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Effect of integrated nitrogen management with vermiwash in corn (*Zea mays* L.) on growth and yield

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This study was undertaken at instructional Farm, Navsari Agricultural University, Navsari, India (20.95°N 72.93°E, elevation of 10 m above sea level) during winter season of 2010 to work out nitrogen (N) management through organic and inorganic sources to increase corn yields and its components with resilient performance under irrigated conditions. The nitrogen treatments tested were 100% N through chemical fertilizer, 75% N through chemical fertilizer + 25% through bio-compost, 75% N through chemical fertilizer + 25% through vermicompost, 50% N through chemical fertilizer + 25% through biocompost + 25% through vermicompost along with two vermicompost treatments *viz.,* no sprays of vermiwash and three sprays of vermiwash. Combined analysis of variance for them depicted significant results for all the yield contributing characters. The highest grain yield (5261 kg ha^{-1}) and stover yield (7405 kg ha^{-1}) were obtained from the 50% nitrogen through chemical fertilizer + 25% through biocompost + 25% through vermi-compost. The use of vermiwash imparted a rise of 11.21% grain and 10.28% stover yield over control.

Key words: Integrated nitrogen management, vermicompost, *Zea mays*, organic farming.

INTRODUCTION

Corn (*Zea mays* L.) has immense yield potential hence is the 'queen of cereals'. Corn thus requires a lot of nutrient for proper growth and yield. Among the major plant nutrients, nitrogen is one of the most important and expensive nutrient marked for its effect on plant growth and yield of cereal crops. Nitrogen plays an important role in the synthesis of chlorophyll and amino acids. This forms the building block of protein and thus contributes to the nutrition of plant. It is also very important for plant metabolism by virtue of being of an essential constituent of structural cell and much diverse type metabolically active compounds. Linear increase in corn production with application of nitrogen up to substantial amount has been reported by several workers (Kaul et al., 1994).

Biocompost is a by-product of sugar industry, rich source of plant nutrients and has favourable effect on soil physical, chemical and biological properties. Application of biocompost to consumable crop minimizes the use of chemical fertilizers improve the quality of soil (Tripathi et al., 2007). The compost prepared through the application of worms usually red wigglers (*Eisenia fetida*), African Nightcrawlers (*Eudrilus eugeniae*) and other earthworms is called vermicompost and the technology of using local species of earthworms for crop production or composting has been called Vermitech (Ismail, 2005). Vermicompost is usually a finely divided peat-like material with excellent structure, porosity, aeration, drainage and moisture holding capacity. Vermiwash is a liquid fertilizer collected after the passage of water through a column of worm activation. It is a collection of excretory and secretory products of earthworms, along with major micronutrients of the soil and soil organic molecules that are useful for

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Table 1. N, P and K content of biocompost, vermicompost and vermiwash.

Nutrient (%)	Biocompost	Vermicompost	Vermiwash	Method used for analysis
N	1.33	1.70	0.01	Modifed kjeldahls method (Jackson, 1967)
P	1.07	0.79	0.08	Vanadomolybdate phosphoric acid yellow colour method (Jackson, 1967)
K	0.80	1.00	0.13	Flame photometer method (Jackson, 1967)

plants (Ansari, 2008). Vermiwash seems to possess an inherent property of acting not only as a fertilizer but also as a mild biocide.

The vermitech complex is efficient in raising the productivity of crops and increasingly becoming famous among farmers for foliar sprays. Therefore its efficiency in improving corn productivity needs to be evaluated. Considering the above facts this study was undertaken to efficiently include vermitech and biocompost in nutrient supplement in corn at Navsari, India. The objective behind this experimentation was to increase or sustain the corn productivity along with increase in use of organic nutrient sources.

