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RESEARCH ARTICLE

Effect of nitrogen and weed management practices in maize and their residual effect on succeeding groundnut

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ABSTRACT

A field experiment was conducted to evaluate nitrogen and weed management practices in maize and their residual effect in groundnut during two consecutive rainy *(Kharif)* and winter *(Rabi)* seasons of 2019-20 and 2020-21 at Dryland Farm, S. V. Agricultural College, Tirupati, Andhra Pradesh, India. Among nitrogen (N) management practices, lower weed density and biomass were registered with control, whereas Green Seeker-directed N management (GSNM) recorded significantly higher kernel and stover yield in maize. Hand weeding twice at 15 and 30 days after sowing (DAS) significantly lowered the weed density and biomass and improved maize kernel and stover yield. This was closely followed by pre-emergence application (PE) of atrazine 1.0 kg/ha followed by (*fb*) post-emergence application (PoE) of topramezone 30 g/ha and atrazine 1.0 kg/ha PE *fb* tembotrione 120 g/ha PoE. Among all the treatment combinations, higher kernel and stover yield of maize was recorded with GSNM and hand weeding twice (15 and 30 DAS). Nitrogen management practices executed in preceding maize did not exert any significant influence on weed and growth parameters in succeeding groundnut. Lower weed density and biomass were recorded with hand weeding twice (15 and 30 DAS), which was at par with brown manuring, atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha or tembotrione 120 g/ha PoE.

Keywords: Groundnut, Maize, Nitrogen management, Productivity, Weed management

INTRODUCTION

India ranks seventh in terms of maize production with a record of 28.76 million tonnes (Mt) from an area of 9.5 million hectares (mha) with productivity of 3.01 t/ha. The state of Andhra Pradesh produced 2.12 Mt of maize from an area of 0.30 mha with a productivity of 7.06 t/ha (Anonymous 2020). As compared to major maize growing regions of the world, the low and unstable productivity in India is due to a number of factors. Of these, improper nutrient management and inadequate weed management appear to the major ones. Among different nutrients, nitrogen (N) plays a crucial role in crop production.

The real-time nitrogen management (RTNM) approach can help to increase N use efficiency by right scheduling of N application as per plant need, based on periodic monitoring of crop nitrogen status (Dobermann *et al*. 2004). As a useful tool for RTNM (Harrell *et al*. 2011), GreenSeeker™ optical sensor determines the fertilizer rate based on plant's normalized difference vegetation index (NDVI).

Yield losses occur to the extent of about 40% due to weed infestation in maize (Singh *et al.* 2015). Although manual hand weeding has been so far the best method of weed management, it is constrained by timely non-availability and higher wages of agricultural laborer. Use of pre- and post-emergence herbicides in right combination may be a cost-effective option to keep the weeds under control during the critical period of crop-weed competition (Kumar *et al*. 2017). Evolution of herbicide resistance in a large number of weed species is also a concern across the world. There should have been a judicious combination of chemical and non-chemical options in order to achieve a rational weed control. There is a need to redesign weed management strategies with the use of new generation herbicides, cover crops, brown manuring and spraying of botanicals.

At present, maize-groundnut cropping sequence is gaining importance under both rainfed and irrigated situations. Since maize is exhaustive and weed sensitive crop, system-based management approach is more appropriate for managing the weeds and nutrient needs. Further, the herbicide application

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in maize may have residual effect on succeeding crops. There is no such comprehensive information on these aspects. Thus, the present study was taken up with an objective to evaluate effective nitrogen and weed management practices for higher productivity in maize and quantify their residual effect in groundnut.

