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Weed Management Strategies under Varied Nitrogen Management Practices in *Kharif* Maize

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ABSTRACT: An investigation was carried out during *kharif* 2019 and *kharif,* 2020 on sandy loam soils of dryland farm at S. V. Agricultural College, Tirupati, Andhra Pradesh. The experiment was laid out in split plot design with three replications. Maize hybrid DHM-117 was used in experimentation. The treatments comprised combination of four nitrogen management practices and nine weed management practices. Among the nitrogen management practices, green seeker directed N application (N_3) recorded significantly higher values of yield attributes, yield and harvest index during both the years of study as well as in pooled mean. Disregarding nitrogen management practices hand weeding twice at 15 and 30 DAS recorded significantly higher values of yield attributes, yield and harvest index over weedy check. However, this treatment closely followed by application of atrazine 1.0 kg ha^{-1} as pre emergence *fb* to pramezone 30 g ha^{-1} as post emergence, atrazine 1.0 kg ha^{-1} as pre emergence *fb* tembotrione 120 g ha^{-1} as post emergence without any significant disparity among them during both the years of study and in pooled mean. Among all the treatment combinations, higher kernel yield of maize was recorded with green seeker directed N application and hand weeding twice at 15 and 30 DAS.

Keywords: Weed Management, Strategies, Nitrogen Management, atrazine, Kharif Maize

INTRODUCTION

Maize (*Zea mays* L.) is one of the major cereal crop alongside rice and wheat with better acclimatization under dissimilar soil and climatic conditions. It is known as "Queen of cereals", owing to highest genetic yield potential amongst the cereals.

India ranks seventh with 28.76 million tonnes of production, in an area of 9.5 million hectares and productivity of 3008 kg ha^{-1}. In Andhra Pradesh, 21.21 lakh tonnes of maize was produced from an area of 3.01 lakh hectares with a productivity of 7055 kg ha^{-1} (Anonymous, 2019-20). Its acreage and production are substantial, but its productivity is quite low due to various biotic and abiotic stresses.

Maize is being an exhaustive crop and the hybrids of maize are highly responsive to fertilizers. Nitrogen losses from the soil plant system with unsynchronized nitrogen application owing to low N fertilizer use efficiency. Split application of N based on crop demand increased kernel yield of maize (Sangoi *et al*., 2007). Nitrogen management strategies that match nitrogen supply with nitrogen demand in both space and time are urgently needed to increase nitrogen use efficiency. Optical sensor green seeker is available for need-based N management in cereals. It determines the fertilizer rate based on plant's normalized difference vegetation index (NDVI). Optical sensors utilization has advanced rapidly in the recent years. As it is able to detect N stress and crop vigour, widely used as the basis for nitrogen application. NDVI values ranges from -1 to +1, with higher values indicating better plant health (Harrell *et al*., 2011).

Maize being a widely spaced crop, mostly grown in rainy season gets infested with adverse weeds and liable to excessive weed competition, which often inflict huge losses ranging from 27-60 per cent depending upon the growth and persistence of weed population (Singh *et al*., 2015). The evolution of herbicide resistance in a large number of weed species across the world has further aggravated the situation into extravagant of resources. Sustainable weed management is a key option to achieve decent crop yield with ecological balance. It must have a harmony with chemical and non-chemical options that can be used judiciously in order to achieve a rational weed control. Hence, it is required to redesign weed management strategies such as usage of new generation of herbicides, use of cover crops, brown manuring and spraying of botanicals.

MATERIALS AND METHODS

A field experiment was conducted during *kharif*, 2019 and *kharif*, 2020 at Dry Land Farm of Sri Venkateswara Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh which is geographically situated at 13.5°N latitude 79.5°E longitude and at an altitude of 182.9 m above mean sea level in the Southern Agro-climatic Zone of Andhra Pradesh. The soil was sandy loam in texture, neutral in soil reaction, low in organic carbon and available nitrogen and medium in available phosphorus and potassium.

