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Effect of tillage practices, weed control and nitrogen levels on yield and growth attributes and nitrogen content in rainfed maize (*Zea mays L.*)

Awadhesh Kumar[1*], V.B. Jaiswal[2] and V.K. Kanaujia[3]

[1]Deptt. of Soil Conservation and Water Management, [2]S M S (Agronomy) and [3]Programme Coordinator,
Directorate of Extension (K.V.K.), C. S. Azad University ofAgriculture and Technology, Kanpur-208002 (U.P.)
***e-mail:** awadheshy427@gmial.com

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Abstract: This experiment was conducted during Kharif 2003 and 2004 at the Soil Conservation and Water Management farm of C.S. Azad University of Agriculture and Technology, Kanpur to find out the impact of tillage practices, weed control methods and nitrogen levels on yield, growth and N concentration in rainfed maize (*Zea mays L.*). Grain and stover yield, growth characteristics like shoot growth, functional leaves, leaf area index and plant dry weight and concentration and total uptake of N in maize was the highest in deep ploughed with MB plough (T_4) followed by two ploughing with cultivator (T_2) and two ploughing with *desi* plough (T_1) but the lowest was under one ploughing with disc harrow (T_3). Pre-emergence application of Atrazine resulted significantly higher growth and yield of maize and N uptake by crop. Application of N up to 120 kg ha^{-1} has significantly increased higher growth and yield of maize and also resulted higher uptake of N over lower levels of the N application.

Key words: Growth attribute, Maize, Nitrogen uptake, Pre-emergence, Tillage, Yield

Introduction

Maize (*Zea mays L.*) is an important cereal crop of the world. In India, it ranks next to rice, wheat, jowar and bajara in respect to area and production. It is generally grown under rainfed condition where poor management of rainfall leads to low and unstable crop production. Tillage, weed and nutrient, specially, nitrogen management may be the integral component of soil and crop management under rain dependent areas. Proper tillage significantly reduces the bulk density and an increase in soil porosity, hydraulic conductivity and infiltration rate and ultimately enhances the profile soil moisture content. Maize is heavily fertilized and widely spaced encourage heavy weed infestation which result into drastic reduction in grain yield. Mechanical weeding is good for root aeration but often it is not possible due to continuous rains during rainy seasons. Therefore, herbicides are getting popularity because of their easiness in application, less time consuming and economical (Daway *et. al.*, 1979).

Materials and Methods

This experiment was conducted during *kharif* season of 2003 and 2004 at the Soil Conservation and Water Management farm of the C.S. Azad University of Agriculture and Technology, Kanpur, lies between 25°26' and 26°58' N latitude and 79°31' and 80^{0}34' E longitude and at 129 m altitude above mean sea level. It is falling in the sub-tropical zone having semi-arid climate and receiving about 800 mm average annual rainfall. The soil of the experimental field was sandy loam having 1.42 Mgm^{-3} bulk density, 29.10% water holding capacity and 11.56% soil aggregates (>0.25 mm). The soil pH was 7.4 and electrical conductivity 0.36 dSm^{-1} with organic carbon content of 0.32%, total available nitrogen 270.0 kg ha^{-1} available phosphorus 18.40 kg ha^{-1} and available potash 184.7 kg ha^{-1}. The experiment comprised 24 treatment combinations of four tillage practices viz., (1) two ploughing with *desi* plough (T_1), (2) two ploughing with cultivator (T_2), (3) one ploughing with disc harrow.(T_3) and (4) one ploughing with MB plough (T_4), two weed control measures viz., (1) weeding and one hoeing (W_1) and (2) Atrazine as pre-emergence (W_2) and three nitrogen levels viz., (1) control without N (N_0), (2) 60 kg N ha^{-1} (N_1) and (3) 120 kg N ha^{-1} (N_2) and was laid out in the split plot design with three replications. Tillage and weed control methods were assigned to main plots and nitrogen levels in sub-plot. The recommended dose of phosphorus (60 kg ha^{-1}) and potash (40 kg ha^{-1}) was applied uniformally in all the treatments. The half dose of nitrogen was applied at sowing and remaining in two equal split doses at 20 and 40 DAS (days after sowing) as per treatments. Maize var. Azad Uttam was sown on July 17, 2003 and July 20, 2004 at a spacing of 45 cm apart by using 25 kg seed ha^{-1} and plant to plant spacing of 20 cm was maintained by thinning after 15 days of sowing. As per treatment, Atrazine as pre-emergence was applied @ 1 kg a.i. ha^{-1} at the next day of sowing and hand weeding and hoeing was done at 20 DAS. Growth observations were recorded at 30 and 60 DAS and yield after crop harvesting on Oct., 4 and 6 of 2003 and 2004, respectively. N content was analyzed by micro-Kjeldahl method given by Piper (1966) and uptake was computed by multiplying N content with dry matter of plant, grain and stover.

