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Effect of integrated nutrient management on growth and yield attributes of maize under winter season (*Zea mays* L.)

Lakhwinder Singh, Santosh Kumar, Kuldeep Singh and Dalwinder Singh

Abstract
An experiment was conducted during *Rabi* season of 2016-2017 at Research Farm of the Department of Agriculrure, Mata Gujri College, Fatehgarh Sahib to study the Effect of integrated nutrient management on growth and yield attributes of maize under winter season (*Zea mays* L.)". The experiment was laid out in randomized block design with eight integrated nutrient management treatments *viz.* T_2- 100% RDF, T_3- 50% RDF + PSB + vermicompost (2.5t/ha), T_4- 75% RDF + vermicompost (5t/ha), T_5- 50% RDF + FYM (5t/ha) + vermicompost (5t/ha), T_6- 50% RDF + FYM (10t/ha) + azotobacter, T_7- 75% RDF + vermicompost (5t/ha) + FYM (5t/ha) + azotobacter and T_8- 75% RDF + azotobacter + PSB were compared with T_1- control. The treatments were replicated thrice. On the basis of results summarized at 30 DAS, the maximum growth were recorded with application of T_2- 100% RDF which was at par with T_7- 75% RDF + vermicompost (5t/ha) + FYM (5t/ha) + azotobacter and T_4- 75% RDF + vermicompost (5t/ha). However at 60, 90 DAS and at harvest stage, the application of T_7- 75% RDF + vermicompost (5t/ha) + FYM (5t/ha) + azotobacter gave best result in term of growth character and yield which is statistically at par to application of T_2- 100 % RDF and T_4- 75% RDF + vermicompost (5t/ha). Application of 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter gave the maximum net returns of Rs. 84272 ha and maximum benefit: cost ratio is observed in T_7- 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter is 1.49.

Keywords: Cob**,** INM, plant height, tassel, yield

Introduction
Maize (*Zea mays* L.) is an important cereal crop and ranks third in production after rice and wheat in India. It is a plant belonging to the family of grasses (Poaceae). In respect of production also USA stands first followed by China. In India, area production and productivity of maize is 9.43 mha, 24.35 mt and 2557kg/ha respectively (*Anonymous* 2015) [1]. Nutrient is the most important constraint for realizing higher productivity of maize. Maize being an exhaustive crop has very high nutrients demand and its productivity mainly depend upon nutrients managements system. The recent energy crisis, high fertilizer cost and low purchasing power of the farming community have made it necessary to rethink alternatives. They enhance crop yield per unit of applied nutrients by providing a better physical, chemical and microbial environment (Madakemohekar *et al.*, 2013) [6]. He also reported that continues application of chemical fertilizer can change the soil pH, upset beneficial microbial ecosystems, increase pest and even contribute to the release of greenhouse gases.
Therefore, under this situation, judicious use of integrated nutrient management is best alternative for sustainable crop productivity while maintaining soil fertility status in maize and other cereal based cropping systems. This ultimately improves crop yield. The available quantity of animal excreta and crop residues cannot meet the country's requirements for crop production. Therefore, maximizing the usage of organic waste and combining it with chemical fertilizers and biofertilizers in the form of integrated manure appears to be the best alternative. Gundlur *et al.*, (2015) [4] state that application of inorganic fertilizers with different sources of organic manures in different proportions has significant role to boost crop productivity, improve nutrient uptake by plants and maintain soil nutrient status in maize based cropping systems. The application of 7.5 t/ha FYM and this much quantity of Azospirillum can produce greater yield of winter maize (Verma, 2011) [12]. Baral and Adhikari (2013) [3] reported that 15 % yield increased when 10 t/ha FYM applied with azotobacter. Taipodia and Yubbey reported in 2013, winter maize seeds inoculated with PSB and 5 t/ha FYM produced maximum grain and stover yield. Application of bio- fertilizer and vermicompost (9 t/ha) increases grain yield (11.7 t/ha) of maize Zaremanesh *et al.*, (2017) [13].