MATERIALS AND METHODS

A field experiment was conducted during two consecutive rainy *(Kharif)* and winter *(Rabi)* seasons of 2019-20 and 2020-21 at Dryland Farm, S. V. Agricultural College, Tirupati, located at 13.5°N latitude and 79.5°E longitude with an altitude of 182.9 m above mean sea level in the Southern Agro-climatic Zone of Andhra Pradesh, India. 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. Four nitrogen management practices, *viz*. control (no. N), recommended dose of nitrogen (RDN, 180 kg/ha), Green Seeker-directed N management (GSNM), and soil–test crop response (STCR)-based nitrogen management (SNM) in main plots, and nine weed management practices, *viz.* unweeded check, hand weeding twice at 15 and 30 days after sowing (DAS), atrazine 1.0 kg/ha as pre-emergence application (PE) followed by (*fb*) topramezone 30 g/ha as post-emergence application (PoE), atrazine 1.0 kg/ha PE *fb* tembotrione 120 g/ha PoE, two sprays of Parthenium water extract 15 l/ha at 15 and 30 DAS, two sprays of sunflower water extract 15 l/ha at 15 and 30 DAS, atrazine 1.0 kg/ha PE *fb* Parthenium water extract 15 l/ha (PoE), atrazine 1.0 kg/ha PE *fb* sunflower water extract 15 L/ha PoE, and brown manuring in sub-plots. A split-plot design with three replications was used.

As per treatments, N was applied in the form of urea. In RDN, split application was done at basal, knee-high and tasseling. In GSNM, one-third dose of total N was applied as basal and the remaining N was top dressed as per Green Seeker readings. Whenever the NDVI values fall below the threshold value of 0.8, N was immediately top dressed at 25 kg/ha to meet the N requirement, irrespective of the crop growth stages. The remaining dose of N was applied at 80 DAS coinciding with the silking stage (Prakasha *et al.* 2020). In SNM, an extra dose of 30% of RDN was applied due to low level of available N in the experimental soil. A uniform dose of 60 kg P_2O_5 and 50 kg K/ha was applied to all the plots. The atrazine PE and tembotrione and topramezone PoE herbicides were sprayed uniformly at 2 and 15 DAS, respectively. The filtered concentrated plant water extracts were sprayed at 15 and 30 DAS. In brown manuring treatment, *Sesbania* was grown in intermediate rows of maize and was knocked down with the application of 2,4 D (Na salt) 1.0 kg/ha at 35 DAS. Data on different parameters of maize were recorded and statistically analyzed following the analysis of variance (Panse and Sukhatme 1985). Maize hybrid '*DHM-117'* was raised with recommended package of practices except for the nitrogen and weed management. Groundnut variety '*Dharani*' was raised after harvest of maize in the undisturbed layout to study the residual effect of different nitrogen and weed management practices as imposed in maize

RESULTS AND DISCUSSION

Weed flora

In two-year field study, maize-groundnut cropping sequence was found infested with mixed weed flora belonging to sixteen taxonomic families, including four species of grasses, two species of sedges, and sixteen species of broad-leaved weeds. The predominant weed species in the experimental field were *Cyperus rotundus* L., *Digitaria sanguinalis* (L). Scop., *Dactyloctenium aegyptium* (L.) Willd., *Blainvillea acmella* L., *Lagascea mollis* Cav. and *Commelina benghalensis* L. Similar type of weed flora was reported by Swetha *et al.* (2015) and Ravi *et al.* (2017).

Effect on weeds

Lower density and biomass of grasses, sedges, broad-leaved, and total weeds were registered in control plots (no. N). RDN and GSNM recorded significantly lower densities of grasses, sedges, broad-leaved and total weeds than SNM (**Table 1**). Initial higher dose of N in SNM might have increased the weed biomass per unit area (Evans *et al.,* 2003). The results were in agreement with the findings of Kristensen *et al.* (2008) and Khan *et al.* (2012).

Among different weed management treatments, hand weeding twice (15 and 30 DAS) recorded significantly lower density and biomass of grasses, sedges, broad-leaved and total weeds over the rest of treatments at 20 DAS. Hand weeding twice (15 and 30 DAS) was found at par with atrazine 1.0 kg/ha PE *fb* topramezone 30 or 120 g/ha PoE in lowering down density and biomass of grasses, sedges, broad-leaved and total weeds at 40 DAS. This was mainly attributed to effective control of weeds with hand weeding twice or sequential application of pre- and post-emergence herbicides (Swetha *et al.* 2015).