Results and Discussion

Yield: Grain and stover yield of maize was significantly influenced by tillage practices, weed control measures and nitrogen levels. Significantly highest grain and stover yield was received under T_4

Table 1: Growth Characters of Maize as influenced by tillage practices, weed control and N levels

Treatment	Functional leves (No.)				Leaf area index				Dry weight (g/Plant)				Shoot girth		Plant height	
	30 DAS		60 DAS		30 DAS		60 DAS		30 DAS		60 DAS		(cm)		(cm)	
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Tillage Practices																
T_1	7.6	7.3	11.5	11.1	0.95	0.82	3.10	2.64	16.0	14.2	123.6	113.3	7.3	6.9	192.1	184.5
T_2	8.1	7.9	12.3	11.9	1.02	0.89	3.36	2.83	17.4	15.0	134.6	120.4	7.4	7.1	205.2	197.7
T_3	7.2	7.0	11.0	10.7	0.91	0.78	2.97	2.54	14.8	13.5	114.8	108.2	7.2	6.9	184.0	177.3
T_4	8.4	8.2	12.8	12.4	1.06	0.92	3.45	2.96	20.1	17.4	155.4	139.9	7.6	7.3	213.7	206.5
S.E. (d)	0.10	0.16	0.14	0.24	0.01	0.01	0.10	0.04	0.40	0.37	3.56	3.24	0.14	0.12	4.58	2.94
C.D.(P=0.05)	0.22	0.34	0.31	0.51	0.03	0.03	0.21	0.09	0.087	0.79	7.64	6.94	0.29	0.25	9.83	6.30
Weed Control																
W_1	7.7	7.4	11.6	11.3	0.96	0.83	3.15	2.67	16.0	14.2	123.6	114.3	7.2	6.9	193.5	186.2
W_2	8.0	7.8	12.1	11.8	1.01	0.87	3.29	2.82	18.1	15.8	140.6	126.6	7.5	7.2	204.0	196.9
S.E. (d)	0.07	0.11	0.10	0.17	0.01	0.01	0.07	0.03	0.29	0.26	2.52	2.29	0.10	0.08	3.24	20.8
C.D.(P=0.05)	0.16	0.24	0.22	0.36	0.02	0.02	N.S.	0.06	0.61	0.56	5.40	4.91	0.21	0.18	6.95	4.46
Nitrogen Levels																
N_0	7.1	6.8	10.9	10.3	0.89	0.76	2.95	2.48	11.9	11.00	90.2	84.1	6.6	6.3	180.6	172.8
N_1	8.0	7.9	12.2	11.9	1.01	0.88	3.29	2.83	17.8	15.9	137.5	128.2	7.5	7.2	203.8	197.3
N_2	8.4	8.2	12.7	12.3	1.05	0.91	3.42	2.13	21.5	18.6	168.7	149.0	7.9	7.6	211.9	204.5
S.E. (d)	0.18	0.20	0.22	0.23	0.02	0.02	0.10	0.07	0.48	0.042	3.87	3.46	0.16	0.14	5.02	5.25
C.D.(P=0.05)	0.37	0.41	0.45	0.46	0.04	0.04	0.20	0.15	0.97	0.86	7.89	7.05	0.33	0.29	10.23	10.69

Table 2: Yield attributes of maize as influence by tillage practices, weed control and N levels

