthy *et al.* (1974a) observed an increase the stover yield when nitrogen level was increased from 60 to 240 kg N/ha. Gangwar and kalera (1980), Singh (1984) and Meshram and Shinde (1982) also recorded higher yield of maize stover with increased nitrogen application. However, Kalia (1975) noted that stover yield did not show significant variation with increasing rate of nitrogen from 30 to 60 and than 90 kg/ha. Alam *et al.* (2003) observed a significant increase in stover yield as a result of increase in nitrogen application. The yield of stover was 29.3, 39.4 and 52.9 q/ha at 0, 60 and 120 kg N/ha, respectively. Singh (1988) experienced increase in stover yield with the increasing level of nitrogen application. Fazeal (1989) recorded maximum stover yield (67.70 q/ha) at 90 kg N/ha while it was minimum (36.73q/h) at no nitrogen application

Various yield attributes of maize, viz., number of cob, number of grains per row, grain weight per cob and per plant, and the size of cob (their diameter and length) were significantly influenced by nitrogen application (Hati and Panda, 1970 and Pandey and Das, 1970). Sharma (1973) observed a beneficial effect on all attributed excepting cob length, cob diameter and grain number per cob with increased rate of nitrogen application

Nitrogen is the most limiting nutrient for maize production. Maize is an exhaustive crop and requires high quantities of nitrogen. The practice of fertilizer recommendation on the basis of individual crop is becoming less relevant because individual crop is a component of cropping system and cannot be grown in isolation. Therefore fertilizer recommendation should be made by giving due considerations to nature of preceding crops or in other words the cropping system as a whole besides the soil condition.

II. MATERIALS AND METHODS

Field experiment under upland ecosystem was conducted in split plot design with three replications at Institute of Agriculture and Animal Science (IAAS) Agronomical research farm Rampur, Chitwan during 2010 and 2011, keeping crop sequence in main plots and nitrogen rates to maize in sub plots. The main plots treatments consisted six crop sequence i.e. fallow-maize, Maize-maize, green gram-maize, cowpea -maize, black gram-maize, cluster bean-maize. The sub-plot treatment consisted five nitrogen rates to maize i.e. 0, 50, 100, 150 and 200 kg N/ha. The soil of the experimental field was free from any kind of salinity/sodicity hazards. Soil was suitable to variety of crops of tropical and subtropical regions. Soil was loamy sandy soil with neutral PH (7.0). The climate of the experimental farm was characterized as subtropical humid. Experiment was laid down in a split plot deign with thirty treatment and three replications. Yield and yield attributes of different summer legumes crops was studied along with Rajkumar, Indian hybrid maize, variety sown at row to row distance 60 cm and plant to plant 20 cm, popularly grown in Chitwan and terai region of Nepal which is a semi-dent and orange flint type possess relatively longer ear with high disease resistant and responsive to fertilizer and water.

The yield attributes character of hybrid maize viz., number of kernels per cob, 1000 kernel weight, cob length, cob diameter, Number of grains per cob, grain weight per cob was recorded and finally grain yield, stover yield and grain and stover ratio of maize per hectare was calculated and statistical analysis was done.

III. RESULT AND DISCUSSION

Post harvest studies

Cob length

Cob length varies significantly due to various cob sequences during both the years (Table 1). Cob length under greengram- maize, cowpea- maize sequences was significantly more than under all other crop sequences during both the years. In 2010 cob length under blackgram-maize, clusterbean-maize and fallow-maize sequences was also significantly more than under maize-maize sequences which was not true during 2011.

Nitrogen rates caused significant variation in cob length during both the years (Table 1). Successive increase in nitrogen rate 0 to 50, 50 to 100 and 100 to 150 and 150 to 200 kg N/ha recorded a significant increase in cob length during both the years.

Interaction due to crop sequences and nitrogen rates influenced cob length significantly during both the years (Table 2).

Maximum cob length was noted under cowpea- maize sequence in 2010 and under greengram– maize in 2011 at 200 kg N/ha. In 2010, cob length noted under cowpea – maize sequence was significantly more than under all the sequences at all the nitrogen rates except greengram-maize at 200 kg /N ha and cowpea – maize sequence at 100 kg N/h. In 2011, cob length under greengram – maize sequence was significantly more than under all the sequences at all nitrogen rates except cowpea – maize , clusterbean – maize at 100, 150 and 200 kg N/ha. Greengram– maize at 50 and 100 kg N/ha and maize – maize at 200 kg N/ha.

