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RESEARCH ARTICLE

Impact of organic methods of nutrient and weed management on weeds nutrient uptake and maize productivity in sandy loam soils of Rajasthan, India

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ABSTRACT

An experiment was conducted during rainy (*Kharif*) season 2019 and 2020 at Instructional Farm, College of Agriculture, Sumerpur, Rajasthan to study the influence of organic methods of nutrient and weed management on weeds growth and nutrient uptake and maize (*Zea mays* L.) productivity. The experiment comprised of six weed management and five nutrient management treatments arranged in split-plot design with three replications. The stale seedbed + hoeing with power weeder at 20 days after seeding (DAS) + hoeing once at 40 DAS and stale seedbed + hoeing once at 20 DAS + application of 5 t/ha of straw mulch applied at 30 DAS recorded significantly lowest mean weed biomass at 30 DAS and at 50 DAS, respectively. They were found on par with weed free check at harvest in respect of recording mean minimum weed biomass and nutrient uptake by different categories of weeds, higher maize and nutrient uptake by maize on pooled basis. Amongst nutrient management treatments, mean minimum weed biomass and nutrient uptake, significantly higher maize yield, protein content, nutrient content and uptake by the maize was recorded with 75% recommended dose of nitrogen (RDN) using vermicompost (75% as basal + 25% as top dress at 30 DAS) + seed treatment with beejamurt + spray of 500 l/ha of jeevamurt twice (at sowing and 30 DAS). The similar trend was recorded in terms of yield and economics of maize. Next best was 75% RDN through vermicompost as basal + seed treatment with beejamurt + spray of 500 l/ha jeevamurt twice (at sowing and 30 DAS). The organic nutrient management treatments significantly increased the nutrient content in maize grain and stover, while weed management treatments have no significant effect.

Keywords: Beejamurt, Farm yard manure, Jeevamurt, Maize, Organic cultivation, Stale seed bed, Straw mulch, Vermicompost, Weed management

INTRODUCTION

Maize contributes to nearly 9 percent to the national food basket of India with cultivated area of nearly 9.2 Mha area with a production of 27.8 million tons (GOI 2020). In Rajasthan, maize is grown in 8.75 lakh ha during *Kharif* as rainfed and irrigated during *Rabi* season with a production of 11.35 lakh tons (Vital Agricultural Statistics 2020). The initial slow growth, wider crop geometry and congenial environment during *Kharif*, hastens the growth and development of weeds that compete with crop severely resulting in the yield losses of 44.1 to 49.1% in North Western Plain Zone of India (Jat *et al.* 2018). The use of power driven tillage implements and also the manual weeding and application of crop residues as mulch for weed management are popular among conservation agriculture practicing farmers to protect the soil as well as environment. The physico-chemical properties of the soil greatly altered by organic nutrient management practices and by maintaining mulches on soil surface. The crop is highly exhaustive and requires nutrients for extended period *i.e.* up to flowering, and it is not possible to maintain through fertilizers and thus composted materials *i.e.* farm yard manure (FYM) and vermicompost as nutrient sources are being suggested to meet the crop nutrient requirement. Further, the application of fermented products of cow dung and cow urine *i.e.* beejamurt for seed treatment and jeevamurt for soil application were found to boost the crop growth due to the congenial soil environment for multiplying favourable soil micro-organisms (Pawar *et al.* 2012, Shannon *et al.* 2006) to maintain the quality of soil sustainability of an agro-ecosystem (Shukla and Tyagi 2009). The present experiment was conducted to find out the effect of organic weed management practices and composted and fermented nutrient sources on nutrient uptake by various categories of weeds and

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maize crop, productivity and economics of maize cultivation under organic production system to reduce dependency of high cost external inputs.