Treatment	No. of cobs/Plant		Grain weight/plant (g)		Shelling (%)	
	2003	2004	2003	2004	2003	2004
Tillage Practices						
T_1	1.05	1.04	34.30	30.96	78.76	77.78
T_2	1.07	1.06	37.54	33.10	79.67	78.84
T_3	1.04	1.03	31.83	28.96	77.99	77.07
T_4	1.09	1.09	44.17	38.18	80.14	79.71
S.E. (d)	0.007	0.012	1.01	1.03	0.69	0.67
C.D. (P=0.05)	0.014	0.025	2.17	2.21	1.48	1.43
Weed control						
W_1	1.05	1.05	34.39	31.01	78.67	78.14
W_2	1.07	1.06	39.52	34.59	79.61	78.57
S.E. (d)	0.005	0.008	0.71	0.73	0.49	0.47
C.D. (P=0.05)	0.010	0.018	1.53	1.56	NS	NS
Nitrogen Levels						
N_0	1.03	1.03	24.97	22.75	76.14	75.04
N_1	1.07	1.06	38.72	34.74	79.53	78.89
N_2	1.09	1.07	47.18	40.91	81.75	81.14
S.E. (d)	0.007	0.010	1.07	1.05	0.76	0.77
C.D. (P=0.05)	0.014	0.020	2.17	2.14	1.56	1.57

which was 16.8 and 16.1, 26.5 and 22.9 and 37.3 and 31.5 per cent higher than T_2, T_1 and T_3 over both years, respectively (Table-3). Similar findings were given by Singh *et al*. (2002) and Kumar (2005). Pre-emergence application of atrazine produced significantly higher grain (28.15 q ha^{-1}) and stover (101.24 q h^{-1}) yield which was 3.28 and 11.83 q ha^{-1} higher than weeding and hoeing practice of weed control. It was due to minimal weed count under W_2 right from germination of maize (Rout and Satapathy, 1996 and Porwal, 2000). Maize yield was also significantly increased with increasing doses of nitrogen. The mean grain and sotver yield 33.55 and 123.74, 27.91 and 85.86 and 18.09 and 55.85 q ha^{-1} was received under 120, 60 and 0 (control) kg N ha^{-1}, respectively. Singh *et al*., 2000 also reported increase in yield of *rabi* maize with increasing N doses up to 200 kg ha^{-1}.

Yield attributes: Number of cobs and grain weight per plant and shelling percentage was observed the significantly highest under one ploughing with mould board plough (T_4) followed by two ploughing with cultivator (T_2) and two ploughing with desi plough

Table 3: Grain and stover yield of maize as influenced by tillage practices, weed control and N levels

Treatments	Grain yield (q/ha)		Stover yield (q/ha)	
	2003	2004	2003	2004
Tillage Practices				
T_1	26.29	23.39	82.39	72.00
T_2	28.74	25.05	88.39	75.32
T_3	24.00	21.79	75.72	68.46
T_4	33.75	29.11	103.11	87.50
S.E. (d)	0.90	0.70	2.41	2.11
C.D. (P=0.05)	1.92	1.50	5.18	4.52
Weed Control				
W_1	26.29	23.46	81.64	72.02
W_2	30.10	26.21	93.16	79.62
S.E. (d)	0.63	0.49	1.71	1.49
C.D. (P=0.05)	1.36	1.06	3.66	3.20
Nitrogen Levels				
N_0	19.11	17.07	59.25	52.44
N_1	29.45	26.37	91.31	80.41
N_2	36.02	31.07	111.64	94.60
S.E. (d)	1.43	0.80	2.78	2.35
C.D. (P=0.05)	2.92	1.46	5.65	4.79

(T_1) but these attributes were lowest under one ploughing with disc harrow (T_3). Varsa *et al.* (1997) reported that deep tillage of soil resulted in increased number of cobs per plant and cob weight. Number of cobs and grain weight per plant and shelling percentage was recorded higher under atrazine (W_2) treated plot as compared to manual weeding (W_1). It is attributes mainly due to less weed competition under atrazine (Rout and Satapathy, 1996).Yield attributes were increased significantly with increasing dose of nitrogen. The number of cobs and grain weight per plant and shelling percentage was the highest under 120 kg N/ha followed by 60 kg N/ha and without N/ha. Similar observations were also recorded by Shivay *et al*. (1999) and Singh *et. al*. (2000)