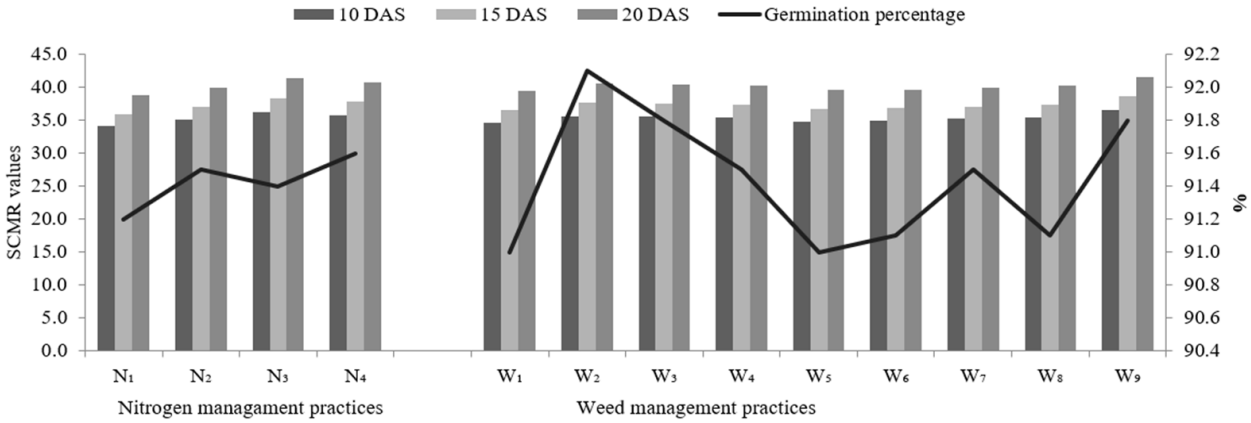

Figure 1. Germination percentage and SCMR values in groundnut as influenced by nitrogen and weed management practices imposed in preceding maize (pooled of two-year data)

Table 1. Effect of nitrogen and weed management treatments on total weed density and biomass in maize

