Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2022; 11(1): 179-184
Received: 09-11-2021
Accepted: 11-12-2021

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Effect of fertigation levels and weed management on yield and nutrient uptake by maize in Inceptisols

Dhanashri Shid, PR Kadu, NM Konde, JP Deshmukh and PR Jadhvar

Abstract
A field study was conducted during *kharif* 2020-21 at Research farm of AICRP on Weed Management, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra to Effect of Fertigation Levels and Weed Management on Yield and Nutrient Uptake by Maize in Inceptisols. The soil of the experimental site was Inceptisol which was moderately alkaline in reaction, low in available nitrogen, medium in available phosphorus and medium in available potassium, deficient in available sulphur, zinc and iron, whereas fairly high in available Cu and Mn. The experiment was laid out in split plot design with three replications. The twenty treatments consisting of four different of fertigation levels and five different of weed management practices. The main plot treatments comprised of different levels of fertilizer in five splits at 75 per cent, 100 per cent and 125 per cent of recommended dose of N and K of fertilizers given through fertigation, however P was applied as basal dose and these treatment were compared with 100 per cent soil application of fertilizers. Whereas, sub plot treatments comprised of five weed management practices *viz.*, Atrazine+ Tembotrione, Atrazine + Topramezon, Atrazine + Halosulfuron, Farmers practices and weedy ckeck. The yield found to be lowest with 75 per cent RDNK and highest with 125 per cent RDNK (5 splits). Among the various weed management practices under study farmers practice (2 hoeing 15-20 Days interval after sowing followed by 2 HW) recorded significantly higher values of major parameters. The nutrient uptake by weeds was lowest in weedy check condition. However, total nutrient uptake by crop was observed maximum in farmers practices followed by Atrazine 0.75 kg/ha PE followed by Topramezone 0.0252 kg/ha POE 20 DAS.

Keywords: Fertigation levels, weed management, Inceptisols, yield, nutrient uptake, farmers practices and maize

Introduction
Maize (*Zea mays* L.), popularly known as makka or makki in India, is one of the front runner versatile crop from Poaceae family. It has emerged as the third most important crop of the globe after wheat and rice. It is known as "Queen of Cereals", due to high productiveness. Globally, it is cultivated on more than 160 million ha area across 166 countries having wider diversity of soil, climate and management practices. The world's total maize production was estimated at 1.07 million thousand tonnes in 2020. Maize is of American origin having been domesticated about 7000 years ago. The United States of America (USA) is the largest producer of maize contributes nearly 35 % of the total production in the world and it is the driver of economy in US. In India, states having largest producers of maize are Karnataka (15%), followed by Rajasthan (13%) and Madhya Pradesh (10%).In Maharashtra Nashik District is top region of Maize production. Nashik accounts for 546,100 tonnes (21.95%) of total production in state. The average productivity during the period has increased by 5.42 times from 547 kg ha^{-1} to 2965 kg ha^{-1} while area increased nearly by three times. Though the productivity in India is almost half of world the average per day productivity of Indian maize is at par with many leading maize producing countries.

Weed management practices in maize considered as most important at critical stages of crop. Weed competition in maize crop observed from 30-45 days after sowing. Amongst all factors, weed accounts for 28-100% yield loss. In maize, appropriate fertigation practices based on actual limiting nutrients and crop requirement is economic and also profitable to increase productivity and yield of the crop. Nutrients are often limiting factor for plant growth. Farmers must supply supplemental nutrients through fertigation system to increase advance yield of the crop and productivity. Fertigation is an appropriate practice for the betterment of the crop yield. Liang *et al.* (1992) [9] reported that with increasing NPK levels through fertigation system significantly increased the grain and straw yield of the Maize.

Fuering *et al.* (1974) [5] stated that applications of fertilizers in presence of irrigation water i.e. through fertigation recorded significantly better interaction on grain yield.

Materials and Methods

The field experiment was carried out at the All India Coordinated Research Project on Weed Management, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the *kharif* season 2020-21 with twenty treatments replicated three times in split plot design. The treatments comprised of control, 100% RDF (120:60:60 NPK kg ha^{-1}) in 3 splits, 75 %, 100 %, 125 % RDNK in combination with Atrazine + Tembotrione, Atrazine + Topramezone, Atrazine + Halosulfuron methyl, Farmers practices and Weedy check. Where N and K applied as basal and topdressed and P applied as basal dose through fertigation.