Growth attributes: Plant height, functional leaves, leaf area index, shoot girth and dry plant weight was recorded the significantly higher under deep ploughing (T_4) over T_2, T_1 and T_3. However, T_2 and T_1 practices were also superior to T_3 (Table 2). These growth characteristics were also significantly influenced due to application of Atrazine as pre-emergence in comparison to weeding and hoeing practice. Kandaswarny *et al.* (1997) and Singh *et al.* (1998) reported that pre-emergence spray of atrazine showed significant effect on growth attributes over other treatments of weed control. Significant response of nitrogen upto 120 kg ha^{-1} was observed on growth characteristics of maize. Plant weight, shoot girth, functional leaves, leaf area index and dry plant weight was registered the highest in 120 kg N ha^{-1} treated plot followed by 60 kg N ha^{-1} but the lowest in control plot (no nitrogen). Shivay *et at.* (1999) also reported significant increase in growth parameters with increasing doses of N applied to maize.

N content and uptake: N content in plants (1.74 and 1.34 %), grain (1.68%) and stover (0.78%) and its uptake by maize crop (129.68 kg ha^{-1}) was estimated the highest in tillage operation with mould board plough (T_4) followed by two ploughing with cultivator (T_2) and *desi* plough (T_1) but the lowest under one ploughing with disc harrow (T_3). The higher N content and uptake by crop under deep ploughing was mainly due to good moisture content, aeration and root development which enhanced the plant growth and finally the uptake and content of N. Similar findings were also given by Reddy *et al.* (1978) and Ide *et. al*. (1985). Atrazine (W_2) resulted higher N content in plant, grain and stover and significantly higher N uptake over manual weeding (W_1). Thakur (1992) and Joshi *et. al.* (1993) also reported that application of herbicide as pre-

Table 4: N content and uptake in maize as influenced by tillage practices, weed control and N levels

Treatment	N content in plant, grain and stover of maize (%)								Total N uptake (kg/ha)	
	30 DAS		60 DAS		Grain		Stover			
	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004
Tillage practices										
T_1	1.59	1.57	1.26	1.24	1.58	1.52	0.73	0.72	102.62	88.00
T_2	1.64	1.61	1.29	1.28	1.62	1.55	0.76	0.75	114.36	95.65
T_3	1.58	1.58	1.24	1.21	1.51	1.50	0.73	0.70	92.60	80.86
T_4	1.74	1.74	1.38	1.32	1.74	1.62	0.80	0.76	143.04	114.33
S.E. (d)									3.43	2.03
C.D. (P=0.05)									7.35	4.36
Weed control										
W_1	1.61	1.57	1.27	1.24	1.57	1.52	0.75	0.72	103.66	88.41
W_2	1.66	1.62	1.31	1.27	1.65	1.57	0.77	0.74	122.65	101.01
S.E. (d)									2.42	1.44
C.D. (P=0.05)									5.20	3.08
Nitrogen levels										
N_0	1.49	1.45	1.26	1.22	1.52	1.49	0.73	0.71	73.21	63.43
N_1	1.58	1.53	1.29	1.25	1.64	1.54	0.76	0.73	118.12	100.06
N_2	1.84	1.80	1.32	1.29	1.68	1.58	0.78	0.75	148.12	120.64
S.E. (d)									3.07	1.84
C.D. (P=0.05)									6.25	3.74

emergence were effective in keeping low weed density. Concentration and uptake of N in plants was increased with increasing levels of N upto 120 kg ha^{-1} (Kumar and Ahlawat, 2004). It was mainly due to sufficient availability of N in the soil which helped in higher uptake of N and finally increased N concentration in plants. The total uptake and concentration of N in maize was recorded the highest under 120 kg N ha^{-1} followed by 60 kg N ha^{-1} and the lowest under control.

Deep ploughing with MB plough, chemical weed control with Atrazine and application of 120 kg N ha^{-1} were responded significantly in enhancing the plant growth and crop yield and boosted the uptake of N over other tillage practices, weed control measure and N levels.

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