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Research Article

RESPONSE OF TILLAGE SYSTEM, NITROGEN LEVEL AND SPLIT APPLICATION OF NITROGEN ON SPRING MAIZE IN CHITWAN, NEPAL

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Abstract

Field experiment was conducted at Phulbari-9, Chitwan, Nepal during 2012 (Feb-July) to investigate response of tillage system, nitrogen level and split application of nitrogen on spring maize. The experiment was laid out in split-split plot design with twelve treatments and three replications, considering two tillage system (conventional and zero tillage) as main factor, three nitrogen levels (60, 120 and 180 kg N ha $^{-1}$) as sub plots and spilt application of nitrogen (50 % each at basal and 45 DAS & 25% each at basal, 30, 45 and 60 DAS) as sub sub plot. Thousand grain weight, number kernel rows ear^{-1}, number kernels ear^{-1}, grain yield, stover yield and harvest index were significantly not influenced by tillage systems. Thousand grain weight, number of kernel rows ear^{-1}, number kernels ear^{-1}, grain yield, stover yield as well as harvest index showed remarkable increase with increasing N rate and number of N split application. Significantly, higher grain yield (8.91 t ha^{-1}) was observed in 180 kg N ha^{-1} applied plot than the plots given 120 kg N ha^{-1} (8.15 t ha^{-1}) and 60 kg N ha^{-1} (5.29 t ha^{-1}). Four equal split application of nitrogen yielded significantly higher grain (7.68 t ha^{-1}) than two equal split application of nitrogen (7.22 t ha^{-1}). It is concluded that either conventional or zero tillage with application of 180 N kg ha^{-1} with four split application can increase yield and yield attributes.

Key words: Tillage; nitrogen rate; split application; grain yield.

Introduction

Maize is one of the important cereal crops and contributes to the larger extent in the world agricultural economy both as food for human beings and feed for animals. It is the second most important staple food crop both in terms of area and production after rice in Nepal. There is rapid increase in maize demand primarily to meet the increased demand for human consumption in the hills as a staple food crops (Ghimire *et al.*, 2007) and for livestock feeds in terai and inner terai areas (Pandey *et al.*, 2007). There is wide gap between supply and demand of maize in Nepal. Mostly, poor management technology, lack of judicious use of nitrogen and high cost of cultivation are major causes for low production of maize in Nepal. The researchers and farmers are looking to adopt alternative tillage methods due to environmental concerns and costs involved. As compared to conventional tillage, yield returns under zero tillage maize production are similar to or even exceed in some cases. Undisturbed soil possesses higher microorganisms and biological activity (Sturny, 1998), which in turn increase nitrogen immobilization, decreases its loss through leaching and results in denitrification (Gilliam and Hoyt, 1987). Generally in zero tillage, fertilizer N rates have been increased as much as 25% to counter the adverse effect on yield from short term immobilization (Randall and Bandel, 1991). Split applications and small basal application are effective fertilizer strategies to reduce nutrient leaching (Sitthaphanit *et al.*, 2009). The timing of any fertilizer application is another low-cost strategy to reduce nutrient leaching, so that nutrient supply is synchronized with plant nutrient demand (Gehl *et al.*, 2005). N fertilization at fine-tuning rate and time by split application in order to coincide nitrogen availability with crop needs is a best management practice that would result in better N use efficiency and yield. Therefore, beneficial tillage system, N levels and N application timings which enhance yield expression were tested and verified to provide better alternative management practices to the farmers facing problem of low maize yield.

Materials and Methods

Field experiment was conducted at Phulbari VDC, Chitwan, Nepal during 2012 (Feb-July).The experimental soil was sandy loam in texture, having slightly acidic pH (5.8), organic matter (2.84), total nitrogen (0.12), available phosphorus (55.43 kg ha^{-1}), available potassium (197.97 kg ha^{-1}). The experiment was laid out in split-split plot design consisting 12 treatments with three replications. Treatments consisted of two tillage systems (conventional and zero tillage) as main factor, three nitrogen levels (60, 120 and 180 kg N ha $^{-1}$) as sub plots and spilt application of Nitrogen (50 % each at basal and 45 DAS & 25% each at basal, 30, 45 and 60 DAS) as sub sub plot. Maize variety Bioseed Raj Kumar was planted with plot size of 14.4 m^2 (4.8 m x 3 m) at the spacing of 60 ×25 cm^2 (RR to PP). Maize crop was fertilized with 60/120/180:60:40 NPK Kg ha^{-1} through urea, SSP and

MOP. The sowing was done on 28th February, 2012 (15th Falgun, 2068).Single plant per hill was maintained by thinning extra plants on 25 DAS. Two weeding cum inter culture at 25 and 55 DAS and three irrigation at grand growth stage, tasseling stage and milking stage were given. Carbofuran @ 2-3 granule per plant against stem borer was applied at grand growth stage. The crop from net plot area was harvested on 15th July, 2012 (31th Ashar, 2069). MSTAT-C package was used for data analysis and mean was separated at 5% level of significance.

