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INTEGRATED RESPONSE OF INORGANIC AND BIO-FERTILIZERS ON YIELD AND YIELD ATTRIBUTES OF TURMERIC

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ABSTRACT: A field experiment was conducted to study the effect of integration of bio- and inorganic fertilizers on yield and yield attributes of turmeric during 2007-08 and 2008-09 at Udai Pratap Autonomous College, Varanasi, U.P. The experiment was laid out with thirteen treatments consisted of combination of two variety of turmeric (V_1 – Padrauna local and V_2 – NDH-18) replicated three times in a randomized block design. The results indicated that application of T_6 (NPK 180:90:90 kg per ha + *Azotobactor chrococcum* @ 2.5 kg per ha + *Pseudomonas floriscence* @ 2.5 kg per ha) significantly increased yield and all yield attributes over all treatments, whereas treatment T_9 (50% R.D. of inorganic nitrogen + 50% R.D. of inorganic phosphorus + 100% R.D. of potash + *Azotobactor chrococcum* @ 2.5 kg per ha + *Pseudomonas floriscence* @ 2.5 kg per ha + 50% nitrogen through carpet waste) was closely followed by treatment T_6. In respect of turmeric variety , NDH-18 was found superior over variety Padrauna local in all above conditions. On the basis of performance treatment T_6 and T_9 may be adopted for higher yield and sustainability.

Keywords : *Turmeric, bio-fertilizer, inorganic fertilizer, yield.*

Turmeric (*Curcuma longa* L. Syn *Curcuma domestica* Val.) is a herbaceous perennial plant belonging to the family Zingiberaceae. It is an ancient, most valuable, sacred spice of India and contains appreciable quantities of proteins (6.3%), lipids (5.1%), carbohydrates (69.4%) and fibre (2.6%). Turmeric is rich in minerals like phosphorus, calcium, iron and vitamin A. Turmeric is a horticultural root-crop that is important not only as a spice and cosmetic, but also as a medicinal plant worldwide (Hermann and Martin, 2; Osawa *et al.* 9; Nakamura *et al.* 8; Ishimine *et al.* 4; Hossain *et al.* 3). It is cultivated for its underground rhizomes which is used as spice and condiment, dye stuff and in drug and cosmetic industry. It forms an important adjuvant in Indian culinary as it tends colour and aromatic flavour to various dishes. It is mainly used as condiment, in the preparation of pickles and curries and as a colouring agent in textile, food and confectionary industries. Turmeric has lot of medicinal properties, it has long been used in India for the treatment of sprains and inflammatory conditions. The turmeric rhizome contains a variety of pigments among which '*curcumin*' is the major pigment responsible for colour and it varies from 3.5 to 9.0 per cent in different varieties. India is the largest producer, consumer and exporter of tumeric in the world. It is grown in an area of 163 thousand ha with an average production of 552.3 thousand tonnes (Kandiannan *et al.,* 5). Considering the economic importance of turmeric and environmental problems caused by chemicals application, it is important to cultivate turmeric using organic and bio-fertilizers. Different organic manures influence differently in terms of yield and quality of turmeric. Hence, it is necessary to know the best source of organic manure which could help in increasing the yield and quality. In view of this background, this study was aimed to evaluate the effect of different bio-organic manures on turmeric yield. Biofertilizers like *Azotobactor chrococcum* and *Pseudomonas floriscence* (PSB) ranks in upper category. *Azobobactor,* a non symbiotic N_2 fixing bacteria, is capable to fix atmospheric nitrogen non symbiotically, by which it can replace chemical fertilizer at too much extent. While *Pseudomonas* is phosphorus solublizing bacteria, which solublizes excess/unused phosphorus in soil and provide the

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plant in soluble/available form. We know that our plants use only 16-18% of applied phosphatic fertilizers, rest phosphetic fertilizers lost by various ways. So by using the PSB we can use maximum phosphatic fertilizers applied. Resulting this the yield and composition will also be increased. Carpet waste is also a very good source of major and minor nutrients, so this is also a very good substitute of chemical fertilizers.

MATERIALS AND METHODS

The study was undertaken at the experimental field of Deptt. of Agricultural Chemistry and Soil Science, Udai Pratap Autonomous College, Varanasi, U.P. during the year 2007-08 and 2008-09 on two variety of turmeric (V_1 – Padrauna local and V_2 – NDH-18) at spacing of 30x 22.5 cm. The investigation was carried out in thirteen treatments which consisted of T_1=Control (No application), T_2=100% inorganic Nitrogen, T_3=100% inorganic Nitrogen + 100%P, T_4=100% inorganic Nitrogen + 100%P+ *Azotobacter,* T_5=100% inorganic Nitrogen + 100% P+PSB, T_6=100% inorganic Nitrogen + 100%P + *Azotobacter* + PSB, T_7=50% inorganic Nitrogen + 50%P + *Azotobacter* + 50% N through carpet waste, T_8=50% inorganic Nitrogen + 50%P + PSB +50% N through carpet waste, T_9=50% inorganic Nitrogen + 50%P + Azotobacter + PSB + 50% N through carpet waste, T_{10}=25% inorganic N + 25%P + *Azotobacter* + PSB + 75% N through carpet waste, T_{11}=*Azotobacter*, T_{12}=PSB and T_{13}=*Azotobacter* + PSB. All the treatments were replicated thrice in randomized block design with both the variety. The yield and yield parameters like yield of rhizome per plant (g), fresh rhizome yield (q per ha), length of rhizome (cm) and width of rhizomes (cm) were recorded by standard methods. The fresh yield was recorded by weighing the rhizome at the time of harvesting in one square meter area. The weighing was done after cleaning the soil at turmeric rhizome. The yield per ha was recorded by the multiplication the value with ten thousand. For yield of rhizome per plant (g), ten random plants with same treatment combinations were taken and obtained the average results. The present data was angularly transformed before statistical analysis.

