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Influence of organic weed management and organic nutrient management practices on yield attributes and yields of maize in Western Rajasthan

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Abstract
An experiment was conducted during 2019-20 and 2020-21 at College of Agriculture, Sumerpur, Rajasthan, India comprises 6 organic weed management and 5 organic nutrient management treatments were implemented in split plot design with 3 replications to find out the best organic weed and nutrient management practice for maize cultivation. The weed free check improved various yield attributes significantly as compared to weedy check and was almost at par to treatment stale seedbed+ hoeing once at 20 DAS + straw mulch @ 5t ha^{-1} at 30 DAS. The weed free check showed its superiority and reflected in grain yield of 3,358 kg ha^{-1}. Among the organic nutrient management practices, the treatment 75% of recommended dose of nitrogen (RDN i.e. 90 kg N equivalent) through vermicompost in two splits (75% at sowing +25% as top dressing at 30 DAS) along with seed treatment with fermented organic manure i.e. *beejamurt* and two spray of *jeevamurt* significant recorded mean maximum grain yield (3,169 kg ha^{-1}) as compared to 100% RDN through FYM at harvest in pooled analysis. Similar trend was reported in various yield attributes.

Keywords: *Beejaumrt*, economics, FYM, *Jeevamurt*, maize, mulch, stale seedbed, yield attributes and yield

Introduction
The continuous uses of synthetic fertilizers and plant protection chemicals deteriorating the soil health, ecosystem and quality of produce are growing concern globally. Presently, Organic farming is being practiced in 187 countries on 72.3 million hectare area and is 1.6 percent increase over 2018. In the second largest populated country of world i.e. India, the cultivable area under organic certification is only 2.30 million ha, which is around 1.6 percent of net cultivated area of the country (FIBL and IFOAM, 2021) [2] instead of maximum number of registered organic producers (13.33 million) during 2019. Maize (*Zea mays* L.) is third most important food crop of the country after rice and wheat where it is grown under varied agro-climatic conditions. The crop contributes to nearly 9 percent to the national food basket where it is cultivated on nearly 9.2 M ha area with a production of 27.8 million tons. It is reported that the yield losses in hybrid maize from weeds in absence of weed management ranged from 44.1 to 49.1 percent in North Western Plain Zone of India (Jeet *et al*., 2017) [5]. Stale seedbed flushing out germinating weed seeds before planting of crop and keep the field weed free up to critical period provided adequate weed control, as well as optimal yield (Lonsbary *et al*., 2003) [7]. The spreading of organic or plastic mulch over soil surface reduces weed problems by preventing weed seed germination or by suppressing the growth of emerging weed seedlings and shifting competition in favour of crop (Maheswari and Karthik, 2018) [8]. The role of balanced nutrition through organic manures *viz.*, FYM and vermicompost is of supreme importance and one of the best options to increase the production and maintain the sustainability of soil and quality of produce. Hence, managing the locally available nutrient sources to overcome the current mismatch of nutrient use ratio and crop nutrient demand is prime requirement. The fermented organic liquid formulations like *beejamurt* and *jeevamurt* prepared with locally available materials used as plant growth promoters help in acquiring better vegetative growth and higher yields (Bhadu, 2019) [1].

Materials and Methods
The field experiments were conducted during *kharif* 2019 and *kharif* 2020 at instructional farm of College of Agriculture Sumerpur, Agriculture University Jodhpur (Rajasthan-India) situated

at agro climatic zone II B (Transitional Plain Zone of Luni Basins) of state of Rajasthan in India. The experimental soils were low in organic carbon and available nitrogen while medium and high in phosphorus and potassium, respectively. The experiment was implemented in split plot design where six weed management and three organic nutrient management treatments were replicated thrice. The gross plot size of the sub plot was 18 m^2 while the gross plot size of main plot was 90 m^2. The maize variety i.e. Pratap Hybrid Maize 3 was sown at recommended spacing of 60 x 25 cm. The lay out of the experimental site was prepared well in advance to incorporate the recommended quantity of well rotten FYM and vermicompost in respective subplots as per treatment, spread and mixed properly and irrigation is provided to prepare stale seedbed. The black polythene of 25 micron was spread and punctured at prescribed distance at the time of sowing of maize. The intercultural practices were performed as per treatments at 20 and 40 DAS while the straw was spreaded at the rate of 5 t ha^{-1} at 30 DAS. The fermented organic products i.e. *jeevamurt* was locally prepared and applied @ 500 l ha^{-1} as per treatment at the time of sowing and 30 DAS. The details of experimental units are as follows