At no nitrogen, cob length noted under cowpea – maize and greengram– maize was significantly higher than under all other sequences during both the years except blackgram- maize sequence in 2011. At 50 kg N/ha , cob length noted under greengram – maize , cowpea – maize , blackgram – maize , clusterbean – maize and fallow – maize sequences was significantly more than under maize – maize sequence in 2010. But during 2011 cob length under greengram – maize sequence was significantly more than blackgram – maize and maize- maize and under blackgram- maize than under maize- maize sequences. At 100 kg N/ha , cob length noted under cowpea – maize sequence was significantly more than blackgram – maize and fallow – maize sequence during both the years . Further at 200 kg N/ha , cob length noted under greengram – maize was significantly more than under blackgram- maize and fallow– maize during both the years .

Under fallow – maize and blackgram – maize sequences cob length noted at 50, 100, 150 and 200 kg N/ha was significantly more than at no nitrogen under maize– maize sequence cob length with 100, 150 and 200 kg N/ha was statistically more than that of no nitrogen and 50 kg N/ha. Under greengram – maize sequence cob length at 200 kg N/ha was significantly more than all other rates in 2010. While during 2011 cob length at 200kg N/ha was significantly more than at 50 kg N/ha and no nitrogen treatment. Cob length at 100 kg N/ha was significantly more than the control in 2010. During 2011 significantly more cob length was noted with 200 kg N/ha than all the nitrogen rates and with 100 and 50 kg N than no nitrogen treatment. Under clusterbean – maize sequences significantly more cob length was noted with 200, 150 and 100 kg N/ha than at no nitrogen and 50 kg N/ha than control during both the years.

Table 1. Effects of crop sequences and nitrogen rates on yield components of maize

Treatments	Cob number (000/ha)		Cob length (cm)		Cob diameter (cm)		Grain number /cob		Grain weight /cob (g)		1000 grain weight (g)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Maize-	58.8	60.1	10.1	10.7	3.25	3.42	276.2	271.0	50.8	51.6	181.5	183.2

maize												
Fallow-maize	59.7	61.2	10.6	11.0	3.43	3.58	268.0	278.6	54.9	53.2	183.8	184.7
Greengram-maize	60.1	61.2	11.8	12.7	3.72	3.85	334.6	338.5	63.0	64.3	191.5	193.0
Cowpea-maize	60.3	61.1	12.2	12.8	3.60	3.75	316.6	321.0	64.5	65.9	191.5	192.5
Blackgram - maize	61.2	61.9	10.7	11.1	3.52	3.64	296.4	301.5	55.7	56.6	187.1	189.3
Clusterbean - maize	61.0	61.1	10.8	11.4	3.48	3.59	275.8	280.2	56.6	57.7	184.6	186.7
S.Em+-	0.6	0.6	0.2	0.3	0.11	0.11	4.6	4.7	0.5	1.3	2.3	2.3
CD at 5%	NS	NS	0.7	1.1	0.36	NS	14.5	14.8	1.7	4.2	NS	NS
Nitorgen rates (Kg/ha)												
0	52.6	53.5	9.1	9.3	3.18	3.25	206.3	209.0	35.1	35.8	162.1	163.6
50	60.5	61.5	10.8	11.5	3.42	3.57	274.3	279.3	47.3	48.3	182.1	183.0
100	62.2	62.9	11.9	12.5	3.62	3.80	338.8	341.9	68.1	67.5	196.1	198.1
150	65.3	66.8	12.4	13.2	3.77	3.94	358.8	363.6	79.9	81.3	206.3	207.5
200	66.2	67.2	12.5	13.7	3.78	3.99	370.2	372.1	80.1	81.6	207.1	207.8
S.Em.+-	0.6	0.6	0.1	0.1	0.05	0.06	3.1	3.2	0.5	0.9	1.9	2.1
C.D. at 5 %	1.7	1.7	0.4	0.4	0.15	0.17	9.0	9.2	1.4	2.7	5.5	6.0

Table 2. Interactions effects between crop sequences and nitrogen rates on cob length (cm)