The experiment was laid out in a split plot design with three replications. The treatments comprised a combination of four nitrogen management practices *viz.*, control (N_1), recommended dose of fertilizer (180-60-50 kg N, P_2O_5, K_2O ha^{-1}) (N_2), green seeker directed N application (N_3) and soil test based nitrogen fertilizer application (N_4) and nine weed management practices unweeded check (W_1), hand weeding twice at 15 and 30 DAS (W_2), pre emergence application of atrazine 1.0 kg ha^{-1} *fb* post emergence application of topramezone 30 g ha^{-1} (W_3), pre emergence application of atrazine 1.0 kg ha^{-1} *fb* post emergence application of tembotrione 120 g ha^{-1} (W_4), application of parthenium water extract 15 l ha^{-1} twice at 15 and 30 DAS (W_5), application of sunflower water extract 15 l ha^{-1} twice at 15 and 30 DAS (W_6), pre emergence application of atrazine 1.0 kg ha^{-1} *fb* post emergence application of parthenium water extract 15 l ha^{-1} (W_7), pre emergence application of atrazine 1.0 kg ha^{-1} *fb* post emergence application of sunflower water extract 15 l ha^{-1} (W_8), brown manuring (desiccation of sesbania at 50 % flowering with 2, 4-D 1 kg ha^{-1}) (W_9). Maize variety DHM -117 was sown with spacing of 60 cm × 20 cm during I fortnight of July during both the years.

Nitrogen was applied in the form of urea and no nitrogen was applied to control plot. The recommended dose of 180 N ha^{-1} was applied in N_2. In green seeker directed N application, 1/3rd of N was applied as basal and the remaining N was top dressed as per green seeker readings. Whenever these NDVI values fall below the threshold value at 0.8, nitrogen was top dressed at 25 kg ha^{-1} immediately to meet the N requirement irrespective of the stage of the crop. The final split application of N was completed by 80 DAS coinciding with the silking stage (Prakasha *et al.*, 2020). In soil test based N fertizer application, additional dose of 30 per cent to the recommended dose of N fertilizer was applied (as experimental field was low in available nitrogen). A uniform dose of 60 kg P_2O_5 and 50 kg K_2O ha^{-1} was applied to all plots.

Hand weeding was done twice at 15 and 30 DAS in the treatment W_2. The required quantities of pre-emergence (atrazine) and post-emergence (tembotrione and topramezone) herbicides were sprayed uniformly on 2 and 15 DAS, respectively. The required quantities of filtered concentrated plant water extracts were sprayed at 15 and 30 DAS. In brown manuring treatment plots (W_9), *Sesbania* was grown in intermediate rows of maize and it was knocked down with 2,4 D at 1.0 kg ha^{-1} at 35 DAS. Field operations such as irrigation and protective measures were taken up according to requirement. The data on number of yield attributes *viz.*, cob length, cob girth, number of kernel rows cob^{-1}, number of kernels cob^{-1} and test weight, kernel and stover yield were recorded as per standard procedures. Data recorded on different parameters of maize was statistically analyzed following the analysis of variance for split plot design as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

A. Effect of nitrogen management practices on maize

Among the nitrogen management practices, green seeker directed N application (N_3) recorded significantly higher values of yield attributes *viz.*, number of cobs plant^{-1}, cob length, cob girth, number of kernel rows cob^{-1}, number of kernels cob^{-1}, test weight, kernel and stover yield of maize during both the years of study as well as in pooled mean. Nitrogen application through NDVI value 0.8 was found to be ideal for achieving higher yield of maize as they matched with crop nitrogen demand. It might also be due to precised nitrogen application in more number of splits compared to other treatments. Adequate supply of nitrogen at appropriate crop growth stages might have enhanced greater attainability of nutrients in the soil which culminated into more absorption and higher uptake by the crop plants that lead to better plant growth. Better translocation and partitioning of assimilates from source to sink due to timely application of 'N' based on crop demand might be accountable for amplifying yield parameters and in turn the yield. This was in consonance with the findings of Prakasha *et al.*, (2020) and Jyosthna (2020).