Thus judicious use of chemical fertilizer with other sources of organic matter enhances crop growth, yield and soil health as well as declined environment pollution.

Materials and Methods

A field experiment was conducted at the Student's Research Farm, Mata Gujri College, Fatehgarh sahib during Rabi seasons of year 2016-2017. The experiment laid out in randomized block design with three replicated. The total treatment combinations were eight. The treatments details are as T_1- Control, T_2- 100% RDF, T_3- 50% RDF + PSB + vermicompost (2.5t/ha), T_4- 75% RDF + vermicompost (5t/ha), T_5- 50% RDF + FYM (5t/ha) + vermicompost (5t/ha), T_6- 50% RDF + FYM (10t/ha) + azotobacter, T_7- 75% RDF + vermicompost (5t/ha) + FYM (5t/ha) + azotobacter and T_8- 75% RDF + azotobacter + PSB. The soil of experimental field was gangetic alluvial in texture, normal pH (7.1), medium in organic carbon (0.65%), available P_2O_5 (22.15kg/ha), K_2O (120.84kg/ha) and N (228.15kh/ha). The field was ploughed and given pre-sowing irritation. After the preparatory tillage, field was divided into 24 different plots of 3m x 3m size. The pretreated seed of variety King GK-3059 (Ganga kaveri brand) were sown by dibbling method in between the rows by using maize seed at the rate of 25kg/ha with a spacing of 60x20cm on17 November, 2016. RDF (Recommended dose of fertilizer) of NPK for Maize is 180, 60, 30 kg/ha. Applied 1/3 N and full of dose P_2O_5 & K_2O as basal and remaining dose of N was applied as topdressing in two split at knee high stage and at Pre-teaselling stage. The amount of vermicompost, FYM, azotobacter and PSB was applied at per treatment wise. The field was kept free from weeds by manual hoeing. Plant protection measures and irrigations whenever required were provided in same manner for all the treatments. Regular biometric observations were recorded at periodic intervals of 30DAS, 60DAS, 90 DAS and at harvest stage. Yield attributes parameters were recorded just before harvesting of crop. The crop was harvested on 10 May 2017 when about 80 per cent of the cobs turned yellowish and grains became hard and then tied in the labelled bundles. The sun dried weight of bundles was recorded. The cobs were removed from the plants, dried and threshed with hand operated maize sheller. Thus grain yield of each plot was recorded.

Result and Discussion

Growth characters

The result of the present study indicated that growth parameters of plant such as plant height, LAI and dry matter accumulation of maize crop were significantly influenced by different integrated nutrients management treatments. Among the integrated nutrient management treatments, at 30 DAS the maximum plant height was recorded in application of 100% RDF followed by 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter and 75% RDF + vermicompost (5t/ha). The plant height increased slowly during early stage of crop growth up to 30 DAS. At 60 DAS the maximum plant height was recorded in application of 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter followed by 100% RDF and 75% RDF + vermicompost (5t/ha). Plant height sharply increased up to 90 DAS. At 90 DAS and at harvest stage the maximum plant height was recorded in application of 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter followed by 100% RDF and 75% RDF + vermicompost (5t/ha). However at 30 DAS the maximum dry matter was recorded with application of 100% RDF followed by 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter and 75% RDF + vermicompost (5t/ha). At 60 DAS the maximum dry matter was recorded with application of 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter followed by 100% RDF and 75% RDF + vermicompost (5t/ha). At 90 DAS and at harvest stage the maximum dry matter was recorded with application of 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter followed by 100% RDF and 75% RDF + vermicompost (5t/ha). Among the integrated nutrient management treatments, at 30 DAS the maximum leaf area index was recorded in application of 100% RDF followed by 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter and 75% RDF + vermicompost (5t/ha). At 60, 90 DAS and at harvest stage the maximum leaf area index was recorded in application of 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter followed by 100% RDF and 75% RDF + vermicompost (5t/ha).