Treatment	2010					2011				
	Nitrogen rates (kg/ha)					Nitrogen rates (kg/ha)				
	0	50	100	150	200	0	50	100	150	200
crop sequences										
Maize- maize	7.8	8.5	12.0	12.1	12.2	8.1	9.2	12.7	13.0	13.1
Fallow-maize	7.9	11.2	11.3	11.8	12.0	8.3	11.5	11.7	12.5	12.6
Greengram-maize	10.7	11.9	11.8	13.1	13,3	10.9	12.9	12.8	14.3	14.4
Cowpea- maize	10.8	11.9	13.3	13.4	13.5	10.9	12.6	13.7	13.9	14.0
Blackgram-maize	9.3	10.8	11.1	11.8	12.1	9.5	11.3	11.4	12.4	12.5
Clusterbean- maize	8.1	10.9	12.1	12.1	12.3	8.3	11.5	13.1	12.9	13.0

	S.Em+-	C.D at 5%	S.Em+-	C.D at 5%
For comparing crop sequences at same or different levels of nitrogen	0.4	1.2	0.5	1.5
For comparing nitrogen rates under same crop sequences	0.3	1.1	0.4	1.1

Cob diameter

Cob diameter was influenced significantly due to various crop sequences in 2010 only (Table 1). Maximum (3.72 cm) cob diameter was noted with greengram- maize sequences which was significantly more than under maize- maize cropping sequences. However, in 2011 also, though the differences were not significant. Maximum cob diameter (3.85 cm) was observed under greengram- maize sequences.

Variation in nitrogen resulted significant variation in cob diameter during both the years (Table 1). Maximum cob diameter was recorded with 200kg N/ha and it was significantly more than with no nitrogen & 50 kg N/ha. Cob diameter with 100 kg N/ha was significantly more than with 50 kg N/ha and no nitrogen. But at 50 kg N/ha it was significantly higher than no nitrogen treatment.

Number of grains per cob

Various crop sequences significantly influences the number of grain per cob during both the years (table 1). Maximum number of grain per cob was noted under green gram- maize sequences and it was significantly higher than under all the other crop sequences during both the years. Number of grains per cob under cowpea – maize sequence was significantly more than under blackgram- maize , clusterbean – maize , fallow– maize and maize– maize sequences . Further number of grains per cob recorded under blackgram – maize sequence was significantly more than under clusterbean– maize , fallow– maize and maize– maize sequences.

Nitrogen rates had significant effects on the number of grain per cob during both the years (Table 1). Maximum number of grain per cob was noted with 200 kg N/ ha. Successive increase in nitrogen from 0 to 50, 50 to 100, 100 to 150 & 150 to 200 resulted a significant increase in grain number per cob. However grain number per cob under 150 kg N and 200 kg N was at par.

Grain number per cob was influenced significantly due to the interaction effect of crop sequences and nitrogen rates during both the years (Table 3)

Maximum grain number was noted under greengram – maize sequence at 200 kg N/ha which was significantly higher than under all the sequences at all the nitrogen rates except t under cowpea – maize at 100, 150 and 200 kg N/ha and maize– maize sequence at 200 kg N/ha during both the years .

At no nitrogen, level grain number noted under greengram- maize , cowpea – maize and blackgram – maize sequences was significantly more than under all other sequences during both the years.

At 30 kg N/ha, greengram – maize sequences resulted significantly maximum grain number than other sequences. Significantly more grain number per cob was observed under cowpea- maize sequence than under blackgram- maize , clusterbean- maize, fallow – maize and maize– maize , under per maize than clusterbean- maize , fallow– maize and maize – maize sequences and under fallow – maize and clusterbean – maize than under maizes– maize during both the years.

At 100 kg N/ha , grain number under greengram– maize and cowpea – maize sequences was significantly higher than under all other sequences during both the years . Significantly more grain number per cob was noted under clusterbean – maize , blackgram- maize and maize – maize in 2010 and under clusterbean – maize and blackgram – maize in 2011 than the grain number noted under fallow – maize sequences.

At 200 kg N/ha, grain number under cowpea – maize sequence was significantly more than under fallow – maize , blackgram– maize and clusterbean– maize sequences during both the years. Significantly more grain number per cob was noted under maize– maize sequence than under fallow – maize and clusterbean – maize in 2010 and under clusterbean – maize in 2011.