Further, critical examination of the data revealed that no nitrogen application (N_1) recorded lowest values of yield attributes *viz.*, number of cobs plant^{-1}, cob length, cob girth, number of rows cob^{-1}, number of kernels cob^{-1}, test weight, kernel and stover yields during both the years of study and in pooled mean.

B. Effect of weed management practices on maize

All the weed management practices significantly increased yield attributes and yield over weedy check. The pronounced effect of increased yield attributes *viz.*, number of cobs plant^{-1}, cob length, cob girth, number of kernel rows cob^{-1}, number of kernels cob^{-1}, test weight, kernel yield, stover yield and harvest index of maize was observed with hand weeding twice at 15 and 30 DAS (W_2).

Table 1: Yield attributes of maize as influenced by nitrogen and weed management practices.

Treatments	Cob length (cm)			Cob girth (cm)			Number of kernel rows cob^{-1}			Number of kernels cob^{-1}			Test weight (g)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Nitrogen management															
N_1	12.2	11.8	12.0	9.8	9.6	9.7	12.1	11.6	11.8	149	142	146	20.3	19.8	20.0
N_2	14.6	14.3	14.5	12.3	11.9	12.1	14.4	13.6	14.0	223	213	218	25.3	24.5	24.9
N_3	17.4	17.0	17.2	14.1	13.9	14.0	14.8	14.1	14.5	288	277	282	28.2	27.3	27.8
N_4	15.9	15.6	15.7	13.7	13.5	13.6	14.5	13.9	14.2	264	246	255	26.7	26.2	26.5
SEm ±	0.35	0.31	0.33	0.37	0.34	0.33	0.31	0.31	0.33	6.5	5.1	5.5	0.5	0.5	0.34
CD (P = 0.05)	1.2	1.1	1.1	1.3	1.2	1.2	1.1	1.1	1.1	23	18	19	1.6	1.6	1.2
Weed management															
W_1	11.9	11.5	11.7	9.8	9.7	9.8	11.7	11.2	11.4	**163**	**158**	**161**	20.5	19.6	20.0
W_2	18.1	17.7	17.9	14.6	14.3	14.5	16.2	14.6	15.4	**298**	**281**	**290**	29.0	28.4	28.7
W_3	17.8	17.6	17.7	14.5	14.2	14.3	15.8	14.4	15.1	**294**	**275**	**285**	28.2	27.7	28.0
W_4	17.8	17.4	17.6	14.3	14.0	14.1	15.8	14.4	15.1	**289**	**271**	**280**	27.9	27.3	27.6
W_5	13.1	12.9	13.0	11.4	11.0	11.2	12.9	12.5	12.7	**185**	**180**	**183**	23.3	22.6	22.9
W_6	13.4	13.0	13.2	11.5	11.1	11.3	12.9	12.8	12.8	**188**	**183**	**185**	23.5	22.7	23.1
W_7	13.4	13.1	13.3	11.5	11.4	11.4	13.1	12.9	13.0	**198**	**192**	**195**	23.9	23.1	23.5
W_8	13.6	13.3	13.5	11.6	11.6	11.6	13.1	12.9	13.0	**203**	**200**	**201**	23.9	23.4	23.7
W_9	16.1	15.6	15.8	13.0	12.8	12.9	14.3	13.9	14.1	**261**	**234**	**248**	26.0	25.4	25.7
SEm ±	0.37	0.43	0.44	0.37	0.39	0.35	0.40	0.37	0.33	**5.9**	**6.2**	**6.8**	0.7	0.5	0.44
CD (P = 0.05)	1.1	1.2	1.2	1.0	1.1	1.0	1.1	1.0	0.9	**17**	**18**	**19**	2.0	1.5	1.3
N at W															
SEm ±	0.75	0.87	0.872	0.73	0.77	0.707	0.80	0.73	0.653	**11.8**	**12.5**	**13.6**	1.39	1.07	0.89
CD (P = 0.05)	2.1	2.4	2.5	NS	NS	NS	NS	NS	NS	**33**	**35**	**39**	3.9	3.0	2.5
W at N															
SEm ±	1.03	0.91	0.982	1.07	0.98	0.976	0.91	1.13	0.942	**18.9**	**15.1**	**16.1**	1.39	1.35	1.01
CD (P = 0.05)	3.4	3.0	3.2	NS	NS	NS	NS	NS	NS	**62**	**50**	**53**	4.6	4.4	3.3