MATERIALS AND METHODS

A field experiment was conducted for two consecutive rainy (*Kharif*) seasons during 2019 and 2020 at the research farm of College of Agriculture, Sumerpur, Pali situated in the western part of Rajasthan at $25^0$09' N latitude and $73^0$04' E longitude with at an elevation of 297.7 m above mean sea level. The region has a typical semi- arid and sub-tropical climate characterized by mild winter and moderate to high summers, associated with mild relative humidity especially during the months of July to September. The total rainfall received during the crop season of the *Kharif* 2019 and *Kharif* 2020 was 636.9 mm and 473.5 mm, respectively. The soil was sandy loam in texture, slightly alkaline in pH, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. A split-plot design with three replications was used. Six organic weed management treatments were assigned to main plots viz., stale seed bed (SS) + hoeing twice at 20 and 40 days after seeding (DAS); SS+ hoeing once with power weeder at 20 DAS (Honda make) +hoeing once manually at 40 DAS; SS +hoeing once manually at 20 DAS + straw mulch 5 t/ha at 30 DAS; SS + black plastic (25 micron) mulch at sowing, weedy check and weed free up to 60 DAS. Five organic nutrient management treatments in sub plots include: 100% recommended dose of nitrogen (RDN) through farm yard manure (FYM); 75% RDN through FYM + seed treatment with beejamrut + jeevamrut 500 l/ha at sowing and 30 DAS; 100% RDN through vermicompost; 75% RDN through spray twice vermicompost as basal + seed treatment with beejamrut + jeevamrut 500 l/ha spray twice at sowing and 30 DAS and 75% RDN through vermicompost (75% as basal + 2% as top dress at 30 DAS) + seed treatment with beejamrut + jeevamrut 500 L/ha spray twice at sowing and 30 DAS. The beejamrut and jeevamrut was prepared by adopting standard methods described by Lunagariya and Zinzala (2017) and Bhadu (2019), respectively The maize crop was cultivated as per recommended package of practices and applied 90 kg N, 60 kg P and 60 kg K/ha using recently notified maize cultivar '*Pratap Hybrid Maize 3*'at the seed rate of 25 kg/ha. The intercultural practices were performed as per treatments while nutrients were applied based on nitrogen requirement. Weeds were collected from two randomly selected spots using a quadrat of 0.25 m^2 at harvest and sun dried for 24 hours followed by oven drying at 65°C till a constant weight was achieved. The final dry weight (biomass) of broad-leaved weeds, grasses and sedges was recorded separately and expressed in kg/ha. The maize grain and stover yield per plot were recorded separately and expressed in kg/ha. After recording weeds biomass at harvest and grain and stover of maize, samples were ground for estimation of N, P and K contents in weeds and maize crop using standard procedures and expressed in percent while uptake was the function of content and dry matter.

RESULTS AND DISCUSSION

Effect on weeds

Two years pooled data **(Table 1)** revealed that broad-leaved weeds, grasses and sedges and total weeds were completely controlled by stale seedbed + plastic mulch up to harvest of the crop and weed free check up to 60 DAS. Among the rest of treatments, stale seedbed + hoeing with power weeder at 20 DAS + hoeing once at 40 DAS, stale seedbed + hoeing once at 20 DAS + application of 5 t/ha of straw mulch at 30 DAS recorded significantly lowest mean biomass of broad-leaved weeds, grasses and sedges and total weeds at 30 DAS and 50 DAS respectively. The weed biomass recorded up to 50 DAS during both the years individually as well as in pooled analysis was not significantly influenced by nutrient management treatments. The organic sources of nutrients with or without fermented organic concoction influenced weed biomass significantly at harvest. The mean minimum weed biomass of broad-leaved and total weeds was recorded with 75% RDN through vermicompost in two splits + seed treatment with beejamurt + spray of jeevamurt twice (**Table 1**). The straw mulching significantly lowered the weeds biomass due to interference with light penetration up to weeds and release of phytotoxins from straw decomposition suppress weed growth and development (Kumar *et al.* 2005, Modak *et al.* 2019). The straw mulch proved very effective in discouraging weed emergence, weed growth and ultimately reduced weed biomass and increased weed control efficiency. The stale seedbed technique was found effective in decreasing the weed biomass in maize production system (Sanbagavalli *et al.* 2016). The use of power weeder as a tool for mechanical hoeing churned well the soil and destroyed the weeds as effectively as manual weeding (Kumar 2020).

Nutrient content and uptake by weeds

Different weed management treatments had no significant effect on nitrogen, phosphorus and potassium content in weeds at harvest during both the years of study (**Table 2**). A significant reduction in

nitrogen, phosphorus and potassium uptake by weeds, grasses, sedges and total weeds was recorded in all weed management treatments as compared to weedy check. The uptake of nitrogen, phosphorus and potassium followed the similar pattern as that of weed biomass observed at harvest (**Table 3**) as the uptake of nutrients is the function of dry matter and nutrient contents. The mean minimum nitrogen, phosphorus and potassium uptake was recorded with SS +hoeing once manually at 20 DAS + straw mulch (5 t/ha) at 30 DAS by broad-leaved weeds and at 60 DAS by grasses, sedges and total weeds at harvest in weed free, on pooled basis, as against the mean maximum in weedy check. Further, significant reduction in uptake of nutrients through broad-leaved weeds, grasses, sedges and total weeds at harvest was observed with 75% RDN through vermicompost in two splits + seed treatment with beejamurt + jeevamurt spray twice followed by 75% RDN through vermicompost as basal+ seed treatment with beejamrut + two spray of jeevamrut 500 L/ha at sowing and 30 DAS. Weed management treatments recorded reduced nutrient uptake over weedy check because of less weed dry matter accumulation in treated plots (Malviya and Singh 2007). The higher weed biomass and higher nutrient uptake at harvest