Results and Discussion

Yield

Fertigation levels and weed management practices had marked and favourable influence on yield of maize.

Effect of fertigation levels

Fertigation levels had marked and favourable influence on growth and yield. There was a significant response to fertigation of 125 per cent RDNK ha^{-1} through fertigation in five splits (52.67 q ha^{-1} and 78.50 q ha^{-1}) than other lower level of fertigation (100 and 75 per cent). The lowest maize yield was recorded at 75 per cent RDNK ha^{-1} applied through fertigation in 5 splits (44.95 q ha^{-1} and 65.33 q ha^{-1}). The saving of fertilizers might be due to reduction in losses of nutrients through volatilization and leaching and better movement of nutrients under fertigation as against soil application of fertilizers as reported by Bharambe *et al.* (1997) [2], Kadam (1997) [7], Shelke *et al.* (1999) [15], Yende (2003) [16] and Pawar *et al.* (2013) [12]. Sivakaran (1999) in maize and sunflower, Deolankar and Berad (1999) [3] in chickpea also reported 20-25 per cent fertilizer saving and yield increase due to fertigation over soil application.

Effect of weed management practices

Among the weed management treatments, W_4 (Farmers practice 3 hoeing 15-20 Days interval after sowing followed by 3 HW)) recorded significantly higher grain and straw yield of maize (55.28 q ha^{-1} and 78.00 q ha^{-1}) followed by W_2, W_1, W_3 and W_5. The lowest grain and straw yield of maize (31.23 q ha^{-1} and 57.02 q ha^{-1}) was recorded with weedy check (W_5). These results are in conformity with the findings of Singh *et al.* (2016) [17], Kakade *et al.* (1999) [8].

Interaction effect

The interaction effect between different fertigation levels and weed management practices on yield of maize was found to be non significant.

Table 1: Effect of fertigation levels and weed management practices on yield of Maize

Treatments	Grain yield	Straw yield
	(q ha^{-1})	
Fertigation levels		
F_1 - 100 % RDF (3 Splits)	47.70	69.29
F_2 - 75 % RDNK (5 Splits)	44.95	65.33
F_3 - 100 % RDNK (5 Splits)	48.67	73.22
F_4 -125 % RDNK (5 Splits)	52.67	78.50
SE (m) ±	1.10	1.35
CD at 5 %	3.80	4.66
Weed management practices		
W_1 -Atrazine + Tembotrione	51.91	74.17
W_2 - Atrazine + Topramezone	53.54	75.37
W_3 - Atrazine + Halosulfuron	50.53	73.36
W_4 - Farmers practices	55.28	78.00
W_5 - Weedy check	31.23	57.02
SE (m) ±	1.11	1.48
CD at 5 %	3.20	4.26
Interaction (FxW)		
SE	2.22	2.95
CD at 5 %	4.44	8.51

