Effect of Maize Variety and Legume, Non Legume Intercropping On Yield and Yield Attributes Of Maize in Foot Hills of Nepal

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ABSTRACT

A field trail of maize intercropping with legumes and non-legumes was conducted on the local tribal farmer's field in Kavilas, a hilly VDC of Chitwan, Nepal during the rainy season of 2012 (April to September). The experiment was laid out in 2 Factor Strip Plot Design with 12 treatments and 3 replications. The treatment comprised of combination of three maize variety of different maturity date [Arun-2 (80-90 DAS), Manakamana-1(120-130 DAS) and Poshilo makai-1(145-155 DAS)] and four intercrops among which three were leguminous intercrop and one was non leguminous intercrop (Blackgram, Greengram, Cowpea and Millet). Among the tested maize varieties, Poshilo Makai-1, a long duration maize variety had significantly higher number of harvested plants per hectare and number of grains/row which assisted in its higher yield (4.72 ton/ha) which is significantly higher than the yields of both Manakamana-1 (3.52 ton/ha) and Arun-2 (2.82 ton/ha). The number of rows per ear and test weight was not found significantly different in different maize varieties however the shelling percentage of short duration maize variety Arun-2 was found to be significantly higher than that of Poshilo Makai-1. The effect of intercropping was not observed to be significant in case of any yield attributing characters of maize.

Key words: Intercropping, legumes, maize, yield.

1 INTRODUCTION

Maize (*Zea mays)* is the world's widely grown cereal and is common in many developing countries as primary staple food crop. It has higher yield potential than any other cereals and thus is popularly known as the 'queen of cereal'. In Nepal, it is the second most staple food crop both in terms of area and production after rice. It is currently grown in 0.87 million hectares land in Nepal with the production of 21 million ton and average productivity of 2.5 ton/ha (MoAD, 2012). It occupies about 28.19% of the total cultivated agricultural land and about 23% of the total cereal production in Nepal. In Nepal, majority of the maize cultivated area i.e. 83% lies in hilly and mountainous region and the rest is in terai region and inner terai region (MoAD, 2012).

Grain legumes are important pulses in Nepal both in terms of their contribution to human nutrition and also as the important component of indigenous cropping systems for improving the soil fertility. The current area under legumes in Nepal is 0.32 million ha (10.81% of the total cultivated area) with the production of 0.31 million tones and productivity of only 0.95 ton/ha (MoAD, 2012). Blackgram (*Vigna mungo* L. Hepper) is the third important grain legume of Nepal (summer) in terms of acreage after lentil and soybean. It occupies 8.22% of total area under legume crops. Currently it is grown in an area of 27496 hectare with the production of 22482 ton and productivity of 0.82 ton/ha (MoAD, 2012). Green gram [*Vigna radiata* (L.) Wilczek] is also the important grain legume of Nepal however area under green gram is still very low in Nepal. It is estimated that 12,000 hectare of cultivated land (4% area of grain legume) is covered by mungbean with average annual production of 6,500 metric tons and average yields of 0.5 ton/ha (Joshi *et al.*, 1997). Cowpea is [*Vigna unguiculata* (L)] known as 'Bodi' is also one of the important grain legumes of Nepal that occupies 0.0042

million hectare of land with the production of 35223 ton and annual productivity of 8 ton/ha (MoAD, 2012).Finger Millet (*Eleusine corocana*) is also one of the important cereal crops of Nepal widely cultivated in hilly regions. It is the fourth important cereal crops of Nepal after Rice, Maize, Wheat occupying 0.2 million hectare of cultivated land with the production of 0.3 million ton and productivity of 1.12 ton/ha.

Maize based cropping pattern is crucial for food security in the mid hills of Nepal where agriculture is the mainstay for livelihood. There is immediate need to conserve the inherent soil properties to sustain the maize production in these regions. At the same time maximum utilization of the land in a logical way might be beneficial to increase the income of the farmers in this region.

Over the past few years intercropping has been recognizing as a potentially beneficial system of crop production in tropical agricultural systems and the evidences suggest that intercropping can provide yield advantage over sole crops not because of high external inputs but rather due to more efficient utilization of resources (Chaudhary and Rosario, 1992).In cereal/legume intercropping system, inclusion of legume component, which has usually short stature growth habit, utilizes space and time more efficiently than a sole cereal crop because legume has ability to fix atmospheric nitrogen to the soil (Heibsh and McCullumn, 1987) and does not effectively compete with cereals plants for nutrients so the complement with each other.

