Influenceof Integrated Weed& Nutrient Management on Productivity & Profitability of Summer Maize (*Zea mays*) Under Rainfed Condition of Assam

ABSTRACT

A field experiment was conducted at the Instructional-cum-Research (ICR) Farm,Assam Agricultural University, Jorhat during the summer season of the year 2020 toevaluate the effects of integrated weed and nutrient management on weed growth,yield attributes and yield of summer maize. The experiment was laid out in factorialrandomizedblockdesignandreplicatedthrice.Thetreatmentconsistedofthreenutrientmanagementpractice*viz.*,100%RDF(N_1);N_1+25kg$ZnSO_4$/ha(N_2)and75 % RDN and 100 % $P_2O_5$and K_2O through chemical fertilizer (CF) + 25 % Nthrough vermicompost + 25 kg $ZnSO_4$/ha (N_3) and four weed management practices*viz.*, weedy check (WM_1), live mulching with cowpea (WM_2), WM_2+ hand weedingat 25 and 45 DAS (WM_3) and Atrazine 500g+Pendimethalin 500g/ha followed byhand weeding at 45 DAS (WM_4). Experimental findings revealed that the different INM practices significantlyaffected the growth parameters, yield and yield attributes of summer maize. Themaximumvaluesof growthparameterswere recordedinthe treatmentinvolvingapplication of 75% RDN and 100% $P_2O_5$and K_2O through CF + 25% N throughVC + 25 kg $ZnSO_4$/ha (N_3). Similarly, yield and yield attributing characters *viz.*,weight of cob with and without husk, length of cob without husk, number of rows percobs, grain per row,grain per cob, 1000 grain weight, shelling percentage, grain(23.76 q/ha) and stover (74.55 q/ha) yield. The growth, Yield and yield attributing parameters of maize were significantly affected by thedifferentweedmanagementpractices.PreemergenceapplicationofAtrazine500g+Pendimethalin 500g/ha followed by hand weeding at 45 DAS (WM_4) resultedthe highest value of yield. Thehighest grain (21.77 q/ha) and stover (71.12 q/ha) yield were recorded in the treatmentWM_4.The interaction effects of different nutrient and weed management practiceswere found not significant. The economic study revealed that the highest gross return(₹.1, 03816.00/ha), net return (₹.67, 956.00) and B: C (1.90) were recorded from thetreatment combination N_3WM_4.

Keywords: vermicompost, cereal crops, weed infestations, Nutrient Management

INTRODUCTION

Maize (Zea mays L) is one of the world's most important cereal crops belonging to the family Poaceae. The wider adaptability, high yield potential and multiplicity of uses as food, feed and forage crop signifies its importance in the world economy. Maize is a C4 plant and having maximum yield potential among the cereals and that is why it is called as "Miracle crop" and the "queen of cereals". Worldwide, maize is cultivated in more than 180 million hectares across 165 countries with a production of 1150 million tons (mt). In India out of the total production, 24% is used as staple food, nearly 16 % for livestock feed, 16 % for industrial purpose and 44 % for poultry feed whereas in world for industry 22 %, feed 61 % and for staple food 17 % is used. (DMR, 2019-20). The primary limitations in maize production are governed by biotic factors such as nutrient deficiency and weed infestations. There are more than 90 species of weeds which cause serious crop-weed competition resulting reduction of maize yield drastically. Maize is susceptible to weed competition and yield reduction up to 70 per cent is reported due to infestation of various weeds in maize. With the application of recent methods of weed management, maize yield could be increased up to 30 percent (Mani *et al.,* 1968). In many studies, it has been proved that the use of different methods of weed control combining the herbicides and the mechanical methods in an integrated manner is more effective in terms of weed control, cost effectiveness and from the point of view of environmental health. Nutrimentmanagementisanothermostimportantthrustareaofsustainable maize production. For realizing maximum corn yield, a balanced nutrientmanagement strategy has to be adopted. Maize requires high amount of nutrients duetoitshighfeedinghabitandhence,highlyfertilesoilisrequiredforyieldmaximization. Inorganic fertilizer alone deteriorates the soil quality. Organic sources also reduce the soildegradation bybinding the soil particles but the main limitation of organic sources is that it containslow amount of nutrients as compared to the inorganic fertilizer, as they are bulky innatureandtheiravailabilityisnotsufficienttofulfillthenutrientdemand.Therefore,itisnecessarytoco mbinetheorganicandinorganicsourcesofnutrientsformaximizationofcropyield,maintenanceofsoilfe rtilityandforreductionofenvironmental pollution. In Assam maize is grown mostly under rainfed situation during *kharif*season.Excessrainfallduringthe*kharif*season,oftenposesmanydifficultiesinfieldpreparation, seed sowing and germination of *kharif*maize. The nutrient loss is alsomaximum during this season and finally crop yield is affected. However, with theevolutionofearlymaturingvarieties, maizecan also begrown in summerseason.