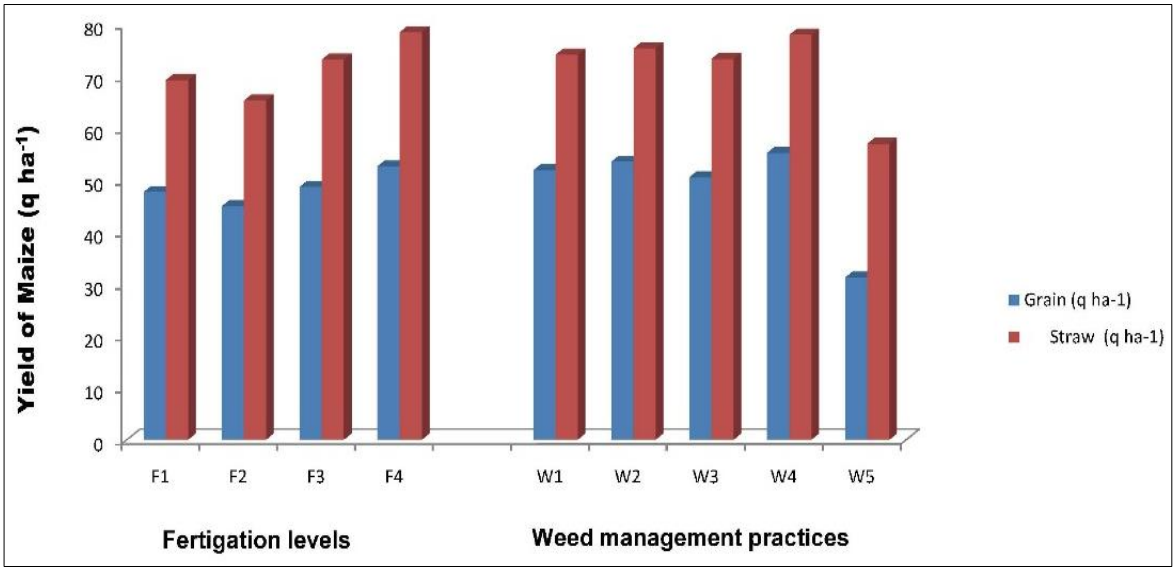

Fig 1: Effect of fertigation levels and weed management practices on yield of maize

Uptake of nutrients

The concentration and availability of various nutrients in the soil for plant uptake depends on soil solution phase which is mainly determined by soil moisture availability. The higher available soil moisture provided due to continuous water supply at alternate days under drip irrigation led to higher availability of nutrients in the soil and thereby increased the nutrient uptake under drip fertigation levels in splits was the result of increased biomass production due to continuous availability of water and nutrients to the crop.

Uptake of nitrogen
Fertigation has vital effect on uptake of nitrogen. The present investigation showed that there is variant difference in the range of uptake of nitrogen in soil due to different fertigation levels and weed management practices.

Effect of fertigation levels
The uptake of nitrogen by maize was differed significantly. The maximum uptake of nitrogen observed in F_4 (154.92 kg ha^{-1}) with 125 % RDNK (5 splits) and minimum in F_2 (130.06 kg ha^{-1}) with 75 % RDNK (5 splits). The nutrient uptake of nitrogen with 125 % RDNK ha^{-1} through fertigation which was significantly higher than 75 % RDNK ha$^{-1.}$ Application of 100 % RDNK ha^{-1} was found second best treatment in respect of uptake of nitrogen.

Effect of weed management practices
Weed management practices significantly influenced on uptake of nitrogen. The present investigation showed that the maximum uptake of nitrogen (166.49 kg ha^{-1}) by maize was found with treatment W_4 (Farmers practice 2 hoeing 15-20 Days interval after sowing followed by 2 HW)) followed by W_2, W_1 and W_3. The minimum uptake of nitrogen (96.74 kg ha^{-1}) by crop was recorded with weedy check, where growth of maize suppressed by weeds and nutrients diverted to weed growth than maize growth. This might be due to reduced crop-weed competition favourably influenced growth of crop due to favourably soil environmental condition resulted in increasing soil nutrient mineralization and thereby increase in residual status of soil nutrient after harvest of maize crop.

Interaction effect
Interaction of fertigation levels and weed management practices in case of nitrogen uptake found to be significant. Similar findings are given by Anjum *et al.* (2007) [1], Deshpande *et al.* (2006) [4], Patil *et al.* (1998) [10] and Pawar *et al*. (2000).

Uptake of phosphorus
The present investigation showed that there is variant difference in the range of uptake of phosphorus in soil due to different fertigation levels and weed management practices. The results pertaining to phosphorus status of soil was significantly influenced by different fertigation levels and weed management practices.

Effect of fertigation levels
The uptake of total phosphorus by maize was differed significantly due to different fertilizer levels. The maximum uptake of phosphorus observed in F_4 (26.72 kg ha^{-1}) with 125 % RDNK (5 splits) and minimum in F_2 (20.70 kg ha^{-1}) with 75 % RDNK (5 splits). The nutrient uptake of phosphorus with 125 per cent RDNK ha^{-1} through fertigation which was significantly higher than 75 per cent RDNK ha^{-1}. Application of 100 per cent RDNK ha^{-1} was found second best treatment in respect of uptake of phosphorus.

Effect of weed management practices
Weed management practices influenced on uptake of phosphorus. The present investigation showed that the maximum uptake of phosphorus (28.70 kg ha^{-1}) by maize was found with treatment W_4 (Farmers practice 2 hoeing 15-20 Days interval after sowing *fb* 2 HW)) followed by W_2, W_1 and W_3. Minimum uptake of phosphorus (15.52kg ha^{-1}) by crop was recorded with weedy check, where growth of maize suppressed by weeds and nutrients diverted to weed growth than maize growth.

Interaction effect
Interaction of fertigation levels and weed management practices in case of phosphorous uptake found to be significant.

