J. Soils and Crops 31 (1) 165-169, June 2021

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

INFLUENCE OF PROPER MECHANICAL MEASURES AND NUTRIENT MANAGEMENT PRACTICES ON MOISTURE USE EFFICIENCY AND YIELD OF MAIZE IN VERTISOL

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ABSTRACT

The field investigation was carried out during *kharif* season for the year 2017-18 at EAD Farm , College of Agriculture Nagpur with the objective to quantify the moisture use and yield of maize under different mechanical measures in-combination with nutrients management practices. Result revealed that, the grain yield of maize was increased with the treatment combination of 125% RDF with ridges and furrows + *in situ* green sunhemp by 8.01 and 19.68 per cent over the 100 % RDF with flat bed (51.88 q ha^{-1}) and 75% RDF with flat bed + *in situ* green sunhemp(45.30 q ha^{-1}), respectively. Moisture use varied over a narrow range from 219.93 to 221.52, 513.17 to 516.90 and 733.11 to 738.43 mm by maize among different treatments, respectively at 30, 70 and 100 per cent of crop growing season.Moisture use increased during 30-70 per cent growing season of crop and it further decreased during 70-100 per cent growing season of crop under all treatments.69.00 per cent of total calculated moisture use recorded during 30-70 per cent growing season of crop, indicating about 514.80 mm moisture use during 70 per cent growing season of crop.Highest moisture use efficiency (7.64 kg ha^{-1}mm^{-1}) was noticed among interactive effect of 125% RDF with ridges and furrows +*in situ* green sunhemp.

(Key words: *In situ* green sunhemp , mechanical measure, moisture use, maize)

INTRODUCTION

A mechanical measure is a beneficial technology for *in situ* moisture conservation in the area of erratic behavior of rainfall and also helps in drainage under heavy rainfall. Practice of making ridges by opening furrow may have an advantage in conservation of more rain water on the bed which enriches soil moisture content (Karunadevi *et al*., 2007).The mechanical measures not only improve soil drainage but also leads to efficient use of limited water for profitable crop production. For uniform distribution of rain water, broad bed furrow, ridges and furrow and flat-bed may be required. With proper land layout or land configuration, the fertilizer use and nutrient use efficiency might be enhanced.

Various factors of production deciding the maize productivity under rainfed condition are nutrients management, mechanical measures and plant density. Out of these factors, mechanical measures and nutrients management have significance in stepping up the yield of maize during the *kharif* season. Maize crop has better yield response to chemical or inorganic fertilizers. Hence, heavy doses of fertilizers are applied to maize; through management practices are helps to increase the production of crop. The present study was taken to investigate the effect of proper mechanical measures and nutrient management practices on soil moisture studies and yield of maize in Vertisol.

MATERIALS AND METHODS

Considering the various management practices adopted by farmers for rainfed maize , the nutrients management and mechanical measures in vertisol were selected during the year 2017-2018 to study the moisture use and yield of maize under different mechanical measures in-combination with various nutrients management.Three treatments of mechanical measures i.e. ridges and furrow + in-situ green sunhemp, broad bed furrow + *in-situ* green

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sunhemp and flat bed + *in-situ* green sunhemp and four nutrients management i.e.0% RDF (00:00:00 kg NPK ha^{-1}), 75% RDF (90:45:45 kg NPK ha^{-1}), 100% RDF (120:60:60 kg NPK ha^{-1}) and 125% RDF (150:75:75 kg NPK ha^{-1}) were studied in Factorial Randomized Block Design, replicated thrice.The soil of experimental plot was clayey in texture, slightly alkaline in reaction, low in available nitrogen and phosphorus, medium in organic carbon, very high in available potassium.The maize variety PKVM Shatak, was sown on 5th July, 2017 by dibbling the seed in rows, marked at a spacing of 60 cm x 20 cm. Open the furrow after one of sowing and cut the sunhemp from bottom and spread it. Half dose of nitrogen through urea was applied at sowing and remaining at 30 days after sowing.Full dose of phosphors and potash was given at the time of sowing to all the plots through single super phosphate and muriate of potash, respectively.

The soil samples were collected from each plots at an interval of 20 days to determine per cent moisture gravimetrically.Soil moisture to a depth of 30 cm was calculated as follows

$$\text{Soil moisture (mm) in 0-30 cm layer depth} = \frac{\text{\% moisture gravimetric} \times \text{Bulk density}}{100} \times 30 \times 10$$

Moisture use by crop during a period was calculated as fallows.