Main plot treatment

W_1-Stale seedbed (SS) + two hoeing at 20 & 40 DAS,
W_2-SS + hoeing with power weeder at 20 DAS + hoeing once manually at 40 DAS,
W_3-SS +hoeing once manually at 20 DAS + straw mulch (5 t ha^{-1}) at 30 DAS,
W_4-SS + black plastic mulch at sowing (25 micron),
W_5-Weed free check (up to 60 DAS) and
W_6-Weedy check

Sub plot treatment

N_1-100% RDN through FYM,
N_2-75% RDN through FYM + seed treatment with *beejamrut* + two spray of *jeevamrut* @ 500 l ha^{-1} at sowing and 30 DAS,
N_3-100% RDN through vermicompost,
N_4-75% RDN through vermicompost as basal + seed treatment with *beejamrut* + two spray of *jeevamrut* @ 500 l ha^{-1} at sowing and 30 DAS and
N_5-75% RDN through vermicompost (75% as basal + 25% as top dress at 30 DAS) + seed treatment with *beejamrut* + two spray of *jeevamrut* @ 500 l ha^{-1} at sowing and 30 DAS.

Thus the experiment was conducted to find out efficiency of various organic weed management and organic nutrient application in weed management and productivity of maize (*Zea mays* L.).

Results and Discussion

Effect on yield attributes

The integration of various organic weed management practices *viz.*, frequent hoeings, stale seedbed, application of straw & polythene mulch, hoeing with power weeder and manual resulted in a significant increase of various yield attributes *viz*. number of cobs $plant^{-1}$, number of grains row^{-1}, weight of cob, weight of grains cob^{-1} and shelling percent in maize during 2019, 2020 and as well as in pooled study as against weedy check (Table 1). The two years mean data revealed that the treatment weed free check recorded significantly maximum mean number of cobs $plant^{-1}$ (1.22), number of grain $rows^{-1}$ (22.21), cob weight (98.78 g), grain weight cob^{-1} (73.41 g) and shelling percent (74.92%) and the increases were 14.0, 10.0, 40.3, 55.8 and 10.9 percent, respectively over their minimum mean values of 1.07, 20.20, 70.43 g, 47.12 g and 67.54% in weedy check, respectively. Further, the treatment stale seedbed+ hoeing at 20 DAS + straw mulch at 5.0 t ha^{-1} at 30 DAS also found almost at par to this treatment in respect of these attributes and significantly superior over rest of treatments under study during *kharif* 2019, *kharif* 2020 and in pooled analysis.

The incorporation of vermicompost @ 75% RDN in two splits (75% as basal + 25% as top dressing at 30 DAS) + seed treatment with *beejamurt* + two spray of *jeevamurt* (at sowing and 30 DAS at 500 l ha^{-1}) recorded significantly higher mean values of various yield attributes of maize over weedy check. The pooled data showed that the treatment recorded mean maximum values of number of cobs $plant^{-1}$ (1.21), number of grains row^{-1} (22.57), cob weight (94.70 g), grain weight cob^{-1} (71.18 g) and shelling percent (76.13%) and were 14.2, 10.9, 10.4, 20.0 and 9.5 percent higher, respectively over the minimum mean values of attributes (1.06, 20.35, 85.79 g, 59.34 g and 69.55%, respectively) in 100% RDN through FYM. Further, this best treatment was at par with 75% RDN through vermicompost as basal + seed treatment with *beejamurt* + spray of *jeevamurt* twice and significantly superior over rest of treatments under study during *kharif* 2019 and *kharif* 2020 and in pooled analysis.