Uptake of potassium
The results pertaining to potassium status of soil was significantly influenced by different fertigation levels and weed management practices. While the interaction of fertigation levels with weed management practices noted significant.

Effect of fertigation levels
The uptake of total potassium by Maize was differed significantly due to different fertilizer levels. The maximum uptake of potassium observed in F_4 (137.06 kg ha^{-1}) with 125 % RDNK (5 splits) and minimum in F_2 (103.32 kg ha^{-1}) with 75 % RDNK (5 splits). The nutrient uptake of potassium with 125 per cent RDNK ha^{-1} through fertigation which was significantly higher than 75 per cent RDNK ha^{-1}. Application of 100 per cent RDNK ha^{-1} was found second best treatment in respect of uptake of potassium.

Effect of weed management practices
Weed management practices significantly influenced on uptake of potassium. The present investigation showed that the maximum uptake of potassium (135.70 kg ha^{-1}) by maize was found with treatment W_4 (Farmers practice 2 hoeing 15-20 Days interval after sowing *fb* 2 HW)) followed by W_2, W_1 and W_3. Minimum uptake of potassium (91.69 kg ha^{-1}) by crop was recorded with weedy check.

Table 2: Effect of fertigation levels and weed management practices on uptake of nitrogen, phosphorus and potassium after harvest of maize

Treatments	Nitrogen	Phosphorous	Potassium
	(kg ha^{-1})		
Fertigation levels			
F_1 - 100 % RDF (3 Splits)	138.71	21.27	116.42
F_2 - 75 % RDNK (5 Splits)	130.06	20.70	103.32
F_3 - 100 % RDNK (5 Splits)	145.63	23.70	124.80
F_4 -125 % RDNK (5 Splits)	154.92	26.72	137.06
SE (m) ±	1.45	0.70	1.77
CD at 5 %	5.03	2.41	6.12
Weed management practices			
W_1 -Atrazine + Tembotrione	147.81	23.70	124.95
W_2- Atrazine + Topramezone	153.44	24.11	126.04
W_3 - Atrazine + Halosulfuron	147.18	23.48	123.61
W_4 - Farmers practices	166.49	28.70	135.70
W_5 - Weedy check	96.74	15.52	91.69
SE (m) ±	1.51	1.02	2.66
CD at 5 %	4.35	2.93	7.78
Interaction (FxW)			
SE	3.02	2.03	5.33
CD at 5 %	9.04	5.85	8.01

Interaction effect
Interaction of fertigation levels and weed management practices in case of potassium uptake found to be significant. Similar results found by Sathyaprakash *et al.* (2007) [14] at TNAU, Coimbatore revealed that nutrient uptake was favorable increased with higher level of NPK through fertigation in maize as compared to soil application of

fertilizer at all the growth stages of maize. Higher dose of NPK through fertigation shows significant influence on post harvest soil available nutrients. Higher post harvest available N, P and K in soil were recorded under drip fertigation as compared to soil application of fertilizer.

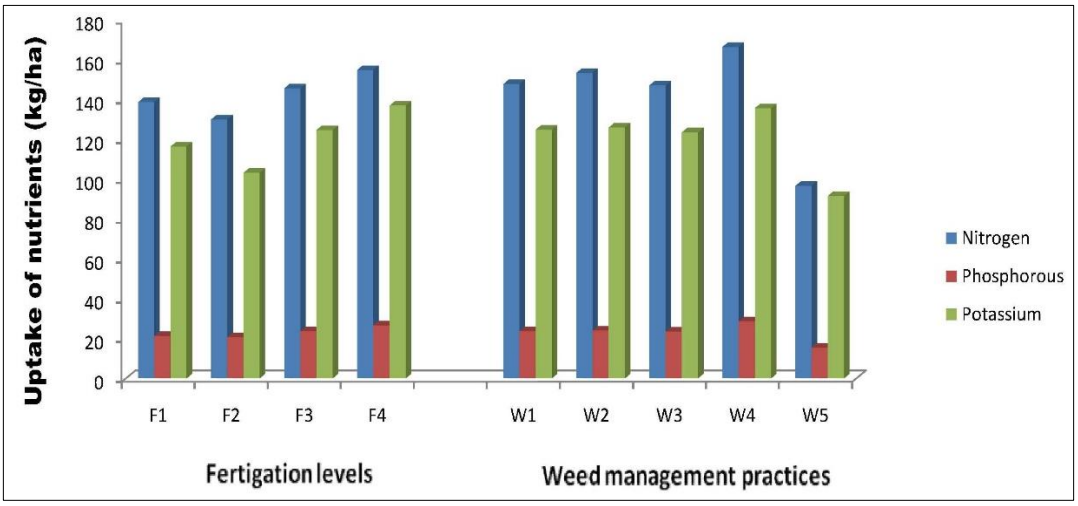

Fig 2: Effect of fertigation levels and weed management practices on uptake of of nutrients after harvest of maize