MATERIALS AND METHODS

The experiment was carried out at the Instructional-cum-Research Farm, Assam Agricultural University, Jorhat, Assam during the summer season of the year 2020. The farm is located at 26°47'N latitude and 94°12'E longitudes and at the elevation of 86.6 meters above mean sea level (MSL) at the upper Brahmaputra valley zone of Assam. During the crop growth period the weekly average humidity during the morning hour ranged from 97% to 85% and evening hour ranged from 80% to 58%. The total rainfall received during the field experimentation was 553.30 mm. Moreover, the distribution of amount of rainfall was not even during the crop period and it was maximum during the month of May and lowest during the month of March. The weekly mean maximum temperature ranged from 32.6 to 26.1 C and the weekly mean minimum temperature ranged from 24.8 to 14.2 C during the crop growing season. The weekly mean evaporation varied from 2.30 mm to 3.64 mm during the crop growing period. The weekly average wind speed varied from 1.73 km per hour to 3.24 km per hour and the maximum weekly bright sun shine hours were recorded during the month of March (6.1 hours/day) and minimum in the month of May (0.3 hours/day). The soil of the experimental site was sandy loam in texture, acidic in reaction, medium in organic carbon (0.71%), low in available N (158.60 kg/ha) and medium in available P_2O_5 (22.87 kg/ha) and K_2O (162.55 kg/ha) and low in available Zn (0.64 ppm). Maize variety used in the experiment was VMH 45. The required quantity of vermicompost was applied one week before seed sowing. The nutrient content in the applied vermicompost was estimated as 1.5 % N, 0.84 % P and 1.30 % K (Table: 1). The recommended N dose for maize is 60 kg/ha in Assam. The quantity of vermicompost applied for fulfilling 25 % of N i.e. 15 kg/ha through vermicompost was calculated. Herbicides used in the experiment were Atrazine and Pendimethalin. Growth parameters viz. plant height and dry matter accumulation at 30, 60 and 90 DAS, number of leaves and 50 days to tasseling for each treatment were recorded, whereas yield and yield attributing characters viz. total number of rows per cob, total number of kernels per row, weight of cob without husk, weight of cob without husk (g/cob), weight of cob with husk (g/cob), length of cob without husk (cm), number of kernels per cob, grain weight per cob (g), 1000 seed weight (g), cob yield with husk (q/ha), cob yield without husk (q/ha), grain yield (q/ha) and stover yield (q/ha) and shelling percentage were recorded.

$$\text{Shelling percentage} = \frac{\text{Grain yield} \times 100}{\text{Cob yield}}$$

Table:1 Quantity of vermicompost (VC) applied based on the nutrient analysis

N contentin VC(%)	Moisturecontentin VC(%)	Quantityof VCapplied(kg/ha)	P contentinVC (%)	K content inVC (%)	Quantity of padded throughVC(kg/ha)	Quantity of Kadded throughVC(kg/ha)
1.5	43.00	1430.00	0.84	1.30	8.40	13.0

RESULTS AND DISCUSSION

Growth parameters

The growth parameters showed a significant impact due to the influence of both INM (Table: 2 and Table: 3). The plantheight of maize was found significantly higher at 30 DAS in N_2 treatment this mightbe due to quick release of nutrients from the chemical fertilizers (Patel *al el.*, 2006).However, at60and90daysaftersowing,significantlyhigherplantgrowthwasrecordedwiththeapplicationof 75%RDNand100%P_2O_5andK_2Othroughchemicalfertilizers+25%Nthroughvermicompost+25kgZ