2 MATERIALS AND METHODS

The field experiment was conducted at Kavilas, Chitwan in a farmer's field of tribal society (Chepang) from January 2012 to October 2012. The experimental site is located in sub-tropical climatic region of central Nepal, 30 kilometer north east of Bharatpur, headquarter of Chitwan district. Geographically it is situated at 27^{o} 77' N latitude and 84^{o} 47' E longitude with an elevation of 332 meter above mean sea level with a slope of 5^{o}. The soil of the experimental site was slightly acidic in reaction with clayey texture. The total rainfall received by the crop was 1546.6 mm during its season.

The experiment was laid out in 2 Factor Strip Plot Design with 12 treatments and 3 replications. The treatment comprised of combination of three maize variety of different maturity date [Arun-2 (80-90 DAS), Manakamana-1(120-130 DAS) and Poshilo makai-1(145-155 DAS)] and four intercrops among which three were leguminous intercrop and one was non leguminous intercrop (Blackgram, Greengram, Cowpea and Millet). Maize varieties were planted in similar pattern with spacing of 70 cm between the rows and 20 cm between the plants and the intercrops were tried on 1:1 basis i.e. in between the two maize rows, the intercrops were sown/ transplanted.

3 RESULTS AND DISCUSSION

Yield attributing characters of maize

Yield attributing characters like number of kernel rows per ear, test weight of the maize varieties did not differ significantly among each other however the numbers of grains per ear rows was found to be significantly different in case of maize varieties. The intercrop effect on yield attributing characters of maize was not observed in the research.

Harvested plants per hectare

In maize, the number of plants per hectare played a significant role in determination of grain yield as it influences on total number of cobs per unit area. There was significant effect of maize variety on plant population per hectare recorded at harvest (Table 1). Higher number of plants per hectare was found significantly higher in case of Poshilo makai-1 (69841.67) than in Manakamana-1 (68255) and Arun-2 (66667.33). Plant number per hectare was also significantly different in case of Manakamana-1 and Arun-2 variety. Short duration maize variety Arun-2 has the lowest plant population as compared to that of medium duration variety Manakamana-1 and long duration variety Poshilo makai-1. Regmi, 2009 mentioned that the plant population of long duration maize varieties Deuti at harvest was 1.99% and 4.38% greater than that of medium duration variety Rampur Composite and short duration variety Arun-2, respectively. Prasad, 2003 also reported the declination in the plant population by 24% and

25% during his experiment in 2001 and 2002 respectively.

Role of intercrop was not found significant in case of final maize population per hectare during the field research (Table 1).

Number of kernel rows per ear

The maize varieties did not differed significantly regarding the number of kernel rows per ear (Table 1) however the long duration maize variety Poshilo makai-1 (11.83) had higher number of kernel rows per ear than that of medium duration maize variety Manakamana-1 (11.17) and Arun-2 (10.83) however the difference was not found significant. On an average, number of kernel rows per ear was found to be 11.28.

Role of intercrops was also not found significant for number of kernel rows per ear in base maize plant. However, the grain row per cob was higher in case of maize varieties intercropped with green gram (12.22). The maize rows per cob was also high in case of maize crop intercropped with cowpea (11.89) however lower number of rows per cob was observed in case of maize intercropped with millet (9.44) however these differences were not significant.

Number of kernels per ear row

Maize varieties showed significant difference in case of number of kernels per ear row and it was found to be 19.83 on an average (Table 1). Grain per kernel row was found to be significantly higher in case of long duration maize variety Poshilo makai-1(22.58) than that in medium duration maize variety Manakamana-1 (19.33) and short duration maize variety Arun-2 (17.58). The grain number per ear row was significantly at par in case of Arun-2 variety and Manakamana-1 variety. Lesser number of grains per row in early maturing cultivar than full season one was also observed by Adhikari *et al.* (2004).In his experiment late maturing variety SOISIWQ – 2 and Rampur Composite produced 364.6 and 344.9 kernels per ear, respectively which was higher than early variety POP 446 C1 (313.5).