At 30 DAS application of 100% RDF gave best results in growth parameters (plant height, LAI, dry matter) because utilization of fertilizer by the plants is usually higher and they are readily available to crop. However at 60, 90 DAS and at harvest stage, the best result in growth parameters is obtained with 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter because FYM and Vermicompost take 25-30 days to decompose in soil and then become available to crop. The reason for higher values of growth parameter can be discussed in the light of fact that crop under these treatments had comparatively make easily extractable and more nutrient available in the field for plants and thereby more availability of nutrients than other treatments which resulted in better crop growth like plant population, plant height, leaf index area and ultimately more dry matter accumulation it might due to application of organic matter and bio fertilizer, help in higher nutrient mobility and therefore, plant uptake more nutrients by reducing nutrient losses through leaching, runoff etc. Control plots produced significantly lower plant height and dry matter of maize. This was due to direct effect of nutrient availability on yield as evident from maximum dry matter resulted from treatment where more nutrient added to soil and in low nutrient available to crop resulted in lower nutrient uptake by maize and thereby reduction in dry matter of maize and lower plant growth character. Similar results were also reported by Nanjappa *et al.,* (2001) [7] Kumar *et al.,* (2005) [5] and Ravi *et al.,* (2012) [8].

Yield attributes

Yield attributes, which determine yield, is the resultant of the vegetative development of the plant. All the attributes of yield *viz.* number of cobs/plant, Number of grain/row, length of cob, Shelling %, and seed index (g) were significantly influenced by different integrated nutrient management methods. All the integrated nutrient management treatments significantly influenced the yield attributes as compared to control. Application of 75% RDF + Vermicompost (5 t/ha) + FYM (5 t/ha) + azotobacter recorded higher yield attributes and were at par of treatment 100% RDF and 75% RDF + vermicompost (5t/ha). Thus, the result indicated that increase in yield contributing characters of plots treated with application of 75% RDF + vermicompost (5t/ha) + FYM (5t/ha) + azotobacter was due to available of more nutrient available to crop plants during critical period lead to more growth. For these reasons, higher growth attributes contributes higher yield attributes. The all growth attributes specially LAI help in plant photosynthesis, which ultimately help in yield attributes. Similar results reported Wagh (2002)

[11] and Samsul *et al.*, (2012) [9].

Yield

Yield is the result of co-ordinate interplay of various growth characters. Grain (q/ha) and stubble yield (q/ha) were significantly influenced by different treatments. Application of 75% RDF + vermicompost (5t/ha) + FYM (5t/ha) + azotobacter recorded higher yield attributes followed by 100% RDF and 75% RDF + vermicompost (5t/ha). However in case of maximum stubble yield was recorded under application of 75% RDF + vermicompost (5t/ha) + FYM (5t/ha) + azotobacter followed by 100% RDF and 75% RDF + vermicompost (5t/ha). The high yield this is due to the availability of more nutrients i.e the results in nutrient application was better due to additional supply of nutrients through biofertilizer azotobacter which might have increased nutrient uptake and better translocation of nutrients. This result can be attributed due to marked improvement plant height, leaf area index, dry matter accumulation, yield and better nutrient utilization. Adequate availability of nutrients resulted in enhanced growth attributes and yield attributes. Increased number of cobs/plant, number of grains /cobs, contributed in high grain yield. The minimum grain yield was recorded under control treatment which was attributed due to fewer nutrients available to crop plants and poor yield attributing characters. Similar findings were also been described by Brar *et al.*, *(*2001) [2], Zaremanesh *et al.*, (2017) [13] also reported the higher grain and biological yield with the application of chemical fertilizer with the application of azotobacter.