nSO_4/ha(N_3)followed by 100% RDF + 25 kg $ZnSO_4$ /ha (N_2) as compared to 100% RDF (N_1).Swarup*et al.* (1998) reported that good crop growth recorded by combing inorganicsource of nutrients with organic sources. Chemical fertilizers are readily available tomeet the initial crop growth requirement but at the later stage of crop growth these arenotequallyavailable.Ontheotherhand,organicsourcesoffertilizersreleasenutrients at a slower rate and remain available for longer period of time. In the presentinvestigation, higher plant height of maize was recorded with recommended dose offertilizer when 75% of the nitrogen was supplied through inorganic sources and 25%through vermicompost along with zinc nutrition. Similar results were also revealed byDadarwal*etal.*(2009)andKhadtare*etal.,*2006).Inrespectofdrymatteraccumulation, number of leaves per plant and days to 50% tasseling, significantlyhigher values were obtained with 75 % RDN and 100 % $P_2O_5$and K_2O throughchemical fertilizers + 25 % N through vermicompost + 25 kg $ZnSO_4$/ha (N_3). Thereason for higher values of growth parameter recorded with integration of organic andinorganic is due to easy availability of plant nutrients from soil for a longer period oftime.Thecombinedapplicationoforganicsourcelikevermicompostmighthave reducedtheleachingandrunofflossesofnutrients.Similarresultswerereported byNanjappa*etal*.(2001),Kumar*etal.*(2005).Integrationofzincmighthaveresultedbettergrowth of thecrop byenhancingits availabilityto themaize crop. Theplantgrowthparameters*viz.*,plantheight,drymatteraccumulation, number of leaves per plant and days to 50% tasseling were found to besignificantly affected due to the different IWM practices (Table:2 and Table :3). Plant height,dry matter accumulation, number of leaves and days to 50% tasseling were found tobemarkedlyhigherwithapplicationofAtrazine500g+Pendimethalin500g/hafollowed by hand weeding at 45 DAS (WM_3) which was followed by mulching +hand weeding at 25 and 45 DAS (WM_3) and live mulching with cowpea (WM_2) ascomparedtotheweedychecktreatment(WM_1).Thiswasmainlyduetotheminimum crop weed competition during the crop growth period under the treatmentshaving different integrated weed management practices. Weed control at the earlygrowth stages of the maize crop enables the crop for efficient utilization of differentgrowth resources *viz.*, nutrients, moisture, light and space. Due to the creation offavourable crop growing environment as a result of minimal crop weed competition,the maize crop registered better growth and development. Similar findings were alsoreportedbyHatti*etal*.(2014) andShantveerayyahawaldar andAgasimani,(2012). No interaction effect was found between INM and IWM on growthparametersof summermaize.

Table: 2. Plant height (cm) and shoot dry weight (g/plant) of summer maize at different days after sowing as affected by integrated weed and nutrient management practices

Treatments	**Plant height**			**Shoot dry weight (g/plant)**		
	30DAS	**60DAS**	**90DAS**	**30DAS**	**60DAS**	**90DAS**
Nutrientmanagement(N)						
N_1:100%RDF	30.30	92.71	156.41	8.18	14.24	28.90
N_2:N_1+25kg$ZnSO_4$/ha	33.02	100.05	170.66	9.45	17.48	34.70
N_3:75%RDNand100%P_2O_5 andK_2O throughCF+25% NthroughVC+25kg$ZnSO_4$/ha	32.15	106.12	177.05	9.30	19.61	38.70
SEm±	0.74	0.22	0.13	0.35	0.13	0.21
CD(P=0.05)	2.15	0.65	0.39	1.03	0.39	0.61
Weedmanagement(WM)						
WM_1:Weedycheck	30.20	97.05	163.80	7.82	15.94	32.00
WM_2:Livemulchingwithcowpea	30.78	98.76	166.74	8.93	16.69	33.50
WM_3:WM_2+handweeding at25and45 DAS	32.37	100.48	169.33	9.31	17.55	34.90
WM_4: Atrazine500g+Pendimethalin500g/hafollowed by handweeding at 45DAS	33.94	102.20	172.29	9.85	18.26	36.00
SEm±	0.85	0.25	0.15	0.40	0.153	0.24
CD(P=0.05)	2.50	0.76	0.46	1.18	0.45	0.70
Interaction(NxWM)						
SEm±	1.48	0.44	0.27	0.70	0.26	0.41
CD(P=0.05)	NS	NS	NS	NS	NS	NS

