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Growth and productivity of maize (*Zea mays* L.) as influenced by organic weed and nutrient management practices in Western Rajasthan

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ABSTRACT

An experiment was conducted during 2019 and 2020 at College of Agriculture, Sumerpur (Rajasthan) to study the effect of organic weed management and organic nutrient management treatments practices on maize (*Zea mays* L.)in split plot design with 3 replications.The two years mean data revealed that the minimum weed infestation (79.1%) and maximum weed control efficiency (93.1%) was recorded in weed free check as against weedy check among various weed management treatments at harvest. Most of the growth attributes, grain (3.36 t ha^{-1}) and stover (6.26 t ha^{-1}) yield of maize were significantly affected by weed management and nutrient management practices and found maximum in weed free check maintained up to 60 DAS closely followed by stale seedbed+ hoeing once at 20 DAS + straw mulch applied @ 5 t ha^{-1} at 30 DAS against weedy check. The application of vermicompost @ 75% of recommended dose of nitrogen (RDN i.e. 90 kg N equivalent) in two splits (75% at sowing +25% as top dressing at 30 DAS) along with seed treatment with fermented *beejamurt* and two sprays of *jeevamurt* registered significantly hgher growth parameters besides grain yield of 3.17 t ha^{-1}as compared to 100% RDN through FYM. The mean gross return, net return and B:C ratio were significantly affected by various weed and nutrient management practice and maximum values were recorded with weedy check and 755% RDN through vermicompost + STB + JT, respectively.

Key words: Economics, FYM, growth attributes, maize, yield, weed parameters.

INTRODUCTION

Maize (*Zea mays* L.) is most important cereal crop of India after rice and wheat is grown under diverse agro climatic condition during *kharif* as rainfed and in *rabi* as irrigated particularly in Rajasthan. The crop is cultivated on nearly 9.72 M ha area with a production of 28.64 million tons during 2019-20 (Agriculture Statistics at a Glance, 2020). The congenial atmosphere during *kharif* season along with wide geometry of crop permits rapid growth of weeds and caused even up to 85% reduction in crop yield (Jagadish *et al.,* 2016). Thus, weed is one the most important limiting factor for potential yield of maize because they limit the production by increasing the competition for nutrients and soil moisture. The continuous use of herbicides particularly in rainfed conditions causes environmental pollution and long residual effects in soil make the crop production un-profitable. The mechanical and cultural methods do not have any residual effect and are environmentally sound.Further they deplete weed seed bank in soil by destroying weeds before flowering. It is well known that the organic manures supply the essential nutrients in balanced proportion for an extended period through slow mineralization (Ramesh *et al.*, 2020). These manures also enrich the soil nutrient pool through increasing the availability of adsorbed and unavailable nutrients on fixed sites through secretion of some organic acids (Bhadu, 2019). The availability of soil pool further hastened by basic components of zero budget farming viz., *jeevmurt* and *beejamurt* as they supply growth promotors and plant growth hormones as well as increased population of beneficial micro-organism (Manjunatha *et al.*, 2009). So the experiment was planned to find out found most economically viable weed management and best nutrient management practice for maize in organic farming

MATERIALS AND METHODS

An experiment was conducted for two consecutive years during *kharif season* of 2019and 2020 at Instructional Farm, College of Agriculture Sumerpur (Agriculture University Jodhpur Rajasthan) located in agro climatic zone II B (Transitional Plain Zone of Luni Basins) of state of Rajasthan. The experiment was conducted in split plot design where six weed

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management (main plot) and five organic nutrient management treatments (sub plot) were replicated thrice. The maize variety i.e. Pratap Hybrid Maize 3 was used as test crop and sown at recommended spacing. Well rotten FYM and vermicompost were applied in respective subplots. The black polythene of 25 micron was spread and punctured at 60 cm apart maintaining 30 cm distance in a row before sowing of crop while the straw mulch was spread @ of 5 t ha^{-1} at 30 DAS. The intercultural practices were performed as per treatments at 20 and 40 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 treatment were:W_1-Stale seedbed + two hoeing at 20 & 40 DAS,W_2-SS + hoeing with power weederat 20 DAS + hoeing once at 40 DAS,W_3-SS+hoeing once 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),andW_6-Weedy check.
N_1-100% RDN through FYM,N_2-75% RDN through FYM + seed treatment with *beejamrut*+ spray of *jeevamrut*twice at 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* at 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* at 500 l ha^{-1} at sowing and 30 DAS.Weed infestationwas calculated at harvest in respect of broadleaf weeds, grasses and sedges and total weeds:

Weed infestation (%) =

$$\left(\frac{\text{Weed count in unit area}}{\text{Total weed count in unit area+Total crop plants present in unit area}}\right)\times 100$$

Weeds were collected from two randomly selected spots using a quadrate of 0.25m^2 at 30DAS and bring to sun dried for 24 hours followed by oven drying at 65°C till a constant weight. The final dry weight of broadleaf weeds and grasses and sedges was recorded and expressed in kg ha^{-1}. The growth attributes were recorded on the basis of five plant observation randomly selected from every experimental unit at different growth stages of maize and averaged. The grain and stover yield of maize was recorded at maturity.The total monetary returns (gross return) of the economic produce obtain from maizewas calculated based on minimum support prices, net return ha^{-1} was calculated by subtracting the total cost of production from the gross returns and benefit: cost ratio (B:C ratio) was calculated using standard practices.

RESULTS AND DISCUSSION

Weed Studies

The field was infested with *Amaranthusviridis*L., *Commelinabengalensis* L., *Cynodondactylon* L Pers., *Digeraarvensis*L. *Echinochloacolona*L. Link., *Cyperusrotundus* L.*Dactylocteniumaegyptium, igitariasanguinalis, Phyllanthusniruri etc.*during cultivation period of 2019 and 2020. The pooled data(Table1) revealed stale seedbed (SS) + plastic mulch application at sowing kept the experimental site without weed infestation up to harvest and achieved 100 % weed control efficiency. Further, treatment weed free check recorded a minimum of 52.54 and 79.08 % infestation of grasses and sedges and total weeds, respectively while stale seedbed + hoeing once at 20 DAS+ straw mulch at 30 DAS recorded minimum infestation of broadleaf weeds at harvest over weedy check. These treatments recorded maximum weed control efficiency of 83.42, 95.49 and 93.08 percent at harvest of broadleaf weeds, grasses& sedge and total, respectively as compared to weedy check. The organic nutrient management treatments, however, failed to infest the field with total weeds significantly at harvest but significantly affected the broadleaf and grasses and sedge as against maximum 100% RDN through FYM.Maintaining weed free check situation free up to 60 DAS reduced crop weed competition helped to divert the critical inputs towards crop (Sunitha *et al.,* 2010). The stale seedbed exhausted the weed seed bank further forced to etiolate the weeds under polythene and straw mulch decreased the weed infestation of various categories of weeds and improved weed control efficiency (Senthilkumar *et al.,* 2019). The availability of nutrients to extended period increased the weed infestation as compared to vermicompost as a source of nutrient.

Table 1: Effect of different treatments on weedinfestation and weed control efficiency in maize crop (pooled of two years)

Treatment	Weed infestation (%)			Weed control efficiency (%)		
	Broadleaf weeds	Grasses & Sedges	Total weeds	Broadleaf weeds	Grasses & Sedges	Total weeds
Weed management						
W_1	32.5	58.8	91.3	68.7	91.0	88.3
W_2	31.9	58.6	90.6	67.9	89.9	87.3
W_3	25.0	54.8	79.9	83.4	91.1	90.2
W_4	0.00	0.00	0.00	100.0	100.0	100.0
W_5	26.5	52.5	79.0	76.1	95.5	93.1
W_6	35.5	61.0	96.5	0.0	0.0	0.0
CD (P=0.05)	2.23	2.48	2.97	0.78	1.02	0.52
Nutrient management						
N_1	26.5	48.5	74.0			
N_2	25.3	46.9	72.2			
N_3	24.6	48.5	73.1			
N_4	25.9	46.2	72.1			
N_5	24.0	48.2	72.2			
CD (P=0.05)	1.39	1.43	NS			

W_1-Stale seedbed + two hoeing at 20 & 40 DAS,W_2-SS + hoeing with power weederat 20 DAS + hoeing once at 40 DAS,W_3-SS +hoeing once 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.N_1-100% RDN through FYM, N_2-75% RDN through FYM + seed treatment with beejamrut+ spray of jeevamruttwice at 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 at 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 at 500 l ha^{-1} at sowing and 30 DAS