The weed management practices markedly improved the soil and aerial environment congenial to improved morphology of plant due to better weed control during critical period and ensured greater availability of nutrients and metabolites and their translocation and accumulation of photosynthetes towards sink (cob) led to appreciable enhancement of yield attributes of hybrid maize as compared to weedy check (Gupta, 2018) [3]. The application of organic manures in split as per need of plants ensures availability of nutrients for extended period and in balanced proportion under efficient root and shoots system boost the yield attributes of maize. The root system provided the nutrients, water and support to the plants while shoot system produced expanded leaves and higher net photosynthesis leads to better development of yield attributes (Bhadu, 2019) [1].

Yields and harvest index

The grain, stover and biological yield of maize during individual as well as in pooled basis was significantly increased in various weed management treatments ac compared to weedy check (Table 2). The weed free treatment recorded maximum maize grain, stover and biological yield of 3,361 kg ha^{-1}, 6,269 kg ha^{-1} and 9,629 kg ha^{-1}, respectively and increases were 71.6, 19.5 and 33.6 percent, respectively over weedy check on pooled basis (1,959 kg ha^{-1}, 5,245 kg ha^{-1} and 7,204 kg ha^{-1}, respectively). Further, the stale seedbed+ hoeing once at 20 DAS + straw mulch at 30 DAS recorded 65.6, 16.5 and 29.9 percent higher grain, stover and biological yields over weedy check, respectively. The mean maximum harvest index of 34.88 percent was recorded in weed free check followed by straw mulched treatment (34.66) and was 28.0 and 27.2 percent significantly superior over weedy check (27.25%) in pooled analysis.

The treatment 75% RDN through vermicompost in two splits (75% basal + 25% top dressed at 30 DAS) + seed treatment with *beejamurt* + two spray of *jeevamurt* gave significantly higher grain (3,169 kg ha^{-1}), stover (6,238 kg ha^{-1}) and biological yield (9,408 kg ha^{-1}) of maize and respective increases in yields were noted by 15.4, 9.7 and 11.6 percent over 100% RDN through FYM (2,749 kg ha^{-1}, 5,683 kg ha^{-1}

and 8,429 kg ha^{-1}, respectively) in pooled analysis. The next best treatment was 75% RDN through vermicompost as basal + seed treatment with *beejamurt* + spray of *jeevamurt* twice in pooled analysis and increased the yields to the extent of 9.3, 7.5 and 8.1 percent, respectively over lowest in 100% RDN through FYM as basal. These treatments recorded significantly maximum harvest index of 33.45 and 32.76 percent as against lowest in 100% RDN through FYM as basal (32.04%) in pooled analysis but failed to influence it both during 2019 and 2020.

Higher yields, shelling percentage and harvest index under the weed management treatments particularly weed free check and straw mulch might be attributed to lower weed dry matter, better weed control efficiency, maximum yield attributes than uncontrolled weed growth (Kumar and Angadi, 2014) [6]. The mulch enhanced the grain yield of maize might be owing to improved yield attributes as it maintain the hydrothermal regime and improved crop development (Virk *et al*., 2019) [11].

The organic manures improved the soil properties and maintained balanced nutrient supply increased the yield attributes, allowed more translocation of photosynthates towards sink might be resulted in increased yield (Javed *et al*., 2019) [4]. The fermented organic products *viz*., *beejamrut* and *jeevamrut* secreted growth promoters *viz*., IAA, GA_3, etc. and increased availability of macro and micro nutrients through beneficial microorganisms present in the liquid organic manures acted as stimulants in the plant system as reported by Majhi *et al.* (2018) [9] and Potkile *et al.* (2018) [10].

Table 1: Effect of different treatments on yield attributes in maize (*Kharif* 2019 and *Kharif* 2020)