MATERIALS AND METHODS

The experiment was carried out at Instructional Farm, Navsari, India (20.95°N 72.93°E, elevation of 10 m above sea level) during winter season of 2010. The experiment included eight treatment combinations comprising of four nitrogen treatments (N_1, 100% N through chemical fertilizer, N_2, 75% N through chemical fertilizer + 25% through bio-compost, N_3, 75% N through chemical fertilizer + 25% through vermicompost, N_4, 50% N through chemical fertilizer + 25% through biocompost + 25% through vermicompost) and two treatments of vermiwash (V_1, no sprays of vermiwash, V_2, three sprays of vermiwash). The experimental design was factorial arranged in randomized block design with three replications.

The soil was clayey in texture with sand 13.87%, silt 19.39% and clay 66.74% as analyze by International pipette Method (Piper, 1950). pH of soil was 7.8 (slightly alkaline) with electrical conductivity 0.36 dSm^{-1} (normal). Nutrient availability in soil was 167 kg ha^{-1} for nitrogen (low), 28 kg ha^{-1} for available phosphorus (medium) and 342 kg ha^{-1} for available potassium (fairly rich) as analyze using standard methods from Jackson (1967).

The analysis of compost, vermicompost and vermiwash for N, P and K content is estimated on dry weight basis as mentioned below in Table 1.

An improved corn variety, “Gujarat Maize-3” evolved through selection at the Main Maize Research Station, Anand Agricultural University, Godhra and release for winter cultivation in Gujarat state during 1999, was been used as test crop. Corn crop cultivar Gujarat Maize-3 was sown with the seed rate of 20 kg ha^{-1} at 60 × 20 cm spacing with dibbling method in North-South direction. The fertilizer dose used throughout experiment was 80- 40-00 NPK kg ha^{-1}. The first irrigation was given just after sowing for germination and subsequently five irrigations were applied accordingly during crop period. Two hand weeding were done to check the weed population. No serious disease and pest were observed during the crop growth period hence no use of insecticide was needed. The data collection for growth and yield attributes was done from randomly selected five plants and then by calculating the average value for each plot. After maturity of crop, harvesting was followed by removing the cobs from plant and subsequently the plants were harvested by sickle from each plot. The yield observations were calculated from whole net plot plant population.

RESULTS AND DISCUSSION

Effect of growth attributes

Various growth attributes *viz.*, plant height, dry matter accumulation per plant, LAI , days to 50% tasseling and silking and days to physiological maturity recorded at periodical interval were significantly influenced due to various nitrogen management (Tables 2 and 3). Application of 50% N through chemical fertilizer + 25% through biocompost + 25% N through vermicompost significantly improved growth in terms of plant height, dry matter accumulation per plant and LAI over the treatment 100% N through chemical fertilizer. However, it was statistically at par with n_2 and n_3.This is probably due to the fact that biocompost and vermicompost supplied major nutrients as well as micro-nutrients ensuring balanced plant nutrition. Besides, it improves physical, chemical and biological properties of the soil. These results are in agreement with findings of Grazia et al. (2003), Singh et al. (2003), Tripathi et al. (2007), Channabasanagowda (2008) and Kumawat (2010).

Days required to 50% tasseling and silking were remarkably reduced with application of 50% N through chemical fertilizer + 25% through biocompost + 25% N through vermicompost which was comparable with 75% N through chemical fertilizer + 25% N through biocompost and, 75% through chemical fertilizer + 25% N through vermicompost as compared to application of 100% N through chemical fertilizer. It is presumed that integrated N supply through chemical fertilizer and organic manures advanced the tasseling and silking over chemical fertilizer in corn due to better plant nutrition and favourable environment for root growth and development.

Application of three sprays of vermiwash (V_2) had significantly higher growth attributes *viz.* plant height, dry matter accumulation per plant and LAI over no vermiwash spray (V_1) (Tables 2 and 3). This may be attributed to

Table 2. Plant height, dry matter accumulation and LAI of corn as affected by integrated N management practices and vermiwash treatments.