Under maize– maize and fallow– maize sequences grain number at 200 kg N/ha was significantly higher than at other nitrogen rates. Significantly more grain number was noted at 100 kg N/ha than no nitrogen and 50 kg N/ha and at 50 kg N/ha than no nitrogen plots during both the years. Under greengram– maize, cowpea– maize, blackgram – maize and clusterbean-maize sequences with 100, 150 and 200 kg N/ha significantly more grain number was recorded than with 50 kg N/ha and no nitrogen treatment and with 50 kg N/ha than that of the control during both the years .

Table 3. Interaction effects between crop sequences and nitrogen rates on grain number per cob

Treatment	2010				2011			
	Nitrogen rates (kg/ha)				Nitrogen rates (kg/ha)			
	0	50	100	150 200	0	50	100	150 200
Crop sequences								
Maize- maize	190.6	220.3	326.0	368.3 368,8	191.6	223.3	328.3	371.3 371.8
Fallow-maize	177.6	249.3	301.0	344.0 345.1	178.3	252.6	305.3	348.0 348.8
Greengram-maize	236.6	346.6	372.6	382.6 383.1	238.6	350.0	375.3	390.0 391.1

Cowpea- maize	216.3	306.6	368.3	375.0 375.8	218.3	315.0	370.0	380.0 381.0
Blackgram -maize	228.3	277.0	335.3	345.0 346.1	234.6	282.0	338.3	351.0 351.8
Clusterbean- maize	188.3	246.6	330.0	338.0 339,1	192.6	253.0	334.0	341.0 341.9

	S. Em+-	C.D at 5%	S. Em+-	C.D at 5%
For comparing crop sequences at same or different levels of nitrogen	8.1	24.0	8.2	24.5
For comparing nitrogen rates under same crop sequences	7.6	22.0	7.8	22.5

Grain weight per cob

Grain weight per cob was significantly affected due to various crop sequences during both the years, (Table 1). Grain weight per cob under cowpea – maize sequence and greengram -maize sequences was significantly higher than under all the other crop sequences during both the years. In 2010, grain weight per cob under clusterbean– maize, blackgram - maize and fallow– maize was significantly higher than under maize– maize sequence was significantly higher than under fallow– maize and maize- maize. Similarly, grain weight under blackgram – maize and clusterbean – maize sequences was significantly more than under maize– maize.

Rate of nitrogen application had significant effects on grain weight per cob during both the years. (Table 1). Grain weight per cob increased significantly with each successive increase in nitrogen rate from 0 to 200 Kg N/ha. However grain weight under 150 kg & 200 kg N was at par.

Interaction effects due to crop sequences and nitrogen rates on grain weight per cob was significant during both the years (Table 4)

Maximum grain weight per cob was noted under cowpea – maize sequence at 200 kg N/ha which was significantly higher than grain weight per cob noted under all the sequences at all the nitrogen rates during both the years.

At no nitrogen level, grain weight per cob under greengram– maize sequence was significantly more than under all the other sequences except cowpea- maize and clusterbean – maize during both the years.

At 50 kg N/ha, grain weight per cob under greengram – maize sequence was significantly higher than under all the other sequences during both the years. Significantly more grain weight per cob was noted under cowpea – maize and clusterbean – maize sequences than under maize– maize and fallow– maize sequences in 2010, In 2010 grain weight per cob noted under maize– maize was significantly more than fallow – maize sequence.

At 100 kg N/ha, grain weight per cob under cowpea – maize sequence was significantly more than under all the other crop sequence during both the years except greengram- maize sequences in 2011 . Grain weight noted under greengram – maize sequence was significantly more than under fallow – maize , clusterbean – maize and maize– maize sequences during both the years . In 2010 , grain weight under blackgram- maize and fallow- maize was significantly more than under clusterbean– maize and maize– maize sequences . But during 2011 , grain weight under blackgram– maize sequence was significantly more than under fallow-maize and maize– maize .

Further at 200 kg N/ha, significantly more grain weight per cob was obtained under fallow – maize sequences than under clusterbean – maize and maize– maize and under maize– maize, blackgram– maize and clusterbean – maize than under maize– maize sequence during 2010. While during 2011, grain weight under greengram– maize, fallow – maize , blackgram- maize and clusterbean – maize sequences was significantly more than under maize– maize sequence.