Uptake of sulphur

The results pertaining to sulphur status of soil was significantly influenced by different fertigation levels and weed management practices. While the interaction of fertigation levels with weed management practices noted significant.

Effect of fertigation levels

The total uptake of sulphur by maize was differed significantly due to different fertilizer levels. The maximum uptake of sulphur observed in F_4 (35.71 kg ha^{-1}) with 125 % RDNK (5 splits) and minimum in F_2 (27.27 kg ha^{-1}) with 75 % RDNK (5 splits). The nutrient uptake of sulphur with 125 per cent RDNK ha^{-1} through fertigation which was significantly higher than 75 per cent RDNK ha^{-1}. Application of 100 per cent RDNK ha^{-1} was found second best treatment in respect of uptake of sulphur.

Effect of weed management practices

Weed management practices affected on uptake of sulphur. The present investigation showed that the maximum uptake of sulphur (34.93 kg ha^{-1}) by maize was found with treatment W_4 (Farmers practice 2 hoeing 15-20 Days interval after sowing *fb* 2 HW)) followed by W_2, W_1 and W_3. Minimum uptake of sulphur (22.03 kg ha^{-1}) by crop was recorded with weedy check, where growth of maize suppressed by weeds and nutrients diverted to weed growth than maize growth.

Table 3: Effect of fertigation levels and weed management practices on uptake of sulphur after harvest of maize

Treatments	Sulphur (kg/ha)
Fertigation levels	
F_1 - 100 % RDF (3 Splits)	27.78
F_2 - 75 % RDNK (5 Splits)	27.27
F_3 - 100 % RDNK (5 Splits)	30.20
F_4 -125 % RDNK (5 Splits)	35.71
SE (m) ±	0.45
CD at 5 %	1.55
Weed management practices	
W_1 -Atrazine + Tembotrione	31.16
W_2- Atrazine + Topramezone	34.74
W_3 - Atrazine + Halosulfuron	28.34
W_4 - Farmers practices	34.93
W_5 - Weedy check	22.03
SE (m) ±	0.60
CD at 5 %	1.72
Interaction (FxW)	
SE	1.20
CD at 5 %	3.45

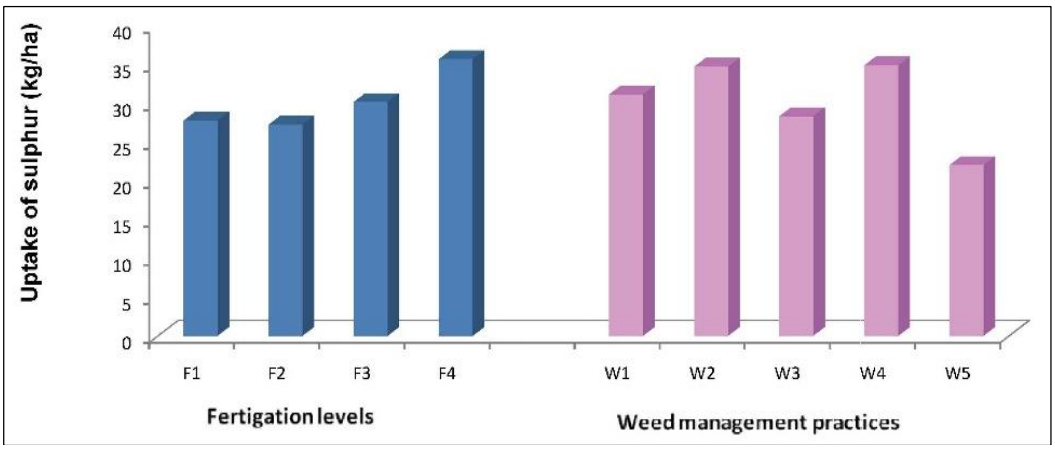

Fig 3: Effect of fertigation levels and weed management practices on uptake of sulphur after harvest maize

Interaction effect

Interaction of fertigation levels and weed management practices in case of sulphur uptake found to be significant. Jinhong *et al.* (1995) [6] gave the information about effects of mineral nutrition on quality of maize. He concluded that the quality of maize (*Zea mays* L.) grain was obviously affected by N, P, K, S, Zn, Mn, Cu, Se and rare-earth elements. The effects of mixed nutrition of N, P, K on grain quality improvement were better than that of any single element.