Treatment	Total weed density (no./m^2)				Total weed biomass (g/m^2)			
	20 DAS		40 DAS		20 DAS		40 DAS	
	2019	2020	2019	2020	2019	2020	2019	2020
Nitrogen management								
Control	6.07 (42.9)	7.33 (62.7)	5.26 (33.7)	5.54 (37.5)	7.16 (67.7)	8.06 (86.3)	6.34 (52.9)	6.59 (57.1)
Recommended dose of fertilizer	7.71 (68.8)	9.29 (99.7)	7.35 (64.3)	7.73 (71.0)	8.20 (89.3)	9.44 (118.4)	7.93 (83.6)	8.45 (95.1)
Green seeker directed N application	7.83 (73.4)	9.43 (106.2)	7.66 (69.9)	8.07 (77.4)	8.55 (96.0)	9.66 (122.6)	8.20 (88.6)	8.80 (102.2)
Soil test-based fertilizer application	8.80 (97.2)	10.38 (134.4)	8.60 (85.6)	8.78 (89.0)	9.69 (122.7)	10.69 (148.9)	9.20 (110.9)	9.65 (121.9)
LSD (p=0.05)	0.73	0.89	0.52	0.56	0.74	0.99	0.61	0.67
Weed management								
Unweeded check	11.12 (132.8)	13.29 (188.9)	10.56 (119.7)	11.02 (130.3)	14.55 (214.5)	15.90 (255.1)	13.72 (192.0)	14.50 (214.6)
Hand weeding twice at 15 and 30 DAS	0.71 (0.0)	1.13 (1.0)	0.71 (0.0)	0.79 (0.1)	2.24 (4.6)	2.50 (5.9)	2.12 (4.1)	2.23 (4.6)
Atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha PoE	6.24 (40.8)	7.44 (58.2)	6.33 (41.7)	6.60 (45.4)	2.46 (5.9)	2.75 (7.6)	2.33 (5.3)	2.46 (5.9)
Atrazine 1.0 kg/ha PE *fb* tembotrione 120 g/ha PoE	6.68 (45.5)	7.98 (65.1)	6.49 (44.0)	6.78 (47.9)	2.70 (7.0)	3.04 (9.0)	2.56 (6.2)	2.70 (7.0)
Application of Parthenium water extract 15 L/ha twice at 15 and 30 DAS	10.96 (127.7)	13.09 (181.5)	10.27 (108.4)	10.72 (117.9)	13.06 (173.5)	14.87 (224.8)	12.31 (155.5)	13.01 (173.8)
Application of sunflower water extract 15 L/ha twice at 15 and 30 DAS	10.93 (125.8)	13.06 (179.1)	10.33 (108.7)	10.73 (117.1)	12.66 (163.0)	14.42 (211.2)	11.94 (146.0)	12.63 (163.5)
Atrazine 1.0 kg/ha PE *fb* Parthenium water extract 15 L/ha PoE	6.77 (46.8)	8.09 (66.8)	6.45 (44.2)	6.72 (47.9)	11.05 (122.2)	12.57 (158.4)	10.39 (108.8)	10.99 (121.9)
Atrazine 1.0 kg/ha *fb* sunflower water extract 15 L/ha PoE	6.67 (45.2)	7.97 (64.8)	6.31 (42.3)	6.58 (45.8)	10.82 (117.2)	12.32 (152.0)	10.18 (104.4)	10.77 (117.0)
Brown manuring	8.30 (70.4)	9.94 (101.0)	7.53 (61.2)	7.85 (66.2)	6.05 (37.6)	6.79 (47.4)	5.72 (33.8)	6.10 (38.4)
LSD (p=0.05)	0.96	1.15	1.04	1.09	1.05	1.20	1.07	1.13
N at W								
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
W at N								
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Data in parentheses are original values, which were transformed to ($\sqrt{X+0.5}$) and analysed statistically

Brown manuring was the next best weed management treatment in reducing the weeds biomass. Application of atrazine 1.0 kg/ha PE *fb* sunflower water extract 15 l/ha PoE and atrazine 1.0 kg/ha PE *fb* Parthenium water extract 15 l/ha PoE were comparable with one another and were significantly lower than application of sunflower water extract 15 l/ha twice at 15 and 30 DAS and

application of Parthenium water extract 15 l/ha twice at 15 and 30 DAS. Application of atrazine PE *fb* plant water extract PoE resulted in greater reduction in weed biomass than the plant water extracts applied alone.

Higher density and biomass of all categories of weeds were recorded with unweeded check due to heavy weed infestation right from sowing to crop harvest confirming Yakadri *et al.* (2015) and Rani *et al.* (2019). There was no significant effect of interaction during both the years of study.

Effect on crop

Maize: Among the nitrogen management practices, GSNM recorded significantly higher kernel and stover yield of maize as evidenced from year-wise well as pooled data. It might be due to precise nitrogen application in more number of splits compared to other treatments. Adequate supply of nitrogen at appropriate crop growth stages might have enhanced greater availability of nutrients in the soil which resulted in more absorption and higher uptake by the crop plants. This also facilitated better translocation and partitioning of assimilates from source to sink, amplifying yield parameters and thereby yield. This was in consonance with the findings of Prakasha *et al.* (2020) and Jyothsna (2020). Maize kernel and stover yields were improved due to hand weeding twice (15 and 30 DAS), which, however, remained at par with the application of atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha PoE; atrazine 1.0 kg/ha PE *fb* tembotrione 120 g/ha PoE (**Table 2** and **3**). This might be due to reduced competition among the crop plants and weeds for the existing resources throughout the crop growth period, enabling the crop plants for better utilization of resources as reflected in terms of higher kernel yield. Lower yields were recorded with weedy check. The results corroborated with the findings of Rani *et al.* (2019) and Mahto *et al.* (2020).