However, it was on par with application of atrazine 1.0 kg ha^{-1} as pre emergence *fb* to pramezone 30 g ha^{-1} as post emergence (W_3), atrazine 1.0 kg ha^{-1} as pre emergence *fb* tembotrione 120 g ha^{-1} as post emergence (W_4) without any significant disparity among them during both the years of study and in pooled mean. This might be due to reduced competition between the crop and weeds for the existing resources all through the crop growing period enabling the crop for maximum utilisation of resources, which enhanced the vegetative and reproductive potential of the crop that might reflected in the form of higher kernel yield of maize. The results corroborates with the findings of Mahto *et al.,* (2020) and Rani *et al.,* (2020).

Lower values of yield attributes *viz*., cob length, cob girth, number of rows cob^{-1}, number of kernels cob^{-1}, test weight, kernel yield, stover yield and harvest index of maize was resulted with weedy check (W_1) during both the years of study and in pooled mean. This might be due to greater competition for the growth resources among the crop and weeds as evident by the lowest crop stature, lesser dry matter production resulted in impoverished partitioning efficiency of assimilates from source to sink which lead to diminished yield attributes and yields of maize. The present results go in consonance the findings of Bahirgul and Ramesh (2019) and Rani *et al.*, (2020). Significant interaction between nitrogen and management practices was observed with cob length, cob girth, number of kernel rows cob^{-1}, number of kernels cob^{-1}, test weight, kernel yield, stover yield and harvest index of maize during both the years of study and in pooled mean.

The treatment combination with green seeker directed N application and hand weeding twice at 15 and 30 DAS (N_3W_2) recorded significantly higher kernel yield but it was on par with green seeker directed N application along with application of atrazine 1.0 kg ha^{-1} as pre emergence *fb* to pramezone 30 g ha^{-1} as post emergence (N_3W_3) and green seeker directed N application and application of atrazine 1.0 kg ha^{-1} as pre emergence *fb* tembotrione 120 g ha^{-1} as post emergence (N_3W_4).

Table 2: Kernel and stover yield (kg ha^{-1}) and harvest index (%) of maize as influenced by nitrogen and weed management practices.

Treatments	Kernel yield (kg ha^{-1})			Stover yield (kg ha^{-1})			Harvest index (%)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Nitrogen management									
N_1	2149	1980	2064	3483	3240	3361	37.23	36.98	37.1
N_2	4111	3933	4022	5170	4991	5081	43.52	43.19	43.4
N_3	5671	5496	5584	6521	6376	6449	46.12	45.90	46.0
N_4	5210	5011	5111	6119	5938	6028	45.46	45.23	45.3
SEm ±	114	116	111	106	111	101	0.14	0.17	0.21
CD (P = 0.05)	393	400	386	367	384	348	0.5	0.6	0.6
Weed management									
W_1	2612	2381	2497	3689	3572	3630	40.13	39.91	40.0
W_2	6293	6150	6221	7017	6833	6925	46.75	46.44	46.6
W_3	6124	5948	6036	6894	6674	6784	46.46	46.27	46.4
W_4	5937	5724	5830	6710	6500	6605	46.19	45.98	46.1
W_5	3029	2869	2949	4210	4033	4121	40.83	40.57	40.7
W_6	3150	2945	3048	4315	4133	4224	41.09	40.69	40.9
W_7	3264	3095	3179	4469	4252	4361	41.21	40.91	41.1
W_8	3341	3179	3260	4557	4338	4447	41.37	41.11	41.2
W_9	4818	4651	4734	6047	5894	5970	43.71	43.54	43.6
SEm ±	141	146	119	176	170	156	0.21	0.15	0.18
CD (P = 0.05)	397	413	337	497	481	441	0.6	0.5	0.6
N at W									
SEm ±	281	292	239	352	341	312	0.49	0.63	0.55
CD (P = 0.05)	794	826	675	NS	NS	NS	NS	NS	NS
W at N									
SEm ±	335	341	325	322	334	303	0.66	0.81	0.69
CD (P = 0.05)	1103	1124	1068	NS	NS	NS	NS	NS	NS