Results and Discussion

Effect on yield attributes

Thousand grain weight (gm), number kernel rows ear^{-1} and number kernels ear^{-1} were not significantly affected by the tillage. However, thousand grain weight (gm), number kernel rows ear^{-1} and number kernels ear^{-1} were higher in conventional tillage than zero tillage (Table 1). There was trend of increasing thousand grain weight, number kernel rows ear^{-1} and number kernels ear^{-1} with increasing N levels from 60 kg ha^{-1} to 180 kg ha^{-1}.Thousand grain weight, number kernel rows ear^{-1} and number kernels ear^{-1} at 180 N Kg/ha were significantly higher than at 120 and 60 kg ha^{-1} N application but number kernel rows ear^{-1} was at par with both 180 and 120 Kg N ha^{-1} (Table 1). Gokmen *et al*. (2001) and Wajid *et al*. (2007) reported that 1000 grain weight increased with increasing N levels. Gungula *et al*. (2007) and Dawadi (2009) observed number of kernels ear^{-1} and number kernel rows ear^{-1} increased with increasing nitrogen levels. Thousand grain weight and kernel rows ear-^{1} were not significantly influenced by split application of nitrogen but number of kernels ear^{-1} was significantly influenced by split application of nitrogen. The equal four split application of N had higher number of kernels ear^{-1} than two equal split applications of N (Table 1). Similar result was found by Amanullah *et al*. (2009) observed number of seed per kernels increased with increase in 4-5 number of N split applications.

Effect on grain yield, stover yield and harvest index

Grain yield (t ha^{-1}), stover yield (t ha^{-1}) and harvest index (%) were not significantly affected by the tillage. However, higher grain yield (7.53 t ha^{-1}) and stover yield (11.63 t ha^{-1}) obtained from CT than grain yield (7.37 ton ha-^{1}) and stover yield (11.29 ton ha^{-1}) obtained from ZT (Table 2). Similarly, tillage had non-significant effect on harvest index as the difference in grain yield and stover yield was not large enough to cause significance in the harvest index. Grain yield, stover yield and harvest index were significantly influenced by the nitrogen levels. The increasing nitrogen levels from 60 to 180 kg ha^{-1} increased the grain yield and stover yield of maize. 180 kg ha^{-1} N application produced grain yield (8.91 t ha^{-1}) and stover yield (13. 69 t ha^{-1}) which was significantly higher than 120 and 60 kg ha^{-1} N application. Harvest index was lowest at 60 kg N ha^{-1} and increased up to 120 kg N ha^{-1}. HI was at par with 120 and 180 kg ha^{-1} N application. Significant increment in grain yield of maize with successive increment in nitrogen rates might be due to significant increment in all yield attributes i.e. number of kernel rows ear^{-1}, number of kernel ear^{-1} and test weight. Ullah *et al.* (2006) also reported that grain yield and stover yield increased with increasing nitrogen levels. Four equal split application of N produced higher grain yield (7.68 t ha^{-1}) and stover yield (11.93 t ha^{-1}) than grain yield (7.22 t ha^{-1}) and stover yield (10.99 t ha^{-1}) from two equal split application of N. But, harvest index was not influenced by split application of N. Grain yield and stover yield significantly increased when N fertilizer was applied in 4-5 splits dose than 2 split dose (Amanullah *et al*., 2007).

Table 1: Effect of tillage, nitrogen levels and split application of N on *thousand grain weight, number of kernels raw ear $^{-1}$ and number of kernels ear^{-1}* on spring maize at Phulbari, Chitwan, 2012

Treatment	1000 grain weight(g)	No. kernel rows ear-^{1}	No. kernels ear-^{1}
Tillage			
Conventional	291.0	13.89	468.9
Zero	287.2	13.68	455.8
LSD	NS	NS	NS
SEm±	0.7	0.084	5.74
Nitrogen levels			
60 kg/ha	252.7 ^{c}	12.38 ^{b}	369.0 ^{c}
120 kg/ha	299.6 ^{b}	14.12 ^{a}	466.1 ^{b}
180 kg/ha	315.0 ^{a}	14.86 ^{a}	555.9 ^{a}
LSD	6.498	0.768	61.00
SEm±	1.992	0.236	18.71
Split application of nitrogen			
Two equal	285.5	13.59	443.0 ^{b}
Four equal	292.8	13.99	481.7 ^{a}
LSD	NS	NS	37.80
SEm±	3.064	0.1544	12.27
CV%	4.50 %	4.75 %	11.26 %
Grand mean	289.12	13.79	462.35

Non-significant (NS). Means followed by the common letter within each column are not significantly different at 5% level of significance by DMRT.