Table 1. Effect of different treatments on weed biomass (kg/ha) at 30 DAS, 50 DAS and harvest in maize (pooled over two years)

Treatment	Broad-leaved weeds			Grasses and sedges			Total weeds		
	30 DAS	50 DAS	At harvest	30 DAS	50 DAS	At harvest	30 DAS	50 DAS	At harvest
*Weed management**									
SS+ HT at 20 and 40 DAS	137.0	63.2	123.2	251.8	253.8	241.7	388.7	317.0	365.0
SS+ H with power weeder at 20 DAS + HO at 40 DAS	69.5	44.6	126.1	191.3	187.4	274.4	260.8	232.0	400.6
SS+ Hoeing once at 20 DAS + Straw mulch at 30 DAS	140.2	15.2	64.9	248.3	44.9	239.7	388.5	60.2	304.5
SS+ Plastic mulch at sowing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Weedy check	596.7	682.3	409.6	2211.0	2304.4	2724.6	2807.7	2986.8	3134.3
Weed free check up to 60 DAS	0.0	0.0	93.1	0.0	0.0	122.6	0.0	0.0	215.7
LSD (p=0.05)	19.5	8.2	13.1	23.0	40.8	47.6	34.6	44.8	38.2
Nutrient management **									
100% RDN FYM	165.5	136.8	177.6	491.1	474.2	756.6	656.6	611.0	934.2
75% RDN FYM + ST B.M + J.M (T)	161.9	135.6	170.6	484.9	462.8	709.4	646.8	598.3	880.0
100% RDN VC	152.0	136.1	163.5	472.5	461.0	760.9	624.5	597.1	924.4
75% RDN VC + ST B.M + J.M (T)	154.6	130.9	169.6	484.0	458.6	678.6	638.5	589.5	848.3
75% RDN VC (2 splits) + ST B.M + J.M (T)	152.2	131.8	135.6	486.2	468.9	697.5	638.4	600.7	833.2
LSD (p=0.05)	NS	NS	10.6	NS	NS	43.6	NS	NS	50.9

*Stale seed bed (SS), hoeing twice (HT), Days after sowing (DAS), hoeing once (HO); ** Recommended dose of nitrogen (RDN), Seed treatment with beejamrut (ST) and two spray of jeevamrut 500 L/ha at sowing and 30 DAS [J.M. (T)], FYM (Farm yard manure, vermicompost (VC), 2 splits (75% as basal + 25% as top dress at 30 DAS).

Table 2. Effect of different treatments on nutrient content in different categories of weeds

Treatment	Nutrient content (%)					
	Broad-leaved weeds			Grasses and sedges		
	N	P	K	N	P	K
*Weed management**						
SS+ HT at 20 and 40 DAS	2.290	0.363	1.418	1.041	0.293	1.328
SS+ H with power weeder at 20 DAS + HO at 40 DAS	2.297	0.364	1.408	1.042	0.294	1.326
SS+ Hoeing once at 20 DAS + Straw mulch at 30 DAS	2.294	0.365	1.419	1.041	0.298	1.319
SS+ Plastic mulch at sowing	-	-		-	-	
Weedy check	2.293	0.362	1.412	1.051	0.294	1.325
Weed free check up to 60 DAS	2.309	0.363	1.421	1.056	0.298	1.343
LSD (p=0.05)	NS	NS	NS	NS	NS	NS
*Nutrient management**						
100% RDN FYM	2.278	0.365	1.417	1.048	0.297	1.340
75% RDN FYM + ST B.M + J.M (T)	2.286	0.363	1.401	1.049	0.292	1.314
100% RDN VC	2.310	0.366	1.430	1.050	0.298	1.340
75% RDN VC + ST B.M + J.M (T)	2.304	0.361	1.407	1.043	0.294	1.320
75% RDN VC (2 splits) + ST B.M + J.M (T)	2.307	0.364	1.423	1.042	0.295	1.327
LSD (p=0.05)	NS	NS	NS	NS	NS	NS

*Stale seed bed (SS), hoeing twice (HT), Days after sowing (DAS), hoeing once (HO); ** Recommended dose of nitrogen (RDN), Seed treatment with beejamrut (ST) and two spray of jeevamrut 500 L/ha at sowing and 30 DAS [J.M. (T)], FYM (Farm yard manure, vermicompost (VC), 2 splits (75% as basal + 25% as top dress at 30 DAS).

with FYM may be attributed to extended nutrients availability in soil profiles due to slow mineralization (Singh and Chouhan 2021).