Table 3: Interaction effect of nitrogen and weed management practices on kernel yield (kg ha^{-1}) of maize.

Treatments	*kharif,* 2019					*kharif,* 2020					Pooled				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
W_1	1042	2134	3775	3499	2612	966	1884	3426	3249	2381	1004	2009	3601	3374	2497
W_2	3287	6265	8050	7570	6293	3178	6099	7918	7404	6150	3232	6182	7984	7487	6221
W_3	3240	6157	7779	7321	6124	2998	5992	7646	7155	5948	3119	6074	7712	7238	6036
W_4	2980	5824	7712	7231	5937	2738	5648	7446	7064	5724	2859	5736	7579	7148	5830
W_5	1401	2766	4245	3703	3029	1242	2584	4179	3473	2869	1322	2675	4212	3588	2949
W_6	1445	2827	4397	3931	3150	1270	2661	4264	3587	2945	1358	2744	4330	3759	3048
W_7	1569	3066	4489	3931	3264	1394	2900	4322	3765	3095	1482	2983	4406	3848	3179
W_8	1644	3217	4532	3972	3341	1468	3052	4365	3831	3179	1556	3135	4448	3902	3260
W_9	2730	4741	6064	5735	4818	2564	4574	5898	5568	4651	2647	4658	5981	5651	4734
Mean	2149	4111	5671	5210		966	1884	3426	3249	2381	2064	4022	5584	5111	
	SEm ±		CD (P = 0.05)			SEm ±		CD (P = 0.05)			SEm ±		CD (P = 0.05)		
N	114		393			116		400			111		386		
W	141		397			146		413			119		337		
N at W	281		794			292		826			239		675		
W at N	335		1103			341		1124			325		1068		

Further, it was noticed that no nitrogen application with unweeded check (N_1W_1) recorded the lowest kernel yield, however it was on par with application of parthenium water extract 15 l ha^{-1} twice at 15 and 30 DAS (W_5), application of sunflower water extract 15 l ha^{-1} twice at 15 and 30 DAS (W_6), pre emergence application of atrazine 1.0 kg ha^{-1} *fb* post emergence application of parthenium water extract 15 l ha^{-1}(W_7) and pre emergence application of atrazine 1.0 kg ha^{-1} *fb* post emergence application of sunflower water extract 15 l ha^{-1} (W_8).

Significantly higher kernel yield in the treatment N_3W_2 might be due to weed free conditions upto critical period of crop weed competition and sensor-determined topdressing of 'N' for maize with increased the number of split applications might have resulted in increased availability of growth resources at distinct physiological phases, which might have inturn supported for better translocation of photosynthates towards development of kernels. Nagalakshmi *et al.*, (2006) and Deshmukh *et al.*, (2009) also revealed significant interaction between nitrogen and weed management practices.

CONCLUSION

From the present investigation it was revealed that among nitrogen management practices green seeker directed nitrogen application was found to be superior over rest of the treatments. Among various weed management practices, hand weeding twice at 15 and 30 DAS had significant influenced on yield attributes, yield and harvest index of maize but at par with application of low volume herbicides**.** Further studies take into account of seasonal variation as well as multi-location in view of making concrete recommendations for maize growers.

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