Moisture use (mm) during a period = Soil moisture (mm) up to 30 cm depth at initial sampling + Rainfall during a period (mm) - Soil moisture (mm) up to 30 cm depth at subsequent sampling - Runoff *

* Runoff was assumed negligible.

Soil moisture up to 30 cm depth at subsequent sampling during a first period is considered as initial soil moisture for second period and likewise.

Total moisture use (mm) = Moisture use (mm) during different periods.

Moisture use efficiency for each treatment was calculated on the basis of economic yield of the crop and total moisture use in given treatment by following formula (Micheal and Ojha., 1983)

$$\text{MUE (kg ha}^{-1}\text{ mm}^{-1}\text{)} = \frac{\text{Crop yield (kg ha}^{-1}\text{)}}{\text{Total moisture use (mm)}}$$

Periodic soil sampling at different date from sowing date was expressed in terms of per cent growing season of crop considering it's scheduled duration.

RESULTS AND DISCUSSION

Yield of maize, (q ha^{-1})

The data pertaining to grain yield of maize as influenced by various treatments are presented in Table 1.The results clearly indicates that, the grain yield of maize was significantly influenced due to mechanical measures and practice of different nutrients management. The grain yield of maize (44.79 q ha^{-1}) was significantly increased among mechanical measure of ridges and furrow + *in situ* green sunhemp which was found at par with BBF+ *in situ* green sunhemp. Ridges and furrow + *in situ* green sunhemp treatment significantly increased grain yield of maize to the tune of 6.52 over flat bed + *in situ* green sunhemp method indicating more amount of soil moisture conserved due to opening of furrow resulted an increased growth stand and finally might have exhibited slight enhancement in yield. Rajashekarappa *et al.*(2014) reported that 15.54 % improvement in the grain yield of maize with moisture conservation practices as compared to control.

Among nutrients management practices,the application of 150:75:75kgNPK ha^{-1}recorded significantly more grain yield of maize (54.10 q ha^{-1}) over the rest of the treatments. An increase in grain yield of maize was 63.10, 61.82 and 57.95 per cent due to application of 150:75:75, 120:60:60 and 90:45:45 kg NPK ha^{-1}, respectively over no use of major nutrients. This might be due to adequate availability of nutrients particularly N and P and better crop stand through 100 and 125 % as this crop requires more nutrients. The highest grain yield of maize (56.40 q ha^{-1}) was obtained in treatment combination of higher dose of 150:75:75 kg NPK ha^{-1} and ridge and furrow + *in situ* green sunhemp and it was found on par with higher dose of NPK + BBF + in situ green sunhemp.Manwar and Mankar (2015) reported 7.66% and 5.11% increase in yield of maize with methods of ridges and furrow and broad bed furrow, respectively over flat-bed method.

Moisture use (mm)

The values related to cumulative moisture use (mm) at different per cent growing season of crop are presented in Table 2.Cumulative moisture use varied over a narrow range from 152.41 to 153.52, 290.31 to 292.42, 435.47 to 438.63, 580.70 to 584.91 and 689.56 to 694.57 mm by maize under different treatments, respectively at 21 days (20.79%), 40 days (39.60%), 60 days (59.40%), 80 days (79.21%) and at 95 days (94.06%) of its growing season. The moisture per cent was determine by gravimetric method and calculated moisture use on a factor consisting soil moisture per cent, rainfall, depth and runoff. The value of moisture use (mm) remained more or less equal at per cent growing season of crop among different treatments.

Calculated moisture use (mm)

Calculated moisture use varied over a narrow range from 219.93 to 221.52, 513.17 to 516.90 and 733.11 to 738.43 mm by maize under different treatments, respectively at 30,

Table 1 . Effect of nutrients management and mechanical measures on grain and fodder yield of maize (q ha^{-1})

Treatments	Grain yield (q ha^{-1})	Fodder yield (q ha^{-1})
A– Mechanical Measures		
1. Ridges and furrows + *in situ* green sunhemp	44.79	60.56
2. Broad bed furrows + *in situ* green sunhemp	43.65	58.91
3. Flat bed + in situ green sunhemp	41.87	56.04
SE (m) ±	0.48	0.59
CD at 5%	1.40	1.73
B – Nutrients Management		
1. 00:00:00 kg NPK ha^{-1}	19.96	29.96
2. 90:45:45 kg NPK ha^{-1}	47.40	61.13
3. 120:60:60 kg NPK ha^{-1}	52.28	68.27
4. 150:75:75 kg NPK ha^{-1}	54.10	74.67
SE (m) ±	0.55	0.68
CD at 5%	1.62	2.00