There was a significant effect of interaction between nitrogen and management practices on kernel and stover yields of maize during both the years. The treatment combination of GSNM with hand weeding twice (15 and 30 DAS) recorded significantly higher kernel yield although it was at par with GSNM along with atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha PoE; GSNM with atrazine 1.0 kg/ha PE *fb* tembotrione 120 g/ha PoE; SNM with hand weeding twice (15 and 30 DAS); SNM with atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha PoE and SNM with atrazine 1.0 kg/ha (PE *fb* tembotrione 120 g/ha PoE. Significantly higher kernel yield in these treatment combinations might be due to maintenance of weed-free environment during critical period of crop-weed competition and sensor determined topdressing of nitrogen for maize with increased number of split applications, leading to increased availability of resources at different physiological growth stages and better translocation of photosynthates to sink. Nagalakshmi *et al.* (2006) and Deshmukh *et al.* (2009) also reported significant interaction between nitrogen and weed management practices. The lowest kernel and stover yields were observed with the non-application of N in unweeded plots, which were comparable even when combined with two sprays of Parthenium or sunflower water extract 15 l/ha (15 and 30 DAS), or the application of

Table 2. Effect of nitrogen and weed management treatments on maize kernel yield (t/ha)

Treatment	2019					2020					Pooled				
	C	RDF	GSD	STF	Mean	C	RDF	GSD	STF	Mean	C	RDF	GSD	STF	Mean
Atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha PoE	3.24	6.16	7.78	7.32	6.12	3.00	5.99	7.65	7.15	5.95	3.12	6.07	7.71	7.24	6036
Atrazine 1.0 kg/ha PE *fb* tembotrione 120 g/ha PoE	2.98	5.82	7.71	7.23	5.94	2.74	5.65	7.45	7.06	5.72	2.86	5.74	7.58	7.15	5830
Application of Parthenium water extract 15 L/ha twice at 15 and 30 DAS	1.40	2.77	4.24	3.70	3.03	1.24	2.58	4.18	3.47	2.87	1.32	2.67	4.21	3.59	2949
Application of sunflower water extract 15 L/ha twice at 15 and 30 DAS	1.44	2.83	4.40	3.93	3.15	1.27	2.66	4.26	3.59	2.94	1.36	2.74	4.33	3.76	3048
Atrazine 1.0 kg/ha PE *fb* Parthenium water extract 15 L/ha PoE	1.57	3.07	4.49	3.93	3.26	1.39	2.90	4.32	3.76	3.09	1.48	2.98	4.41	3.85	3179
Atrazine 1.0 kg/ha *fb* sunflower water extract 15 L/ha PoE	1.64	3.22	4.53	3.97	3.34	1.47	3.05	4.36	3.83	3.18	1.56	3.13	4.45	3.90	3260
Brown manuring	2.73	4.74	6.06	5.73	4.82	2.56	4.57	5.90	5.57	4.65	2.65	4.66	5.98	5.65	4734
Unweeded check	1.04	2.13	3.77	3.50	2.61	0.97	1.88	3.43	3.25	2.38	1.00	2.01	3.60	3.37	2497
Hand weeding twice at 15 and 30 DAS	3.29	6.26	8.05	7.57	6.29	3.18	6.10	7.92	7.40	6.15	3.23	6.18	7.98	7.49	6221
Mean	2.15	4.11	5.67	5.21		1.98	3.93	5.50	5.01		2.06	4.02	5.58	5.11	
	SEm ±		LSD (p=0.05)			SEm ±		LSD (p=0.05)			SEm ±		LSD (p=0.05)		
N	0.11		0.39			0.12		0.40			0.11		0.39		
W	0.14		0.40			0.15		0.41			0.14		0.34		
N at W	0.28		0.79			0.30		0.83			0.27		0.81		
W at N	0.34		0.83			0.35		0.86			0.33		0.85		

C: Control; RDF: Recommended dose of fertilizer; GSD: Green seeker directed N application; STF: Soil test-based fertilizer application

atrazine 1.0 kg/ha PE *fb* Parthenium/sunflower water extract 15 L/ha PoE.