Effect on maize yield, economics and nutrient uptake

The two years pooled mean data indicated that the weed free situation up to 60 DAS gave maximum grain yield of maize (3.36 t/ha) which was statistically similar to treatment SS + hoeing once manually at 20 DAS + straw mulch (5 t/ha) at 30 DAS (3.24 t/ha) and lowest of 1.96 t/ha in treatment weedy check (**Table 4**). Likewise, weed free check up to 60 DAS and SS +hoeing once manually at 20 DAS + straw mulch (5 t/ha) at 30 DAS have recorded significantly higher stover yield over weed free up to 60 DAS, during both the years. Among the nutrient management treatments, the mean maximum grain yield of 3.17 t/ha was recorded with 75% RDN through vermicompost in two splits + seed treatment with beejamurt + spray of jeevamurt spray twice closely followed by 75% RDN through

Table 3. Effect of treatments on nutrients uptake (kg/ha) by weeds at harvest (pooled of two years)

Treatment	Broad-leaved weeds			Grasses and sedges			Total weeds		
	N	P	K	N	P	K	N	P	K
*Weed management**									
SS+ HT at 20 and 40 DAS	2.82	0.45	1.75	2.52	0.71	3.21	5.34	1.16	4.96
SS+ H with power weeder at 20 DAS + HO at 40 DAS	2.90	0.46	1.78	2.86	0.81	3.64	5.76	1.27	5.41
SS+ Hoeing once at 20 DAS + Straw mulch at 30 DAS	1.49	0.24	0.92	2.49	0.71	3.18	3.98	0.95	4.10
SS+ Plastic mulch at sowing	-	-	-	-	-	-	-	-	-
Weedy check	9.38	1.48	5.79	28.59	8.00	36.11	37.97	9.48	41.90
Weed free check up to 60 DAS	2.15	0.34	1.33	1.30	0.37	1.65	3.45	0.71	2.98
LSD (p=0.05)	0.29	0.04	0.20	0.33	0.17	0.85	0.41	0.14	0.70
*Nutrient management***									
100% RDN FYM	4.01	0.64	2.51	7.87	2.23	10.09	11.89	2.87	12.60
75% RDN FYM + ST B.M + J.M (T)	3.87	0.62	2.40	7.48	2.08	9.30	11.36	2.70	11.70
100% RDN VC	3.78	0.60	2.33	7.79	2.25	10.16	11.57	2.85	12.48
75% RDN VC + ST B.M + J.M (T)	3.93	0.61	2.40	7.10	2.00	8.97	11.03	2.61	11.37
75% RDN VC (2 splits) + ST B.M + J.M (T)	3.14	0.50	1.93	7.52	2.04	9.28	10.66	2.54	11.20
LSD (p=0.05)	0.27	0.04	0.17	0.50	0.14	0.67	0.70	0.16	0.76

*Stale seed bed (SS), hoeing twice (HT), Days after sowing (DAS), hoeing once (HO); ** Recommended dose of nitrogen (RDN), Seed treatment with beejamrut (ST) and two spray of jeevamrut 500 L/ha at sowing and 30 DAS [J.M. (T)], FYM (Farm yard manure, vermicompost (VC), 2 splits (75% as basal + 25% as top dress at 30 DAS).