Under all the crop sequences grain weight per cob noted with 200 kg N/ha was significantly higher than with all other nitrogen rates. But grain weight per cob at 100 kg N/ha was significantly more than no nitrogen and 50 kg N/ha and with 50 kg N/ha than no nitrogen during both the years.

Table 4. Interaction effects between crop sequences and nitrogen rates on grain weight per cob (g)

Treatment	2010					2011				
	Nitrogen rates (kg/ha)					Nitrogen rates (kg/ha)				
	0	50	100	150	200	0	50	100	150	200
Crop sequences										
Maize- maize	30	44.6	59.3	69.4	69.5	31.0	45.3	60.6	69.6	70.1
Fallow-maize	31.3	40.0	66.9	81.5	81.7	32.0	41.1	57.6	82.3	82.8

Greengram-maize	40.8	59.5	72.3	79.4	79.8	42.0	61.0	73.6	80.6	80.9
Cowpea- maize	37.9	48.9	79.1	92.1	92.8	38.0	50.0	80.6	95.6	96.0
Black gram -maize	33.4	41.0	69.3	79.6	80.1	34.0	42.0	70.0	80.6	80.8
Clusterbean- maize	37.2	50.1	61.9	77.3	77.9	38.0	51.0	63.0	79.0	79,9
For comparing crop sequences at			S.Em+-	C.D at 5%			S.Em+-	C.D at 5%		
same or different levels of nitrogen			1.2	3.6			2.4	7.1		
For comparing nitrogen rates under same crop sequences			1.2	3.6			2.3	6.6		

Thousand grain weight

Weight of 1000 grain did not differ significantly due to different crop sequences during both the years (Table 1)

Rate of nitrogen application caused significant various in 1000 grain weight during both the years. Significantly higher 1000 grain weight was observed with 150 kg N/ha and 200kg N/ha than that with 0, 50, 100 kg N/ ha significantly more 1000 grain weight was recorded with 100 kg N / ha Than with 0, 50 kg N/ha. Further 50 kg N/ ha treatment was significantly superior to no nitrogen treatment.

Grain yield

Effects of different crop sequences on grain yield was significant during both the years (Table 5). Maximum grain yield was obtained under greengram- maize sequences and it was significantly higher than the yield obtained under all other sequences except cowpea- maize and blackgram- maize sequences during both the years.

In 2010, grain yield obtained under cowpea -maize, blackgram- maize and clusterbean- maize was significantly more than under fallow -maize and maize-maize sequences. Further grain yield under fallow- maize sequences was significantly higher than maize- maize sequences. But in 2011, grain yield obtained under cowpea- maize, blackgram -maize sequences was significantly more than under clusterbean –maize, fallow-maize and maize- maize sequences. Similarly grain yield under clusterbean-maize, fallow- maize sequence was significantly higher than under maize-maize sequence.

Rate of nitrogen application influenced the grain yield significantly during both the years.(Table 5). Successive increase in nitrogen rate from 0 to 200 kg N/ha resulted a simultaneously and a significant increase in grain yield, However grain yield under 150 kg N and 200 kg N it not differ significantly.

Stover yield

Stover yield was affected significantly due to the different crop sequences during both the years.(Table 5). In 2010 the Stover yield obtained under greengram- maize sequence was significantly higher than all other sequences. Further Stover yield under cowpea-maize, blackgram-maize and clusterbean-maize sequence was significantly higher than fallow-maize and maize-maize sequence. But stover yield under fallow- maize, sequence was significantly higher than under maize – maize sequence In 2011 stover yield under greengram-maize, cowpea-maize and blackgram-maize being statistically the same was significantly more than stover yield noted under clusterbean-maize, fallow-maize and maize-maize sequences, Similarly, stover yield under clusterbean-maize sequence was significantly more than under fallow-maize and maize-maize sequences. Further stover yield under fallow-maize sequence was significantlu more than under maize-maize sequence

Nitrogen rate had significant influences on stover yield during both the years (Table 5). Statistically higher stover yield was obtain with 150 kg N/ha and 200 kg N/ha than stover yield with all the other rates of nitrogen during both the years.

In 2010 Stover yield noted with 100 kg N/ha and 50 kg N/ha was significantly more than with no nitrogen plots. But in 2011 stover yield was significantly higher under 100 kg N/ha over 0, 50 kg N/ha and under 50 kg N/ha over no nitrogen plots.