Table: 3. Number of leaves/plants and of summer maize at different days after sowing as affected by integrated weed and nutrient management practices

Treatments	**Number of leaves/ plants**			**50%tasseling**
	30DAS	**60DAS**	**90DAS**	
Nutrientmanagement(N)				
N_1:100%RDF	3.67	6.98	8.09	62.93
N_2:N_1+25kg$ZnSO_4$/ha	4.91	7.97	9.08	61.35

N_3:75%RDNand100%P_2O_5 andK_2O throughCF+25% NthroughVC+25kg$ZnSO_4$/ha	4.73	8.49	9.96	60.11
SEm$\pm$	0.52	0.50	0.51	1.18
CD(P=0.05)	NS	NS	NS	NS
Weedmanagement(WM)				
WM_1:Weedycheck	3.94	7.30	8.46	62.60
WM_2:Livemulchingwithcowpea	4.07	7.75	8.95	61.43
WM_3:WM_2+handweedingat25and 45 DAS	4.41	7.84	9.11	61.06
WM_4: Atrazine500g +Pendimethalin500g/hafollowed by handweeding at 45DAS	5.18	8.37	9.43	60.76
SEm$\pm$	0.60	0.58	59	1.37
CD(P=0.05)	NS	NS	NS	NS
Interaction(NxWM)				
SEm$\pm$	0.08	0.24	1.03	2.37
CD(P=0.05)	NS	NS	NS	NS

Yield attributes and yield

The yield attributes and yield of maize were significantly affected bythe various INM practices (Table: 4, Table: 5, and Table: 6). The parameters like weight of cob with and without husk,length of cob without husk, number of grain rows per cob, number of grains per row,number of grains per cob, 1000-grain weight was found significantly higher under theINM practices as compared to RDF practice. All the characters associated with yieldattributes under INM practices were found statistically significant over the RDF. Thiswas mainly due to the availability of nutrient as organic sources of nutrient providenutrient for a longer period of time. The accessibility of nitrogen enhanced in soil duetosteadyreleaseofthenutrientsfromorganicsources asdescribedbyKumari*et al.*(2010). The enhanceaccessibility of phosphorus may be due to production oforganic acids released at the time of microbial decomposition of organic matters. Theorganicacidsenhancethesolubilityofnativephosphorus,therebyenhancesthephosphorus availability. On the other hand, the enhance potassium availability in soilmight be due to positive effect of organic source on the reduction of potassiumfixation and release of potassium as a result of interaction of organic with clay. Thesefindingscloselycorroboratethefindingsof Das *etal*.(2004).TheN_3treatmentregistered 25 % higher cob weight than the N_1 treatment.It was clearly indicated thatintegration of different source of organic and inorganic nutrients enhance the nutrientuse efficiency by crop plant; because of this maize yield was enhanced. Mugwe*et al*.(2009) revealed that combine application of organic and inorganic source of fertilizergave significantly higher yield than only sole source of fertilizer. Similar, effect wasrevealed by Dilshad*et al*. (2010), Osman *et al*. (2010). This is also because of the factthat application of vermicompost not only enhances microbial activities, but alsoimprovessoilphysicalconditionandmicronutrients(Jilani*etal*.,2007).Kanchikerimath and Singh (2001) also revealed that when organic source appliedalongwith inorganicsourcemaizecropyieldwasincreased. Among the INM practices, 75% N through chemical fertilizer + 25%nitrogen through vermicompost provide the best result. This combination of differentsource of nutrients provides adequate amount of macro and micro nutrient and alsoenhance physical and chemical properties of soil and ultimately nutrient availabilityfor plant which is benefited for growth as well as for yield attributes of maize plant.Similar,findings arecloseaccordancewithreportedbyParsad*et al*. (2003). The Grain, cob yield without husk, stover yield and shelling % of maize were significantly affected bythe various INM practices. Application of 75% N through RDF + 25% N through vermicompostenhances the stover yield of maize and almost similar trend was followed in case ofgrain yield of maize. The higher yield under these treatments was due to favourableeffect of nutrient application on crop vegetative growth and yield attributes of crop.The increasing trend in stover and grain yield of maize under these treatments may bedue to betterments in physical and chemical properties of soil and balance availabilityof nutrient and carbon which work on growth and yield improving characters of cropplant. Similar, findings were also revealed by Saini and Kumar (2014) and Nasab*et. al*.(2015). Applicationofzincplaysacrucialroleincropproductivityasitinvolves directly in physiological process and inadequate supply of zinc reduce theyieldofmaizeby10%(SubediandMa,2009).ApplicationofZincfertilizerincreases the growth and yield attributes and ultimately yield of maize (Abunyevaand Mercie-Quarshie, 2004).The reasongiven by these researchers for improving themaize yield with zinc application was focused mainly on improvement on kernelnumberand thousand kernel weights.