Interaction	Mechanical Measures					
Nutrients Management	Grain yield (q ha^{-1})			Fodder yield (q ha^{-1})		
	RF + GS*	BBF + GS	FB + GS	RF + GS	BBF + GS	FB + GS
00:00:00 kg NPK ha^{-1}	21.24	20.44	18.20	31.66	30.74	27.45
90:45:45 kg NPK ha^{-1}	48.91	47.98	45.30	62.77	61.73	58.88
120:60:60 kg NPK ha^{-1}	52.59	52.37	51.88	69.42	68.94	66.43
150:75:75 kg NPK ha^{-1}	56.40	53.78	52.11	78.39	74.22	71.38
SE (m) ±		0.95			1.17	
CD at 5%		2.84			-	

* GS = *in situ* green sunhemp

Table 2.Observed moisture use (mm) at different per cent growing season of crop

Treatments	Cumulative moisture use (mm) at different per cent growing season of crop				
	21 days 20.79%	**40 days** 39.60%	**60 days** 59.40%	**80 days** 79.21%	**95 days** 94.06%
T1- Ridges and furrow + GS* + 00:00:00 NPK kg ha^{-1}	153.37	292.13	438.20	584.34	693.89
T2- Ridges and furrow + GS + 90:45:45 NPK kg ha^{-1}	153.52	292.42	438.63	584.91	694.57
T3- Ridges and furrow + GS +120:60:60 NPK kg ha^{-1}	153.28	291.97	437.95	584.01	693.50
T4- Ridges and furrow + GS +150:75:75 NPK kg ha^{-1}	153.08	291.58	437.37	583.24	692.58
T5- Broad bed furrow + GS + 00:00:00 NPK kg ha^{-1}	152.95	291.34	437.01	582.76	692.01
T6- Broad bed furrow + GS + 90:45:45 NPK kg ha^{-1}	152.79	291.02	436.54	582.12	691.26
T7- Broad bed furrow + GS + 120:60:60 NPK kg ha^{-1}	152.98	291.39	437.09	582.86	692.13
T8- Broad bed furrow + GS + 150:75:75 NPK kg ha^{-1}	152.67	290.79	436.19	581.65	690.70
T9- Flat bed furrow + GS + 00:00:00 NPK kg ha^{-1}	152.41	290.31	435.47	580.70	689.56
T10- Flat bed furrow + GS + 90:45:45 NPK kg ha^{-1}	152.61	290.69	436.04	581.46	690.47
T11- Flat bed furrow + GS + 120:60:60 NPK kg ha^{-1}	152.66	290.78	436.17	581.63	690.67
T12- Flat bed furrow + GS + 150:75:75 NPK kg ha^{-1}	152.46	290.39	435.59	580.86	689.76
Mean	152.89	291.23	436.85	582.54	691.75

GS= *in situ* green sunhemp

Table 3. Calculated moisture use by maize under different treatments

Treatments	Cumulative moisture use (mm) during different periods of per cent growing season of crop			at different per cent growing season of crop		
	0-30 %	30-70 %	70-100 %	30%	70%	100%
T1- Ridges and furrow +GS +00:00:00 NPK kg ha^{-1}	221.31	295.08	221.32	221.31	516.39	737.71
T2- Ridges and furrow +GS +90:45:45 NPK kg ha^{-1}	221.52	295.38	221.53	221.52	516.90	738.43
T3- Ridges and furrow + GS 120:60:60 NPK kg ha^{-1}	221.18	294.92	221.19	221.18	516.10	737.29
T4- Ridges and furrow+GS+150:75:75 NPK kg ha^{-1}	220.89	294.53	220.90	220.89	515.42	736.32
T5- Broad bed furrow + GS + 00:00:00 NPK kg ha^{-1}	220.71	294.28	220.72	220.71	514.99	735.71
T6- Broad bed furrow + GS + 90:45:45 NPK kg ha^{-1}	220.47	293.96	220.48	220.47	514.43	734.91
T7- Broad bed furrow +GS +120:60:60 NPK kg ha^{-1}	220.75	294.33	220.76	220.75	515.08	735.84
T8- Broad bed furrow +GS+150:75:75 NPK kg ha^{-1}	220.29	293.73	220.30	220.29	514.02	734.32
T9- Flat bed furrow + GS + 00:00:00 NPK kg ha^{-1}	219.93	293.24	219.94	219.93	513.17	733.11
T10- Flat bed furrow + GS + 90:45:45 NPK kg ha^{-1}	220.22	293.62	220.23	220.22	513.84	734.07
T11- Flat bed furrow + GS + 120:60:60 NPK kg ha^{-1}	220.28	293.72	220.29	220.28	514.00	734.29
T12- Flat bed furrow + GS + 150:75:75 NPK kg ha^{-1}	219.99	293.33	220.00	219.99	513.32	733.32
Mean	220.63	294.17	220.64	220.63	514.80	735.44