Treatment	Cobs plant^{-1}			Grain rows^{-1}			Cob weight (g)			Weight of grain cob^{-1} (g)			Shelling (%)		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Weed management															
W_1	1.16	1.17	1.17	21.20	21.69	21.44	91.45	95.36	93.40	67.04	70.16	68.60	73.72	73.66	73.69
W_2	1.13	1.15	1.14	20.55	21.03	20.79	92.65	92.71	92.68	69.63	67.90	68.77	72.20	71.17	71.68
W_3	1.19	1.20	1.19	21.10	21.60	21.35	96.14	97.57	96.86	69.99	72.76	71.37	74.28	74.49	74.39
W_4	1.17	1.20	1.19	21.22	21.72	21.47	91.93	94.09	93.01	64.62	69.49	67.05	73.19	75.06	74.12
W_5	1.20	1.24	1.22	21.95	22.47	22.21	99.04	98.51	98.78	72.64	74.19	73.41	74.43	75.40	74.92
W_6	1.08	1.05	1.07	19.97	20.43	20.20	70.06	70.80	70.43	45.95	48.28	47.12	67.70	67.38	67.54
S.Em. ±	0.03	0.03	0.02	0.34	0.30	0.23	1.13	1.19	0.82	1.33	1.33	0.94	1.31	1.32	0.93
CD (P=0.05)	0.09	0.09	0.06	1.07	0.95	0.67	3.56	3.76	2.43	4.18	4.18	2.77	4.14	4.15	2.74
Nutrient management															
N_1	1.06	1.07	1.06	20.13	20.58	20.35	81.77	89.81	85.79	57.77	60.91	59.34	69.52	69.59	69.55
N_2	1.13	1.12	1.12	20.40	20.88	20.64	88.11	91.08	89.59	63.57	64.28	63.92	70.91	70.92	70.91
N_3	1.15	1.18	1.16	20.90	21.39	21.14	90.55	92.39	91.47	65.91	66.92	66.42	72.13	72.78	72.45
N_4	1.21	1.21	1.21	21.27	21.78	21.53	93.26	92.23	92.74	68.48	70.35	69.41	74.39	74.73	74.56
N_5	1.25	1.26	1.25	22.30	22.83	22.57	97.38	92.02	94.70	69.16	73.20	71.18	75.99	76.27	76.13
S.Em. ±	0.02	0.02	0.02	0.21	0.18	0.14	0.65	1.02	0.60	1.21	0.58	0.67	1.15	1.30	0.87
CD (P=0.05)	0.07	0.06	0.05	0.58	0.50	0.38	1.84	NS	1.69	3.43	1.64	1.87	3.27	3.70	2.44

Table 2: Effect of different treatments on yields and economics of maize (*Kharif* 2019 and *Kharif* 2020)

Treatment	Yield (kg ha^{-1})									Harvest index (%)		
	Grain			Stover			Biological					
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Weed management												
W_1	2945	3133	3039	6141	6266	6203	9086	9399	9242	32.41	33.34	32.88
W_2	2827	3039	2933	6091	6294	6192	8918	9333	9126	31.72	32.56	32.14
W_3	3137	3352	3245	6008	6215	6112	9145	9568	9356	34.30	35.02	34.66
W_4	3030	3137	3083	5948	6117	6033	8978	9255	9116	33.76	33.89	33.82
W_5	3241	3475	3358	6187	6329	6258	9428	9804	9616	34.33	35.43	34.88
W_6	1914	2003	1959	5137	5353	5245	7051	7356	7204	27.21	27.28	27.25
S.Em. ±	61	55	41	116	87	72	166	90	94	0.34	0.57	0.33
CD (P=0.05)	191	172	120	365	274	214	523	282	278	1.07	1.80	0.98
Nutrient management												
N_1	2662	2837	2749	5575	5790	5683	8237	8627	8432	32.12	32.68	32.40
N_2	2733	2921	2827	5830	6063	5946	8562	8984	8773	31.77	32.30	32.04
N_3	2839	3020	2930	5979	6137	6058	8817	9158	8988	32.01	32.74	32.38
N_4	2928	3084	3006	6027	6196	6111	8955	9280	9117	32.51	33.00	32.76
N_5	3084	3255	3169	6184	6293	6238	9268	9548	9408	33.02	33.87	33.45
S.Em. ±	42	40	29	88	64	55	99	55	57	0.46	0.47	0.33
CD (P=0.05)	121	115	82	251	183	153	282	155	159	NS	NS	0.91

Conclusion

After 2 years of research and considering various yield attributes, yield and economic of maize, it could be concluded that maintaining straw mulch after stale seedbed and split application of organic manures along with *jeevamurt* and *beejamurt* increased yield parameters and yields in maize and became more remunerative as compared to rest of treatments in terms of net return and benefit: cost ratio.

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