Treatments	Plant height (cm)				Dry matter accumulation (g plant^{-1})				LAI			
	30 DAYS	60 DAYS	90 DAYS	At harvest	30 DAYS	60 DAYS	90 DAYS	At harvest	30 DAYS	60 DAYS	90 DAYS	At harvest
Integrated N management												
N_1	53.30	133.54	160.34	162.07	6.17	73.74	153.98	166.77	0.96	1.87	2.15	2.01
N_2	54.83	139.20	166.23	169.18	7.17	77.22	160.58	178.02	1.06	2.08	2.22	2.16
N_3	55.81	142.57	170.59	173.27	7.22	79.29	163.08	180.77	1.10	2.12	2.29	2.24
N_4	57.15	148.43	177.48	179.22	7.66	81.49	172.79	187.42	1.13	2.18	2.37	2.29
S. E. ±	0.92	3.55	4.12	4.11	0.19	1.87	4.34	4.77	0.03	0.05	0.05	0.06
CD (P=0.05)	2.70	10.37	12.03	11.99	0.56	5.47	12.65	13.91	0.09	0.16	0.15	0.16
Vermiwash												
V_1	52.50	134.81	162.53	164.38	6.58	75.20	156.04	171.42	0.95	1.88	2.16	2.09
V_2	58.04	147.06	174.79	177.49	7.52	80.68	169.17	185.07	1.18	2.24	2.36	2.26
S. E. ±	0.65	2.51	2.91	2.90	0.14	1.32	3.07	3.37	0.02	0.04	0.03	0.04
CD (P=0.05)	1.91	7.33	8.50	8.47	0.39	3.86	8.95	9.84	0.07	0.1	0.10	0.11
Interaction												
N x V	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. (%)	4.73	7.13	6.90	6.80	7.66	6.80	7.54	7.56	8.56	7.29	6.49	7.17

N_1: 100% N through chemical fertilizer; N_2: 75% N through chemical fertilizer + 25% through biocompost; N_3: 75% N through chemical fertilizer + 25% through vermi-compost; N_4: 50% N through chemical fertilizer + 25% through biocompost + 25% through vermi-compost; V_1: No vermiwash and V_2: Three sprays of vermiwash (20, 40 and 60 DAS).

presence of growth hormones, enzymes, and other secretions of earthworms which could stimulate the growth and development of crop and even develop resistance in crops. Vermiwash would certainly have the soluble plant nutrients apart from some organic acids and mucus of earthworms and microbes which influence the growth attributes (Shivsubramanian and Ganeshkumar, 2004).

Besides the period for 50% tasseling and silking significantly reduced due to vermiwash spray (v_2) as compared to no vermiwash spray (V_1) (Table 3). This may be due to presence of growth hormones and nutrients in the vermiwash that favourably affected the growth and development of plants leading to early tasseling and silking in plats. These results are in agreement with the findings of Thangavel (2003).

Effect on yield and yield components

Various yield attributes (Table 4) *viz.,* length of ear, girth of ear, grains ear^{-1}, grain and biological yield were significantly influenced by nitrogen N treatments.

Treatment receiving 50% N through chemical fertilizer + 25% N through biocompost + 25% N through vermicompost (N_4) had significantly higher grain (5261 kg ha^{-1}) and stover (7405 kg ha^{-1}) and was statistically at par with 75% N through chemical fertilizer + 25% through biocompost (N_2) and 75% N through chemical fertilizer + 25% through vermicompost (N_3). The higher seed and stover yield with integrated N management treatments might be due to remarkable increase in yield components such as length of ear, girth of ear, grains per ear. This is due to adequate supply of photosynthates for

Table 3. Days to 50% tasseling and silking of corn along with days to physiological maturity as influenced by integrated N management practices and vermiwash treatments.