Findings on yield attributes and yield were found to be significantunder variousIWM treatments (Table: 4, Table: 5, and Table: 6). The significantly higher weightof cob with andwithout husk, length of cob without husk, rows per cob, grain per row, grain per cob,1000-grain weight were found under IWM practice (WM_4) followed by WM_3 andWM_2andthelowestvalueswerefoundunderweedycheck(WM_1)treatment.Different weed management practices significantly affected thegrowth andyieldattributes of corn. This might be due to creation of changed micro-climate in terms ofphysical environment for mechanical manipulation of soil and minimum crop-weedcompetition under hand weeding which led to good yield component and ultimatelybetteryield(Mundra*etal*.,2003).Theyieldadvantageduetovariousweedmanagement methods as compared to weedy check were mainly attributed for goodyieldattributingparametersandcomparativelylessweedpopulationandweedbiomassalongwithhigherweedcontrolefficiency.Thefindingsareincloseconformity withthosereportedinmaize by Singh*etal*.,(2005).Pre-emergenceapplicationofAtrazineandPendimethalin@1kg/hafollowedby handweedingresulted significantly higher cob length, number of grains per cob grain row whereas,lower values of these parameter were foundunder weedy check. Similar reductionwasalsoobserved underun-weededplotbyPandey*et al.*, (2001). Nointeractioneffectwasfoundbetween INMandIWMongrowthparametersof summermaize.

Table: 4. Number of grain rows per cob, Number of grains per row, grains per cob of summer maize as affected by integrated weed and nutrient management practices

Treatments	Grain rows percob	Grainperrow	Grain per cob
Nutrientmanagement(N)			
N_1:100%RDF	11.74	20.53	241.54
N_2:N_1+25kg$ZnSO_4$/ha	13.54	23.11	312.49
N_3:75%RDNand100%P_2O_5andK_2O throughCF+25%Nthrough VC+25kg$ZnSO_4$/ha	15.10	25.22	380.28
SEm$\pm$	0.04	0.14	1.87
CD(P=0.05)	0.14	0.41	5.48
Weedmanagement(WM)			
WM_1:Weedycheck	12.79	22.05	284.40
WM_2:Livemulchingwithcowpea	13.22	22.65	302.13
WM_3:WM_2+handweedingat25and45DAS	13.65	23.04	316.65
WM_4:Atrazine500g+Pendimethalin500g/hafollowed by handweeding at45DAS	14.17	24.06	342.56
SEm$\pm$	0.05	0.16	2.16
CD(P=0.05)	0.16	0.48	5.60
Interaction(NxWM)			
SEm$\pm$	0.09	0.28	3.85
CD(P=0.05)	NS	NS	NS

Table: 5. Weight of cob with husk (g/cob), weight of cob without husk (g/cob), length of cob without husk (cm), 1000 grain weight(g), weight of grain per cob(g) of summer maize as affected byintegratedweedand nutrient managementpractices

Treatments	Wt. of cobwithhusk	Wt.ofcobwithout husk	Length of cobwithouthusk	1000grain wt.	Wt.of grainper cob
Nutrientmanagement(N)					
N_1:100%RDF	218.36	172.06	16.10	291.26	75.64
N_2:N_1+25kg$ZnSO_4$/ha	241.37	188.44	19.71	301.38	90.18