In case of intercrops effect on number of kernels per ear rows, no significant effect was observed during the research trail. However, number of kernels per ear row was found slightly higher in case of maize intercropped with Black gram (21.0) than those of maize intercropped with Cowpea (19.67), Millet (19.67) and Green gram (19.0).

Test weight

It was observed that on an average the test weight was found to be 220.97 gram and ranged from 200.92 gram to 250 gram (Table 1). There was no significant effect of maize varieties on the test weight however test weight of long duration maize variety Poshilo makai-1 (250 gram) was found to be higher than that of short duration variety Arun-2 (200.92 gram) and medium duration maize variety Manakamana-1 (230 gram).

Regarding the effect of intercrops on the test weight of base maize crop, no significant results are obtained. However, slight increment in test weight of maize grains was obtained in case of maize intercropped with Black gram (230.11 gram) and Cowpea (230 gram) than those intercropped with Green gram (220.89 gram) and Millet (220.89 gram).

Shelling percentage

Significant difference was observed among the maize varieties regarding the shelling percentage (Table 1). Shelling percentage was observed to be significantly higher in case of short duration maize variety Arun-2 (81.75) than that of long duration maize variety Poshilo makai-1 (77.5). The medium duration maize variety Manakamana-1(78.40) showed intermediate result between the other two maize varieties. It was due to the fact that the grain cob ratio was higher in early variety than late variety. Pandey *et al.* (2007) reported that early variety Pool17 gave higher shelling percentage (80 %) than full season variety Deuti (76 %) and Shitala (74 %), respectively in the year 2005-2006.

In contrast, no effect of intercrop was observed in the shelling percentage of the base maize crop during the field research.

Table 1. Dynamics of yield attributing characters of maize as influenced by its variety and intercrop at Kavilas, Chitwan during rainy season 2012

Treatments	Plant Population at harvest	Rows/Cob	Grain/row	Test weight (1000 seed)	Shelling percentage
Factor A, Maize Varieties					
Arun-2	66667.33^{c}	10.83	17.58^{b}	200.92	81.75^{a}
Manakamana-1	68255.00^{b}	11.17	19.33^{b}	230.00	78.40^{ab}
Posilo Makai-1	69841.67^{a}	11.83	22.58^{a}	250.00	77.5^{b}
SEm±	220.28	0.70	0.73	13.95	0.85
LSD	864.90	NS	2.85	NS	3.35
Factor B, Intercrops					
Black gram	68255.00	11.56	21.00	230.11	79.30
Green gram	68254.67	12.22	19.00	220.89	79.19
Cowpea	68254.56	11.89	19.67	230.00	79.08
Millet	68254.44	9.44	19.67	220.89	79.30
SEm±	462.98	0.62	0.62	13.67	1.85
LSD	NS	NS	NS	NS	NS
CV %	2.03	17.52	11.64	20.41	7

NS- Non significant. Means followed by common letter (s) within column are non – significantly different based on DMRT at P = 0.05. SEm- Standard Error of Mean. CV-Coefficient of Variation

Grain yield

Average grain yield of all maize varieties was observed 3.7 t/ha and ranged from 2.86 t/ha to 4.72 t/ha (Table 2). The collected and analyzed data showed significant difference between the maize varieties (Arun-2, Manakamana-1 and Poshilo makai-1) regarding the grain yield and stover yield along with the harvest index. the long duration variety emerged as significantly superior variety with grain yield of 4.72 t/ha which was distinctly higher than the grain yield of short duration maize variety Arun-2 (2.82 t/ha) whereas the medium duration variety Manakamana-1 (3.52 t/ha) was intermediate between the other two varieties. Long duration varieties compared to short duration varieties tended to be taller and to produce a larger number of leaves, larger LAI, larger TDW and higher grain yield (Yamaguchi, 1973).Thus, it can be well understood that even in the similar condition of soil and weather, varieties differ in respect of grain yield. Pandey and Agrawal, 1991 also mentioned that the suitability of varieties to a particular agro-climate is the most important factor in realizing their yield potential.