Groundnut: Residual effect of both nitrogen and weed management practices as imposed in maize was found to be non-significant in influencing germination percentage, phytotoxicity and SPAD chlorphyll meter reading (SCMR) values. This might be due to the degradation of herbicides by several ways that resulted in less persistence of applied herbicides as also reported by Nazreen (2017) and Sathyapriya and Chinnusamy (2020).

Nitrogen management practices in maize did not exert any significant influence on weed dynamics, pod yield and haulm yield of groundnut. Irrespective of nitrogen management practices, total weed density and biomass in groundnut were lower with hand weeding twice (15 and 30 DAS), which was however, at par with brown manuring, application of atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha or tembotrione 120 g/ha PoE (**Table 4**). Higher pod and haulm yield of groundnut was recorded with brown manuring, which, however, remained at par with hand weeding

Table 3. Effect of nitrogen and weed management treatments on maize stover yield (kg/ha)

Treatment	2019					2020					Pooled				
	C	RDF	GSD	STF	Mean	C	RDF	GSD	STF	Mean	C	RDF	GSD	STF	Mean
Atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha PoE	4.50	6.97	8.21	7.88	6.89	4.25	6.76	7.96	7.72	6.67	4.38	6.87	8.09	7.80	6.78
Atrazine 1.0 kg/ha PE *fb* tembotrione 120 g/ha PoE	4.37	6.50	8.18	7.79	6.71	4.12	6.32	7.93	7.63	6.50	4.25	6.41	8.05	7.71	6.60
Application of Parthenium water extract 15 L/ha twice at 15 and 30 DAS	2.67	3.94	5.47	4.76	4.21	2.42	3.79	5.35	4.57	4.03	2.54	3.86	5.41	4.67	4.12
Application of sunflower water extract 15 L/ha twice at 15 and 30 DAS	2.73	4.01	5.49	5.03	4.31	2.48	3.87	5.47	4.72	4.13	2.60	3.94	5.48	4.87	4.22
Atrazine 1.0 kg/ha PE *fb* Parthenium water extract 15 L/ha PoE	2.92	4.37	5.54	5.04	4.47	2.67	4.12	5.36	4.85	4.25	2.80	4.25	5.45	4.94	4.36
Atrazine 1.0 kg/ha *fb* sunflower water extract 15 L/ha PoE	2.98	4.54	5.55	5.06	4.53	2.76	4.29	5.30	5.00	4.34	2.87	4.41	5.43	5.03	4.43
Brown manuring	4.55	5.89	7.03	6.71	6.05	4.30	5.75	6.97	6.55	5.89	4.43	5.82	7.00	6.63	5.97
Unweeded check	2.02	3.25	4.84	4.64	3.69	1.90	3.22	4.76	4.41	3.57	1.96	3.23	4.80	4.53	3.63
Hand weeding twice at 15 and 30 DAS	4.50	7.05	8.37	8.15	7.02	4.25	6.80	8.29	7.99	6.83	4.38	6.93	8.33	8.07	6.92
Mean	3.47	5.17	6.52	6.12		3.24	4.99	6.38	5.94		3.36	5.08	6.45	6.03	
	SEm ±		LSD (p=0.05)			SEm ±		LSD (p=0.05)			SEm ±		LSD (p=0.05)		
N	0.11		0.37			0.11		0.38			0.11		0.35		
W	0.18		0.50			0.17		0.48			0.16		0.44		
N at W	0.32		0.90			0.33		0.91			0.30		0.88		
W at N	0.35		0.99			0.34		0.96			0.31		0.91		

C: Control; RDF: Recommended dose of fertilizer; GSD: Green seeker directed N application; STF: Soil test-based fertilizer application

Table 4. Effect of nitrogen and weed management practices executed in preceding maize on weed parameters and pod and haulm yield of succeeding groundnut