N_3:75%RDNand100%P_2O_5 andK_2O throughCF+25% NthroughVC+25kg$ZnSO_4$/ha	254.32	206.37	21.67	311.12	105.78
SEm$\pm$	0.38	0.43	0.15	0.29	0.58
CD(P=0.05)	1.12	1.27	0.46	0.87	1.72
Weedmanagement(WM)					
WM_1:Weedycheck	231.53	181.76	18.06	297.19	85.42
WM_2:Livemulchingwithcowpea	236.97	185.29	18.65	300.35	87.82
WM_3:WM_2+handweeding at25and45 DAS	240.83	192.17	19.54	302.14	91.95
WM_4: Atrazine500g+Pendimethalin500g/ hafollowed by handweeding at 45DAS	242.74	196.61	20.39	305.33	96.93
SEm$\pm$	0.44	0.50	0.18	0.34	0.67
CD(P=0.05)	1.30	1.46	0.53	1.01	1.98
Interaction(NxWM)					
SEm$\pm$	0.76	0.86	0.31	0.59	1.17
CD(P=0.05)	NS	NS	NS	NS	NS

Table: 6. Grain yield (q/ha), cob yield without husk (q/ha), stover yield (q/ha)and shelling % of summer maize as affected by integrated weed andnutrientmanagementpractices

Treatments	Grainyield	Cob yieldwithouthusk	Stoveryield	Shelling %
Nutrientmanagement(N)				
N_1:100%RDF	17.24	29.46	60.64	57.12
N_2:N_1+25kg$ZnSO_4$/ha	20.11	33.88	67.27	59.37
N_3:75%RDNand100%$P_2O_5$and K_2OthroughCF+ 25%N throughVC + 25kg$ZnSO_4$/ha	23.76	37.21	74.55	64.04
SEm$\pm$	0.29	0.52	1.32	1.32
CD(P=0.05)	0.85	1.52	3.87	3.88

Weedmanagement(WM)				
WM_1:Weedycheck	19.45	32.31	64.24	58.31
WM_2:Livemulchingwithcowpea	19.72	32.76	66.88	59.56
WM_3:WM_2+handweeding at25and45 DAS	20.53	33.78	67.69	60.59
WM_4:Atrazine500g+Pendimethalin500g/hafollowed by handweeding at45DAS	21.77	35.21	71.12	62.25
SEm$\pm$	0.33	0.60	1.52	1.53
CD(P=0.05)	0.98	1.76	4.47	4.48
Interaction(NxWM)				
SEm$\pm$	0.58	1.04	2.64	2.64
CD(P=0.05)	NS	NS	NS	NS

Economics

Economics of cultivation is the most importantfactorwhich decidestheadoptionofimprovedpracticesbythegrowers (Table: 7).Inthepresentstudy,underdifferentintegratedweedandnutrientmanagementpractices,the combination N_3WM_4 involving application of75 % RDNand 100 %P_2O_5 andK_2O through chemical fertilizers + 25 % N through VC + 25 kg $ZnSO_4$/ha andapplication of Atrazine 500g+Pendimethalin 500g/ha followed by hand weeding at 45DASrecordedthehighestgrossreturn (₹ .103816.00)andnetreturn(₹ .67955.00)and benefit-cost ratio (1.90) owing to highest crop productivity registered in thiscombination.

Table: 7
Economicsofsummermaizeasaffectedbyintegratednutrientandweedmanagementpractices

Treatment Combination	Cost ofcultivation(₹ /ha)	Grossreturn(₹ /ha)	Net return(₹ /ha)	B:C
N_1WM_1	31000	65260	34260	0.90
N_1WM_2	32400	74490	42090	1.30
N_1WM_3	34800	78494	43694	1.25
N_1WM_4	33700	81614	47914	1.42
N_2WM_1	32500	81770	49270	1.51
N_2WM_2	33800	86190	52390	1.55
N_2WM_3	36300	88946	52646	1.45
N_2WM_4	34800	90220	55420	1.59
N_3WM_1	34600	82680	48080	1.39
N_3WM_2	35800	94846	59046	1.65
N_3WM_3	36900	96018	59118	1.60
N_3WM_4	35860	103816	67956	1.90

CONCLUSION

Results of the experiment shows that application of 75 % RDN and 100 %P_2O_5 and K_2O through chemical fertilizers + 25 % N through vermicompost + 25 kg$ZnSO_4$/ha resulted the highest growth, yield attributes, yield and net return of summermaize.Among the integrated weed management practices, pre emergence applicationof Atrazine 500 g + Pendimethalin 500 g /ha followed by hand weeding at 45 DASresulted the maximum cropgrowth,betteryieldand netreturnofsummermaize.

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