Table 4. Effect of different treatments on maize yield and economics

Treatment	Yield (t/ha)									Economics	
	Grain			Stover			Biological			Net return (`/ha)	B C ratio
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	Pooled	Pooled
*Weed management**											
SS+ HT at 20 and 40 DAS	2.94	3.13	3.04	6.14	6.27	6.20	9.09	9.40	9.24	27599	1.50
SS+ H with power weeder at 20 DAS + HO at 40 DAS	2.83	3.04	2.93	6.09	6.29	6.19	8.92	9.33	9.13	28401	1.55
SS+ Hoeing once at 20 DAS + Straw mulch at 30 DAS	3.14	3.35	3.24	6.01	6.21	6.11	9.14	9.57	9.36	32364	1.59
SS+ Plastic mulch at sowing	3.03	3.14	3.08	5.95	6.12	6.03	8.98	9.25	9.12	15589	1.23
Weedy check	1.91	2.00	1.96	5.14	5.35	5.24	7.05	7.36	7.20	14820	1.36
Weed free check up to 60 DAS	3.24	3.47	3.36	6.19	6.33	6.26	9.43	9.80	9.62	31799	1.55
LSD (p=0.05)	0.19	0.17	0.12	0.36	0.27	0.21	0.52	0.28	0.28	2901	0.05
*Nutrient management**											
100% RDN FYM	2.66	2.84	2.75	5.57	5.79	5.68	8.24	8.63	8.43	22253	1.43
75% RDN FYM + ST B.M + J.M (T)	2.73	2.92	2.83	5.83	6.06	5.95	8.56	8.98	8.77	26602	1.53
100% RDN VC	2.84	3.02	2.93	5.98	6.14	6.06	8.82	9.16	8.99	20750	1.35
75% RDN VC + ST B.M + J.M (T)	2.93	3.08	3.01	6.03	6.20	6.11	8.95	9.28	9.12	26016	1.47
75% RDN VC (2 splits) + ST B.M + J.M (T)	3.08	3.25	3.17	6.18	6.29	6.24	9.27	9.55	9.41	29857	1.54
LSD (p=0.05)	0.12	0.11	0.08	0.25	0.18	0.15	0.28	0.15	0.16	1815	0.03

*Stale seed bed (SS), hoeing twice (HT), Days after sowing (DAS), hoeing once (HO); ** Recommended dose of nitrogen (RDN), Seed treatment with beejamrut (ST) and two spray of jeevamrut 500 L/ha at sowing and 30 DAS [J.M. (T)], FYM (Farm yard manure, vermicompost (VC), 2 splits (75% as basal + 25% as top dress at 30 DAS).

vermicompost as basal + seed treatment with beejamrut + jeevamrut 500 l/ha spray twice at sowing and 30 DAS of 3.01 t/ha and were 15.4 and 9.3 per cent superior, respectively over 100% RDN through FYM (2.75 t/ha).The similar pattern was observed in stover yield. Increase in yield in vermicompost as an organic source of plant nutrients might be due to increase in photosynthetic area, dry matter accumulation per plant, more translocation of photosynthates towards sink and improved yield attributes (Javed *et al.* 2019). The organic concoction produced favorable effects of IAA, GA_3, macro and micronutrients along with beneficial microorganisms present in the liquid organic manures acted as stimulants in the plant system (Majhi *et al.* 2018).

The mean maximum net return of ₹ 32,364/ha was recorded in the integrated weed management practice of stale seedbed + hoeing at 20 DAS + straw mulch at 30 DAS as against the minimum of ₹ 14,820/ha in weedy check. This treatment also gave highest B:C ratio of 1.59 as against the lowest in SS + plastic mulch at sowing (1.23) in pooled study. The treatment 75% RDN through vermicompost in two splits +seed treatment with beejamurt + spray of jeevamurt twice recorded maximum net return of Rs.

Table 5. Effect of different treatments on nutrient content (%) and protein content (%) in maize

Treatment	Nutrients						Protein Grain
	Grain			Stover			
	N	P	K	N	P	K	
*Weed management**							
SS+ HT at 20 and 40 DAS	1.662	0.325	0.370	0.701	0.127	1.326	10.39
SS+ H with power weeder at 20 DAS + HO at 40 DAS	1.655	0.324	0.367	0.701	0.126	1.321	10.35
SS+ Hoeing once at 20 DAS + Straw mulch at 30 DAS	1.670	0.331	0.372	0.709	0.130	1.331	10.44
SS+ Plastic mulch at sowing	1.659	0.324	0.367	0.699	0.127	1.324	10.37
Weedy check	1.646	0.321	0.360	0.686	0.126	1.319	10.29
Weed free check up to 60 DAS	1.674	0.331	0.372	0.714	0.131	1.336	10.46
LSD (p=0.05)	NS	NS	NS	NS	NS	NS	NS
*Nutrient management***							
100% RDN FYM	1.635	0.320	0.363	0.682	0.124	1.313	10.22
75% RDN FYM + ST B.M + J.M (T)	1.649	0.323	0.366	0.691	0.125	1.322	10.31
100% RDN VC	1.658	0.326	0.367	0.703	0.128	1.325	10.36
75% RDN VC + ST B.M + J.M (T)	1.669	0.329	0.369	0.709	0.129	1.331	10.43
75% RDN VC (2 splits) + ST B.M + J.M (T)	1.694	0.333	0.374	0.722	0.131	1.340	10.59
LSD (p=0.05)	0.019	0.006	0.006	0.013	0.003	0.012	0.12