Uptake of micronutrients

The results pertaining to uptake of micronutrients status was non significantly influenced by different fertigation levels and weed management practices.

Effect of fertigation levels

Fertigation levels has notable effect on uptake of micronutrients. The Fe in plant varied from 219.77 g ha^{-1} to 268 g ha^{-1} indicating highest dose of Fe in F_4 (268 g ha^{-1}) with 125 % RDNK (5 splits) and found to be lowest in F_2 (219.77 g ha^{-1}) with 75 % RDNK (5 splits). Mn is varied from 224.53 g ha^{-1} to 268.81 g ha^{-1} and found to be highest in F_4 (268.81 g ha^{-1}) 125 % RDNK (5 splits) and lowest in F_2 (224.53 g ha^{-1}) 75 % RDNK (5 splits). Zn found to be highest in F_4 (265.79 g ha^{-1}) with 125 % RDNK (5 splits) and lowest in F_2 (219.39 g ha^{-1}) with 75 % RDNK (5 splits). Cu found to be highest in F_4 (187.93 g ha^{-1}) with 125 % RDNK (5 splits) and found to be lowest in F_2 (151.03 g ha^{-1}) with 75 % RDNK (5 splits).

Effect of weed management practices

Uptake of micronutrients (Fe, Mn, Zn, Cu) influenced by different weed management practices. Numerically highest doses of micronutrients (Fe, Mn, Zn, Cu) recorded in farmers practices (260.18 g ha^{-1}, 270.81 g ha^{-1}, 267.34 g ha^{-1} and 193.56 g ha^{-1}) respectively followed by W_2, W_1 and W_3 and W_5. indicating lower doses in weedy check (181.80 g ha^{-1}, 190.98 g ha^{-1}, 172.67 g ha^{-1}, 126.47 g ha^{-1}) respectively.

Interaction effect

The interaction of different fertigation levels and weed management practices was found to be non significant. Similar results found by Salem *et al.* (2012) [13] conducted an experiment in the Agricultural Research and Experimental Centre, Faculty of Agriculture, Benha University, Egypt during 2007 and 2008 seasons to investigate the effect of adding Zn, Mn, Fe in different methods on maize yield and nutrient concentration and nutrient uptake.

Table 4: Effect of fertigation levels and weed management practices on uptake of micronutrients after harvest of maize

Treatments	Fe	Mn	Zn	Cu
Fertigation levels	**(g ha^{-1})**			
F_1 - 100 % RDF (3 Splits)	221.84	238.05	221.17	159.11
F_2 - 75 % RDNK (5 Splits)	219.77	224.53	219.39	151.03
F_3 - 100 % RDNK (5 Splits)	240.66	253.89	258.21	179.71
F_4 -125 % RDNK (5 Splits)	268.58	268.81	265.79	187.93
SE (m) ±	2.97	6.49	3.16	1.23
CD at 5 %	NS	NS	NS	NS
Weed management practices				
W_1 -Atrazine + Tembotrione	250.11	254.08	255.51	168.28
W_2- Atrazine + Topramezone	257.38	263.38	262.20	191.28
W_3 - Atrazine + Halosulfuron	239.11	252.33	247.99	167.64
W_4 - Farmers practices	260.18	270.81	267.34	193.56
W_5 - Weedy check	181.80	190.98	172.67	126.47
SE (m) ±	3.82	6.27	4.29	2.28
CD at 5 %	NS	NS	NS	NS
Interaction (FxW)				
SE	7.64	12.55	8.57	4.56
CD at 5 %	NS	NS	NS	NS

Conclusion

The integration of fertigation levels and weed management practices found beneficial for higher yield of maize and uptake of nutrients. Therefore, the application of nutrients through drip fertigation with 125 % RDNK in 5 splits and weed management with farmers practices through 2 hand weedings + 2 hoeings advocated for improving soil health, yield and nutrient uptake of maize grown in Inceptisols.

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