Effect on growth attributes

The dry matter accumulation by maize plant was significantly influenced by various weed management practices at different growth stages of crop as compared to weedy check. The treatment weed free check recorded mean maximum dry matter of 47.1 and 210.7 g plant^{-1}at 50 DAS and at harvest, respectively over weedy check (30.8 and 175.6 g plant$^{-1,}$ respectively) and mean maximum plant height of 156.4 and 185.1 cm was significantly superior over weedy check (144.9 and 170.2 cm, respectively) (Table 2). Similarly the nutrient management practices, through organic sources *viz*, vermicompost and FYM inoculated with fermented organic products viz. *beejamurt* and *jeevamurt* reported significant variations in dry matter accumulation and plant height. The pooled data revealed that 75% RDN through vermicompost in two split + seed treatment with *beejamurt*+spray of *jeevamurt* twice recorded maximum plant height of 157.2 and 184.9 cm while plant dry matter of 44.1 and 206.18 g plant^{-1} as compared to lowest recorded in 100% RDN through FYM at 50 DAS and at harvest, respectively.

Phenology of maize plants

The initiation of reproductive growth i.e. days to 50 % tasseling and days to 50 % silking in maize was reported significantly advanced in weed and nutrient management practices as against the irrespective checks. Among the organic weed management practices, weedy free check came early in tasselling by 5.2 days and in silking by 4.7 days as against weedy check (56.5 days and 60.6 days, respectively) followed by stale seedbed + hoeing once at 20 DAS + straw mulch at 30 DAS.Application of 75% RDN through vermicompost in two splits + seed treatment with *beejamurt*+ spray of *jeevamurt* twice reported earliest tasselling (52.6 days) and silking (56.5 days) and were 2.3 and 2.3% earlier over 100% RDN through FYM (53.9 and 57.8 days) followed by 75% RDN through vermicompost as basal + seed treatment with *beejamurt*+ spray of *jeevamurt* twice (53.1 days and 57.1 days), respectively on pooled basis. Data on leaf area index associated with hybrid maize measured maximum of 3.59 in the treatment stale seedbed + plastic mulch at sowingclosely followed by weed free check (3.54) and were 16.2 and 14.6 % higher over the lowest in weedy check (3.09), respectively at 50 DAS.

Table 2: Effect of different treatments on growth attributes in maizepooled of two years

Treatment	Plant height (cm)		Dry matter (g plant^{-1})		Days to 50 % taselling	Days to 50 % silking	LAI at 50 DAS	Cob length (cm)	Gob girth (cm)
	50 DAS	At harvest	50 DAS	At harvest					
Weed management									
W_1	154.5	181.3	44.2	205.0	53.1	57.0	3.4	13.5	7.9
W_2	153.6	180.8	41.9	204.2	53.3	56.8	3.4	13.5	7.7
W_3	155.7	182.6	44.3	208.1	52.5	56.2	3.4	13.9	8.0
W_4	155.7	182.4	43.1	206.0	52.8	56.6	3.5	13.4	7.8
W_5	156.4	185.1	47.1	210.7	51.2	55.9	3.5	14.2	8.3
W_6	144.9	170.2	30.8	175.6	56.4	60.9	3.0	12.0	7.0
CD (P=0.05)	3.37	4.07	1.78	4.59	0.92	0.95	0.1	0.36	0.25
Nutrient management									
N_1	148.3	175.7	39.7	195.6	53.9	57.8	3.3	12.8	7.5
N_2	152.7	178.8	40.9	200.4	53.4	57.5	3.3	13.1	7.7
N_3	154.0	180.8	42.4	202.8	53.2	57.4	3.4	13.5	7.9
N_4	155.2	182.1	42.7	203.3	53.1	57.1	3.5	13.7	7.9
N_5	157.2	184.9	44.1	206.1	52.7	56.5	3.6	14.1	8.1
CD (P=0.05)	2.33	3.17	1.34	4.02	0.51	0.60	0.11	0.55	0.22