Grain and Stover ratio

Different crop sequences did not influences grain and stover ratio significantly during both the years (Table 5). Little higher grain to Stover ratio was recorded in 2011 than 2010. Slightly higher grain to stover ratio was recorded under cowpea -maize sequences during both the years and it was comparable under greengram-maize sequence during second year.

Nitrogen rates affected grain to stover ratio significantly during both the years. (Table 5) Grain to stover ratio recorded with 200, 150 and 100 kg N /ha was significantly higher than with no nitrogen and 50 kg nitrogen during both the years.

Table 5. Effects of crop sequences and nitrogen rates on grain yield, stover yield and grain : stover ratio of maize

Treatments	Grain yield (kg/ha)	Stover yield (kg/ha)	Grain : stover ratio

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Crop sequences	2010	2011	2010	2011	2010	2011
Maize -maize	3102	3490	7428	8102	0.41	0.43
Fallow -maize	3702	4320	8566	9818	0.43	0.44
Greengram- maize	4840	5230	10504	11050	0.46	0.47
Cowpea- maize	4758	5202	10092	10850	0.47	0.47
Blackgram-maize	4474	5114	9950	11272	0.44	0.45
Clusterbean- maize	4394	4618	9976	10348	0.44	0.44
S.Em.±	134	134	110	142	0.01	0.01
C.D at 5%	426	422	348	450	NS	NS
Nitrogen rates (kg/ha)						
0	2296	2570	6002	6564	0.38	0.39
50	4042	4460	9808	10538	0.41	0.42
100	4836	5432	10136	11278	0.47	0.48
150	5674	6188	11728	12578	0.48	0.49
200	6256	6548	11922	12700	0.50	0.51
S.Em±	122	90	170	156	0.01	0.01
C.D at 5%	352	260	490	448	0.03	0.03

IV. SUMMERY AND CONCLUSION

Grain yield of maize was higher after summer legumes than after maize, fallow and clusterbean. Maximum grain yield of maize (4840 kg/ha in 2010 and 5230 kg/ha in 2011) was recorded under greengram-maize sequence followed by cowpea-maize, whereas the lowest grain yield was noted under maize-maize during both the years. Grain yield recorded with 200kg N/ha was maximum (6250 kg/ha in 2010 and 6548 kg/ha in 2011) while lowest yield (2296 kg/ha in 2010 and 2570 kg/ha in 2011) was under no nitrogen application.

Maximum cob diameter (3.72 cm in 2010 and 3.85 cm in 2011) was recorded under greengram-maize sequence and it was minimum under maize-maize sequence. Cob diameter was maximum (3.78 cm in 2010 and 3.99 cm in 2011) with 200 kg N/ha while it was minimum at no nitrogen application.

Cob length noted under cowpea-maize sequence was maximum (12.2 cm in 2010 and 12.8 cm in 2011) which was comparable to greengram – maize. While cob length was minimum under maize-maize sequences. Maximum cob length (12.5 cm in 2010 and 13.3 in 2011) was recorded with 200 kg N/ha and it was minimum under control.

Maximum grain number per cob (334.6 in 2010 and 338.5 in 2011) was noted under greengram– maize sequences and minimum under fallow – maize in 2010 and under maize – maize in 2011. Grain number per cob was maximum 359.0 in 2010 and 364.0 in 2011) noted with 200 kg N/ha while it was minimum with no nitrogen during both the years .

Maximum grain weight per cob (64. 5 g in 2010 and 65 .9 g in 2011) was recorded under cowpea– maize sequences which was comparable to greengram– maize sequences, while it was minimum under maize– maize. Grain weight per cob was maximum (80.0 g in 2010 and 82.0 g in 2011) recorded with 200 kg N/ha and it was minimum under no nitrogen application Maximum 1000 grain weight (191.5 g in 2010 and 193.0 g in 2011) was recorded under greengram– maize sequence. While it was minimum under maize-maize sequence. 1000 grain weight was maximum (206.5 g in 2010 and 208 .0 g in 2011) with 200 kg N/ha and it was minimum with no nitrogen application.

Stover yield was maximum (10504 kg/ha in 2010 and 11050 kg /ha in 2011) under greengram – maize sequences while it was minimum under maize– maize sequences. Maximum Stover yield (11922 kg /ha in 2010 and 12700 kg /ha in 2011) was recorded with 200 kg N/ha while it was minimum with no nitrogen application.

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