Table 4. Effect of mechanical measures and nutrients management on moisture use (mm) and moisture use efficiency (kg ha^{-1} mm^{-1})

Treatments	Moisture use (mm)	Moisture use efficiency (kg ha^{-1} mm^{-1})
A- Mechanical Measures		
1. Ridges and furrows + in situ green sunhemp	737.00	6.07
2. Broad bed furrows+ in situ green sunhemp	734.84	5.93
3. Flat bed+ in situ green sunhemp	733.45	5.71
SE (m) $\pm$	1.45	0.063
CD at 5%	—	0.19
B – Nutrients Management		
1. 00:00:00 kg NPK ha^{-1}	734.19	2.17
2. 90:45:45 kg NPK ha^{-1}	734.65	6.45
3. 120:60:60 kg NPK ha^{-1}	735.46	7.12
4. 150:75:75 kg NPK ha^{-1}	736.11	7.34
SE (m) $\pm$	1.15	0.073
CD at 5%	—	0.22

Interaction Nutrients Management	Mechanical Measures: Moisture use (mm)			Moisture use efficiency (kg ha^{-1} mm^{-1})		
	RF+GS*	BBF+GS	FB+GS	RF+GS	BBF+GS	FB+GS
00:00:00kg NPKha^{-1}	735.59	734.49	732.47	2.88	2.77	2.48
90:45:45kg NPK ha-^{1}	736.94	733.95	733.04	6.63	6.53	6.17
120:60:60 kg NPK ha^{-1}	737.50	735.01	733.87	7.12	7.12	7.08
150:75:75 kg NPK ha^{-1}	737.96	735.94	734.42	7.64	7.30	7.09
SE (m) $\pm$	2.00			0.12		
CD at 5%	—			—		

* GS = *in situ* green sunhemp

70 and 100 per cent of its growing season of crop. Calculated moisture use during different per cent growing season of crop i.e. 0-30, 30-70 and 70 -100 per cent growing season varied over a narrow range from 219.93 to 221.52, 293.24 to 295.38 and 219.94 to 221.53 mm, respectively under different treatments. This shows that moisture use increased during 30-70 per cent growing season of crop and it further decreased during 70-100 per cent growing season of crop under all treatments.Moisture use under different treatments recorded 29.99 per cent of total calculated moisture use during 0-30 per cent growing season of crop as against 69.00 per cent during 30-70 per cent, indicating about 514.80 mm moisture use during 70 per cent growing season of crop. Patil (1987) noted 64.29 to 65.99 per cent of total moisture use for different treatments by the end of 70 per cent of growing season of crop.

Moisture use efficiency(kg ha^{-1} mm^{-1})

It was observed that MUE values differed significantly due to treatments of mechanical measures and under different doses of fertilizers management practices (Table 4). However, interaction effect on MUE was found non-significant. MUE was computed as the grain yield and cumulative water use (mm). It was observed that MUE was found to increase significantly (6.07 kg ha^{-1} mm^{-1}) with the method of ridges and furrows+ *in situ* green sunhemp but it was found statistically at par with BBF+ *in situ* green sunhemp (5.93 kg ha^{-1} mm^{-1}). WUE values found increased (7.34 kg ha^{-1} mm^{-1}) under application of 125% RDF(150:75:75 kg NPK ha^{-1}) and found at par with 100% RDF (120:60:60 kg NPK ha^{-1}).This clearly shows that 100% RDF was equally superior to higher dose of RDF. Ugale *et al.* (2000) reported that the highest MUE of 11.78 kg ha^{-1} mm^{-1} in ridges and furrow treatment open at 90 cm width and two lines under maize cultivation. Mahitha *et al.* (2014) observed that higher soil moisture content was noticed due to ridges and furrows method than other methods of land configuration.

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Rec. on 15.10.2020 & Acc. on 28.10.2020