Treatment	Total Weed density (no./m^2)		Total Weed biomass (g/m^2)		Groundnut pod yield (t/ha)		Groundnut haulm yield (t/ha)	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
Nitrogen management								
Control	8.6(76.6)	10.3(107.5)	7.3(55.3)	8.6(77.3)	2.45	2.28	3.44	3.36
Recommended dose of fertilizer	8.7(76.8)	10.3(107.8)	7.3(55.1)	8.6(77.1)	2.52	2.34	3.51	3.44
Green seeker directed N application	8.9(79.8)	10.5(111.7)	7.5(58.1)	8.9(81.1)	2.70	2.50	3.66	3.58
Soil test-based fertilizer application	9.0(82.8)	10.7(115.7)	7.7(61.3)	9.1(85.3)	2.62	2.42	3.55	3.50
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Weed management								
Unweeded check	10.1(101.4)	11.8(138.2)	8.9(78.9)	10.4(108.7)	2.21	2.04	3.29	3.09
Hand weeding twice at 15 and 30 DAS	7.2(50.9)	8.7(75.5)	5.5(30.3)	6.7(44.1)	2.93	2.74	3.80	3.73
Atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha PoE	7.3(53.6)	8.9(78.9)	5.7(32.4)	6.9(47.0)	2.91	2.72	3.74	3.66
Atrazine 1.0 kg/ha PE *fb* tembotrione 120 g/ha PoE	7.5(55.3)	9.0(81.2)	5.9(33.9)	7.0(48.9)	2.86	2.66	3.68	3.65
Application of Parthenium water extract 15 L/ha twice at 15 & 30 DAS	10.0(100.2)	11.7(137.3)	8.9(78.1)	10.4(107.8)	2.26	2.07	3.33	3.30
Application of sunflower water extract 15 L/ha twice at 15 & 30 DAS	10.0(99.2)	11.7(136.0)	8.8(76.9)	10.3(106.2)	2.29	2.10	3.34	3.30
Atrazine 1.0 kg/ha PE *fb* Parthenium water extract 15 L/ha PoE	10.0(98.7)	11.7(135.5)	8.8(76.5)	10.3(105.6)	2.32	2.13	3.40	3.36
Atrazine 1.0 kg/ha *fb* sunflower water extract 15 L/ha PoE	10.0(98.7)	11.6(135.2)	8.8(78.1)	10.4(107.7)	2.37	2.18	3.42	3.38
Brown manuring	7.3(52.7)	8.8(77.8)	5.7(31.7)	6.8(46.0)	2.99	2.81	3.88	3.79
LSD (p=0.05)	0.82	0.83	0.77	0.87	0.27	0.23	0.23	0.25
Interaction								
N at W								
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
W at N								
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Data in parentheses are original values, which were transformed to ($\sqrt{X+0.5}$) and analysed statistically

twice (15 and 30 DAS) and application of atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha or tembotrione 120 g/ha PoE. Better weed suppression coupled with higher residual nitrogen availability might have increased the yield attributes which in turn led to higher pod yield conforming earlier reports of Sathyapriya and Chinnusamy (2020).

Weedy check plots were comparable with the plots treated with two sprays of Parthenium/ sunflower water extract 15 l/ha (15 and 30 DAS) or application of atrazine 1.0 kg/ha PE *fb* Parthenium or sunflower water extract 15 l/ha in significantly registering higher weed density and biomass and lower yield levels in groundnut. Higher weed growth was due to prolific weed seed production in preceding crop, leading to severe crop-weed competition along with lower pod yield in groundnut (Rani *et al.* 2019).

Conclusion

It was concluded that Green Seeker-directed N management (GSNM) along with either hand weeding twice or application of atrazine 1.0 kg/ha PE *fb* topramezone 30 g/ha /tembotrione 120 g/ha PoE proved to be the most effective option in managing weeds and increasing the productivity of maize. When the groundnut is grown as a succeeding crop, it would be worthwhile to go for brown manuring, hand weeding twice or sequential application of pre- and post-emergence herbicides in preceding maize for an efficient weed management in maize-groundnut cropping system.

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