Table 2: Effect of tillage, nitrogen levels and split application of N on *grain yield (t ha^{-1}), stover yield (t ha^{-1}) and harvest index (%)* on spring maize at Phulbari, Chitwan, 2012

Treatment	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Harvest index (%)
Tillage			
Conventional	7.53	11.63	0.39
Zero	7.37	11.29	0.39
LSD	NS	NS	NS
SEm±	0.03162	0.1595	0.002357
Nitrogen levels			
60 kg/ha	5.29 ^{c}	8.45 ^{c}	0.38 ^{b}
120 kg/ha	8.15 ^{b}	12.24 ^{b}	0.40 ^{a}
180 kg/ha	8.91 ^{a}	13.69 ^{a}	0. 39 ^{a}
LSD	0.491	0.878	0.00941
SEm±	0.1506	0.2691	0.002887
Split application of nitrogen			
Two equal	7.22 ^{b}	10.99 ^{b}	0.39
Four equal	7.68 ^{a}	11.93 ^{a}	0.39
LSD	0.352	0.766	NS
SEm±	0.114	0.249	0.00235
CV%	9.50 %	10.20 %	4.40 %
Grand mean	7.45	11.46	0.39

Non-significant (NS). Means followed by the common letter within each column are not significantly different at 5% level of significance by DMRT.

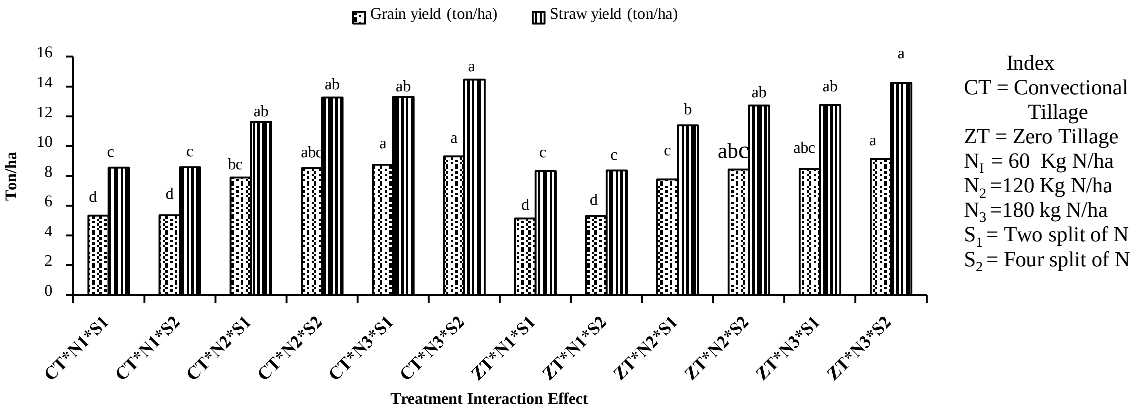

Fig. 1: Interaction effect of tillage, nitrogen levels and split application of N on grain yield and straw yield of spring maize at Phubari, Chitwan, 2012

There was no interaction between tillage, nitrogen levels and split application of N on grain yield and stover yield (Fig. 1). The grain yield and stover yield was higher as well as statistically similar in both tillage system under 180 kg N ha^{-1} and four split application of N. Grain yield and stover yield were at par with both two and four equal split application of 60 kg N ha^{-1}. Likewise, four equal split application of 120 kg N ha^{-1} had similar grain yield and stover yield as that of two equal split application of 180 kg N ha^{-1}

Conclusion

Yield and yield attributes were not influenced by tillage system. Application of 180 N kg ha^{-1} resulted in maximum thousand grain weight, number kernels ear^{-1}, grain yield and stover yield than than application of 120 and 60 kg N ha^{-1}. Four equal split application of N concluded in higher kernels ear^{-1}, grain and stover yield than two equal split of N. Further research works for understanding the response of tillage, nitrogen levels and timing of nitrogen for higher sustainable maize production in different agro-ecological conditions is recommended

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