Table 1: Effect of integrated nutrients management on growth attributes parameters of maize

Treatment details	Plant height (cm)				Dry matter accumulation (g/plant)				Leaf area index		
	30 DAS	60 DAS	90 DAS	at harvest stage	30 DAS	60 DAS	90 DAS	at harvest stage	30 DAS	60 DAS	90 DAS
T_1 = Control	15.20	23.31	38.22	154.07	7.10	11.19	24.33	174.73	0.41	1.76	3.03
T_2 = 100% RDF	21.55	41.26	85.33	202.91	11.89	20.20	50.61	232.96	1.15	2.90	4.27
T_3 = 50% RDF + PSB + vermicompost (2.5t/ha)	16.77	29.74	65.89	167.53	7.80	13.20	29.85	194.79	0.60	2.59	3.48
T_4 = 75% RDF + vermicompost (5t/ha)	20.00	41.18	85.22	197.85	10.70	17.80	47.62	227.37	0.90	2.87	4.17
T_5 = 50% RDF + FYM (5t/ha) + vermicompost (5t/ha)	17.89	35.43	74.66	185.63	8.50	14.83	33.62	209.30	0.80	2.73	3.97
T_6 = 50% RDF + FYM (10t/ha) + azotobacter	17.11	29.78	66.33	187.31	8.23	14.80	29.23	205.56	0.77	2.73	3.70
T_7 = 75% RDF + vermicompost (5t/ha) + FYM (5t/ha) + azotobacter	20.66	41.95	92.44	211.17	11.07	21.47	56.73	239.85	1.00	3.06	4.29
T_8 = 75% RDF + azotobacter + PSB	19.22	36.51	81.11	190.11	10.10	16.13	39.13	209.88	0.83	2.78	3.93
SEm (±)	0.85	1.21	2.55	6.51	0.37	0.60	1.37	9.83	0.06	0.05	0.10
CD (P = 0.05)	2.57	3.68	7.73	19.75	1.12	1.83	4.17	29.82	0.17	0.17	0.31

Table 2: Effect of integrated nutrient management on yield attributes and yield parameters of maize

Treatment details	Cob/ plant	Length of cob (cm)	No. of grain/cob	No. of grain/row	Shelling (%)	Seed index (g)	Grain yield (q/ha)	Stubble yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
T_1 = Control	1.00	9.94	116.89	13.70	57.97	17.90	28.69	78.53	112.12	23.39
T_2 = 100% RDF	1.89	18.44	382.75	26.13	74.00	29.03	50.28	122.28	188.33	27.49
T_3 = 50% RDF + PSB + vermicompost (2.5t/ha)	1.11	13.44	135.89	18.40	64.10	21.80	40.47	99.20	136.90	24.35
T_4 = 75% RDF + vermicompost (5t/ha)	1.78	17.44	311.11	24.07	72.93	28.23	49.99	123.07	180.93	26.75
T_5 = 50% RDF + FYM (5t/ha) + vermicompost (5t/ha)	1.33	15.00	220.00	21.80	71.07	24.10	46.55	107.75	162.40	25.69
T_6 = 50% RDF + FYM (10t/ha) + azotobacter	1.22	13.44	170.89	20.30	67.83	22.73	43.53	104.53	155.37	25.32
T_7 = 75% RDF + vermicompost (5t/ha) + FYM (5t/ha) + azotobacter	2.11	19.22	399.76	28.50	76.67	30.45	63.70	145.77	207.93	29.58
T_8 = 75% RDF + azotobacter + PSB	1.66	15.55	275.00	23.47	72.37	25.23	47.30	108.99	170.37	26.27
SEm (±)		0.89	10.54	10.54	2.44	0.56	1.62	5.09	5.77	5.70
CD (P = 0.05)	NS	2.68	31.84	31.84	7.41	1.69	5.88	15.45	17.30	NS

Conclusion

On the basis of results summarized above, it can be concluded that application of 75% RDF + vermicompost (5 t/ha) + FYM (5t/ha) + azotobacter in maize under timely sown condition gave the best results in respect to growth, yield and net income. Second best treatment is 100% RDF and the lowest net income overall was in control treatment.

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