Treatments	Days to 50% tasseling	Days to 50% silking	Days to physiological maturity
	Integrated N management		
N_1	60	64	111
N_2	58	62	112
N_3	57	61	112
N_4	54	58	115
S. E. ±	1.40	1.39	0.90
CD (P=0.05)	4.08	4.07	2.64
	Vermiwash		
V_1	59	63	112
V_2	55	59	113
SEM ±	0.99	0.99	0.90
CD (P=0.05)	2.88	2.88	2.64
	Interaction		
N x V	NS	NS	NS
C.V. (%)	6.88	6.41	2.26

N_1: 100% N through chemical fertilizer; N_2: 75% N through chemical fertilizer + 25% through biocompost; N_3: 75% N through chemical fertilizer + 25% through vermi-compost; N_4: 50% N through chemical fertilizer + 25% through biocompost + 25% through vermi-compost; V_1: No vermiwash and V_2: Three sprays of vermiwash (20, 40 and 60 DAS).

Table 4. Yield components, grain and stover yield along with harvest index of corn as influenced by integrated N management practices and vermiwash treatments.

Treatments	Length of ear (cm)	Girth of ear (cm)	No. of grains ear^{-1}	Grain yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
			Integrated N management			
N_1	13.77	12.70	421	4498	6060	41.31
N_2	14.91	13.83	455	5148	6971	42.51
N_3	15.21	14.29	459	5248	7226	42.10
N_4	15.84	14.88	479	5261	7405	41.63
S. E. ±	0.40	0.37	10.32	181	221	1.19
CD (P=0.05)	1.08	1.09	30.14	528	647	NS
			Vermiwash			
V_1	14.35	13.33	443	4771	6577	41.74
V_2	15.54	14.52	465	5306	7253	42.03

Table 4. Contd.

S. Em. ±	0.26	0.26	7.30	128	156	0.84
CD (P=0.05)	0.76	0.77	21.31	373	458	NS
			Interaction			
N x V	NS	NS	NS	NS	NS	NS
C.V. (%)	7.00	7.64	6.43	10.16	9.07	8.03

N_1: 100% N through chemical fertilizer; N_2: 75% N through chemical fertilizer + 25% through biocompost; N_3: 75% N through chemical fertilizer + 25% through vermi-compost; N_4: 50% N through chemical fertilizer + 25% through biocompost + 25% through vermi-compost; V_1: No vermiwash and V_2: Three sprays of vermiwash (20, 40 and 60 DAS).

development of sink and balanced nutrition with integrated N management. These findings are alike with those reported by Hussaini et al. (2001), Pattanshetti et al. (2002), Singh et al. (2003), Kar et al. (2006), Kumar et al. (2007) and Sujatha et al. (2008).

Different N management treatments failed to express any significant effect on harvest index. Similar results were also reported by Porwal and Jain (1999).

The length of ear, girth of ear, grains per ear and was also significantly influenced by vermiwash treatments. This is primarily attributed to better growth of plants in terms of plant height and dry matter accumulation per plant due to vermiwash spray which led to adequate supply of photosynthates as well as to direct supply of major and micronutrients to developing ears and grains (Radhakrishnan 2009). Besides, growth hormones, enzymes and other organic substrates in vermiwash were also supposed to affect favourably the yield components.

Treatment receiving three spays of vermiwash (V_2) significantly produced higher seed (5306 kg ha^{-1}) and stover (7253 kg ha^{-1}) yield over no vermiwash spray. The improvement in grain and stover yield might be due to significant increase in yield components like length of ear, girth of ear and grains per ear which ultimately resulted into higher productivity. The results were supported by the findings of Thangavel (2003), Ansari (2008) and Gopal et al. (2010). But still Vermiwash treatment did not significantly affect harvest index. These results indicate that 75% N through chemical fertilizer + 25% N through biocompost (N_2) was economical for corn crop.

Conclusions

On the basis of experimental results it could be concluded that for better growth and higher yields of corn, the crop should be fertilized with 50% N through chemical fertilizer + 25% through biocompost + 25% through vermi-compost. But on economic point of view treatment 75% N through chemical fertilizer + 25% N through biocompost (N_2) can also be adopted to minimize the cost of production along with sustained corn yields. The three spray of vermiwash also reflected to great influence over yield of corn. Thus should be adopted for obtaining higher yield from corn crop.

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