Furthermore, the intercrop had also significant effect on the grain yield of the base maize crop (Table 2). Significantly higher grain yield was achieved from the maize crop intercropped with any of the legumes as compared to that of maize crop intercropped with non-leguminous component. The maize grain yield was significantly high in case of maize intercropped with cowpea (3.97 t/ha) as compared to that of maize intercropped with millet (2.98 t/ha). Yield of grains in case of maize intercropped with green gram (3.83 t/ha) and black gram (3.96 t/ha) were at par with that of the grain yield from the maize crop intercropped with cowpea.

Stover yield

Average stover yield of maize varieties (Arun-2, Manakamana-1 and Poshilo makai-1) under intercropping was found to be 14.16 t/ha and it ranged from 10.02 t/ha to 18.89 t/ha (Table 2). Stover yield was found significantly higher in case of longer duration variety Poshilo makai-1 (18.89 t/ha) than that of short duration maize variety Arun-2 (13.59 t/ha) and medium duration maize variety Manakamana-1 (13.59 t/ha). The stover yield of both Arun-2 and Manakamana-1 were at par. Higher straw yield of Poshilo makai-1 related to its greater LAI, greater plant height, more number of leaves and total dry matter accumulation as compared to that of Arun-2 and Manakamana-1. Long duration varieties compared to short duration varieties tended to be taller and to produce a larger number of leaves, larger LAI, larger TDW and higher grain yield (Yamaguchi, 1973).Similarly, lower LAI, lower plant height and low dry matter accumulation in Arun-2 variety resulted in the lower stover yield in case of short duration maize variety Arun-2.

Apart from the role of maize variety in stover yield, the intercrop also played a key role in stover yield of the base maize crop. Stover yield in case of maize intercropped with any of the legumes Black gram (15.22 t/ha), Green gram (14.72 t/ha) and Cowpea (15.31 t/ha) was significantly higher than that of maize intercropped with non-legume component Millet (11.41 t/ha). Regarding the stover yield, maize varieties intercropped with legumes were at par.

Harvest index

The mean harvest index of all maize varieties used in the research (Arun-2, Manakamana-1 and Poshilo makai-1) was found to be 0.21 and ranged from 0.20 to 0.22 (Table 2). Harvest index of maize was significantly affected by the maize variety. The harvest index of short duration maize variety Arun-2 (0.22) was found significantly higher than that of medium duration variety Manakamana-1 (0.21) and long duration variety Poshilo makai-1 (0.20). The harvest index of medium duration maize variety Mankamana-1 was also significantly higher than that of long duration variety Poshilo makai-1.

No effect of intercrops was observed in case of harvest index of base maize crop.

Table 2. Grain yield, stover yield and harvest index of maize as influenced by its variety and intercrop at Kavilas, Chitwan during rainy season 2012

Treatments	Grain yield (ton/ha)	Stover yield (ton/ha)	Harvest index
Factor A, Maize Varieties			
Arun-2	2.86^{b}	10.02^{b}	0.22^{a}
Manakamana-1	3.52^{ab}	13.59^{b}	0.21^{b}
Posilo Makai-1	4.72^{a}	18.89^{a}	0.20^{c}
SEm±	0.31	1.19	0.00091
LSD	1.22	4.67	0.0036
Factor B, Intercrops			
Black gram	3.96^{a}	15.22^{a}	0.208
Green gram	3.83^{a}	14.72^{a}	0.208
Cowpea	3.97^{a}	15.31^{a}	0.208
Millet	2.98^{b}	11.41^{b}	0.208
SEm±	0.14	0.57	0.0002
LSD	0.48	1.92	NS
CV %	25.35	25.57	0.31

NS- Non significant. Means followed by common letter (s) within column are non – significantly different based on DMRT at P = 0.05. SEm- Standard Error of Mean. CV-Coefficient of Variation

CONCLUSION

Maize varieties and intercrop species play a crucial role in determination of various plant parameters. Final plant population is one of the most important parameter that determines the production of any agronomic crops from the given land. Maize varieties were found different in case of final plant stand where long duration maize variety showed higher plant stand. The yield attributes and yield of the maize crop was highly influenced by its variety however the effect of intercropping was not observed in these characters except yield. Yield attributing characters of maize varied as per varieties but the effect of intercropping was only seen in case of final grain yield. Intercropping of legumes proved to be beneficial over non legume as it assisted for higher maize yield. Also shelling percentage of the short duration varieties was found to be higher than that of other varieties.

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