Among the various organic nutrient management treatments, the highest mean LAI of 3.58 was measured with75% RDN through vermicompostin two splits + seed treatment with *beejamurt*+ spray of *jeevamurt* twice,which was 8.8 %higher against 100% RDN through FYM (3.29)followed by75% RDN through vermicompost+ seed treatment with *beejamurt*+ spray of *jeevamurt* twice. The mean maximum cob length of 14.2 cm and cob girth of 8.3 cm was recorded in treatment weed free check as against the lowest in weedy check (12.0 cm and 7.0 cm) among various weed management practices and 14.07 cm and 8.13 cm in treatment 75% RDN through vermicompost in two splits + seed treatment with *beejamurt* + spray of *jeevamurt* twice as against 100% RDN through FYM (12.76 cm and 7.49 cm, respectively).As discussed earlier, the weed management practices markedly improved the congenial micro climate by reducing weed infestation as against weedy check and improved the various growth parameters and entered in reproductive phase quickly. The improved morphology of plant in terms of plant height, dry matter accumulation and higher leaf area index reciprocally cause a better weed control during critical period and ensured greater availability of nutrients and their absorption by plants resulted in better growth and translocation and accumulation of photosynthetes towards sink (cob) led to appreciable enhancement of yield of hybrid maize as compared to weedy check (Kumar, 2020). The organic manures appliedin split ensured availability of nutrients for an extended period as well as in balanced proportion because of efficient root and shoots systemof 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).

Yields

The grain and stover yield of maize was significantly increased in various weed management practices as compared to weedy check (Table 3). The data showed that maintaining weed free situation through frequent hoeing recorded maximum maize grain and stover yield of 3.36 and 6.27tha^{-1} and increases were71.4 and 19.4 percent, respectively over weedy (1.96 and 5.25 t ha^{-1}, respectively). 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*resulted in significantly higher grain and stover yield of maize of 3.17 t ha^{-1}and 6.24 t ha^{-1}and their respective increases were 15.3 and 9.9% over 100% RDN through FYM (2.75 and 5.68 t ha^{-1}, respectively), respectively. Higher yields under the weed management treatments particularly weed free check might be attributed to lower weed dry infestation, better weed control efficiency, improved growth attributes than uncontrolled weed growth (Kumar and Angadi, 2014).The organic manures

improved the soil properties and maintained balanced nutrient supply increasedthe growth attributes, induce tasselling and silkingmight be resulted in increased yield (Javed *et al.* 2019). The *beejamrut* and *jeevamrut*secreted growth promotors *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), Potkile *et al.*(2018) and Rino *et al.* (2020).

Table 3: Effect of different treatments on yields and economics of maize (Mean of two years)

Treatment	Yield (t ha^{-1})			Economic		
	Grain	Stover	Biological	Gross return (Rs ha^{-1})	Net returnRs ha^{-1})	B:C
Weed management						
W_1	3.04	6.20	9.09	82576	27599	1.50
W_2	2.93	6.19	8.92	80174	28401	1.55
W_3	3.24	6.11	9.14	87021	32364	1.59
W_4	3.08	6.03	8.98	83175	-5311	0.94
W_5	1.96	5.25	7.05	56016	14820	1.36
W_6	3.36	6.26	9.43	89915	31799	1.55
CD (P=0.05)	0.12	0.21	0.52	2901	2901	0.05
Nutrient management						
N_1	2.75	5.68	8.24	74864	18770	1.38
N_2	2.83	5.95	8.56	77209	23119	1.48
N_3	2.93	6.06	8.82	79781	17266	1.31
N_4	3.01	6.11	8.95	81617	22532	1.42
N_5	3.17	6.24	9.27	85593	26373	1.49
CD (P=0.05)	0.08	0.15	0.28	1815	1815	0.03

Economics

The data indicated that all the organic weed management practices significantly increasedthe gross return of maize over weedy checkand mean maximum gross return of Rs89,915 $ha^{-1}$was recorded in treatment weed free check as against Rs56,016 ha^{-1} in weedy check (Table 3). While, the maximum mean net return and B:C ratioof Rs32,364 $ha^{-1}$and 1.59 were recorded in treatment stale seedbed + hoeing at 20 DAS + straw mulch at 30 DAS which was found statistically similar to weed free check. The treatment 75% RDN through vermicompost in two splits +seed treatment with *beejamurt* + spray of *jeevamurt* twice recorded maximum mean gross return of Rs85,593 ha^{-1}, net return of 26,373ha^{-1}, and B:C ratio of 1.49 and was statistically superior over rest ofthe treatments in pooled study.These higher gross and net returns and benefit:cost ratio under various weed management and nutrient management treatments attributed due to better weed-control efficiency, growth parameters and higher grain yields (Virk *et al.*, 2019 and Bhadu, 2019).

From these results, it may be concluded that maintaining weed free situation and application of straw mulch after stale seedbed as weed management practice and split application of vermicompost along with *jeevamurt* and *beejamurt*as integrated nutrient management practice increased growth parameters and yields in maize and became more sustainable and economically viable as compared to rest of the treatments.

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