*Stale seed bed (SS), hoeing twice (HT), Days after sowing (DAS), hoeing once (HO); ** Recommended dose of nitrogen (RDN), Seed treatment with beejamrut (ST) and two spray of jeevamrut 500 L/ha at sowing and 30 DAS [J.M. (T)], FYM (Farm yard manure, vermicompost (VC), 2 splits (75% as basal + 25% as top dress at 30 DAS).

Table 6. Effect of organic weed and organic nutrient management practices on nutrients uptake (kg/ha) by maize at harvest (pooled of two years)

Treatment	Grain			Stover			Total		
	N	P	K	N	P	K	N	P	K
*Weed management**									
SS+ HT at 20 and 40 DAS	50.50	9.91	11.27	43.51	7.89	82.27	94.01	17.80	93.53
SS+ H with power weeder at 20 DAS + HO at 40 DAS	48.52	9.50	10.78	43.46	7.79	81.81	91.98	17.29	92.59
SS+ Hoeing once at 20 DAS + Straw mulch at 30 DAS	54.18	10.77	12.10	43.37	7.93	81.34	97.54	18.70	93.44
SS+ Plastic mulch at sowing	51.14	9.99	11.33	42.24	7.66	79.88	93.38	17.65	91.21
Weedy check	32.23	6.29	7.07	36.05	6.60	69.23	68.28	12.89	76.31
Weed free check up to 60 DAS	56.20	11.15	12.52	44.73	8.18	83.66	100.93	19.33	96.18
LSD (p=0.05)	2.30	0.47	0.58	1.88	0.44	3.19	3.31	0.74	3.39
*Nutrient management**									
100% RDN FYM	44.93	8.82	10.01	38.85	7.04	74.62	83.78	15.87	84.63
75% RDN FYM + ST B.M + J.M (T)	46.63	9.13	10.38	41.16	7.47	78.64	87.79	16.60	89.01
100% RDN VC	48.56	9.57	10.80	42.62	7.76	80.32	91.18	17.32	91.12
75% RDN VC + ST B.M + J.M (T)	50.16	9.92	11.13	43.40	7.91	81.32	93.56	17.82	92.45
75% RDN VC (2 splits) + ST B.M + J.M (T)	53.70	10.57	11.90	45.09	8.21	83.60	98.80	18.78	95.50
LSD (p=0.05)	1.43	0.34	0.36	1.45	0.27	2.17	1.82	0.38	2.13

*Stale seed bed (SS), hoeing twice (HT), Days after sowing (DAS), hoeing once (HO); ** Recommended dose of nitrogen (RDN), Seed treatment with beejamrut (ST) and two spray of jeevamrut 500 L/ha at sowing and 30 DAS [J.M. (T)], FYM (Farm yard manure, vermicompost (VC), 2 splits (75% as basal + 25% as top dress at 30 DAS).

29,857/ha and B:C ratio of 1.54 and was statistically superior over 100% RDN through vermicompost (₹ 20,750/ha and B:C ratio of 1.35, respectively). These findings were witnessed due to better uptake of nutrients by crop, lowest weed biomass and higher grain yield (Patil and Udmale 2016 and Virk *et al.* 2019).

Nitrogen, phosphorus and potassium content of maize grain and stover remained unaffected due to various weed management treatments, during both the years (**Table 5**). Nitrogen, phosphorus and potassium content, mean maximum protein content in grain and stover of maize was maximum with 75% RDN through vermicompost in two splits + seed treatment with beejamurt + jeevamurt spray twice followed by 75% RDN through vermicompost as basal + seed treatment with beejamurt + spray of jeevamurt spray twice (**Table 5** and **6**). The marked improvement in N, P and K uptake in grain and stover seems to be on account of more availability of nutrients and their diversion towards the crop and higher grain and stover yields (Gupta 2018). The use of vermicompost along with bio-fertilizers sustain availability of nutrients might be owing to extended supply as per crop requirement and corresponding increase of nutrients uptake by plants (Chhetri and Sinha 2020).

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