RESULTS AND DISCUSSION

The integration of bio- and inorganic fertilizers on yield and yield attributes of turmeric (Table 1) revealed that, the different treatments applied in both varieties of turmeric have well marked effect on rhizome yield. Application of T_6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azatobacter* + Phosphorus solublizing bacteria) recorded significantly higher fresh rhizome yield in both the varieties—Padrauna Local and NDH-18 (259.32 q per ha and 388.99 q per ha, respectively) which was closely followed by T_9 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + Phosphorus solubliz-ing bacteria + 50% Nitrogen through carpet waste) in both the varieties—Padrauna Local and NDH-18 (252.56 q per ha and 378.84 q per ha). In treatment T_7 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + 50% Nitrogen through carpet waste) and treatment T_{10} (25% inorganic nitrogen + 25% inorganic phosphorus + *Azatobacter* + Phosphorus solublizing bacteria + 75% Nitrogen through carpet waste) showed similar result in both the turmeric varieties—Padrauna Local (V_1) and NDH-18 (V_2) (223.24 q per ha and 334.87 q per ha, respectively). In respect of fresh rhizome yield, turmeric variety NDH-18 was found superior over variety Padrauna Local. The economic yield is a function of yield attributing characters like dry matter production and its accumulation in different plant parts. In the present study, the increase in rhizome yield with the application of T_6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria) can be traced back to the significant increase in the yield attributing characters over other treatments. Application of T_6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria) significantly increased the number and size of primary, secondary and tertiary rhizomes over all the other manures and RDF.

Table 1: Integrated influence of organic and inorganic fertilizers on yield attributes of turmeric.

Treatments	Length of rhizome (cm)		Width of rhizome (cm)		Yield of rhizome per plant (g)		Fresh rhizome yield (q/ha)	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1=Control (No application)	3.47	5.21	1.51	2.26	149.57	224.35	180.40	270.60
T_2=100% inorganic Nitrogen	4.26	6.38	1.84	2.77	183.22	274.83	220.99	331.48
T_3=100% inorganic Nitrogen + 100%P	4.48	6.71	1.94	2.91	192.57	288.85	232.26	348.40
T_4=100% inorganic Nitrogen+100%P+ *Azotobacter*	4.56	6.84	1.98	2.97	196.31	294.46	236.77	355.16
T_5=100% inorganic Nitrogen+100%P+ PSB	4.69	7.04	2.04	3.05	201.91	302.87	243.54	365.31
T_6=100% inorganic Nitrogen+100%P+ *Azotobacter*+PSB	5.00	7.49	2.17	3.25	215.00	322.50	259.32	388.99
T_7=50% inorganic Nitrogen+50%P + *Azotobacter*+50% N through carpet waste	4.30	6.45	1.86	2.80	185.09	277.63	223.24	334.87
T_8=50% inorganic Nitrogen+50%P + PSB +50% N through carpet waste	4.43	6.65	1.92	2.89	190.70	286.05	230.08	345.01
T_9=50% inorganic Nitrogen+50%P + *Azotobacter*+ PSB + 50% N through carpet waste	4.87	6.30	2.11	3.17	209.39	314.09	252.56	378.84
T_{10}=25% inorganic N_2 + 25%P + *Azotobacter*+PSB+75% N through carpet waste	4.30	6.45	1.87	2.80	185.09	277.63	223.24	334.87
T_{11}=*Azotobacter*	3.91	5.86	1.70	2.54	168.26	252.39	202.95	304.42
T_{12}=PSB	4.04	6.06	1.75	2.63	173.87	260.81	209.71	314.57
T13=*Azotobacter* + PSB	4.17	6.26	1.81	2.71	179.48	269.22	216.48	324.72
C.D. (P=0.05)	0.176		0.072		7.318		9.054	

These findings are in conformity with the findings of Vadiraj *et al.* (11) and Krishnamurthy *et al.* (7) in turmeric and Patil (10) and Khalil *et al*. (6) in onion.

The increase in yield parameters and final yield with the application of T_6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria) and T_9 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria + 50% Nitrogen through carpet waste) is attributed to increased dry matter production and its accumulation in different plant parts which in turn reflects the translocation of photosynthates from source to sink. Thus, due to higher photosynthates the rhizome characters might have developed to the maximum extent and resulted in higher rhizome yields. Similar results were obtained Blay *et al.* (1) in onion and Khalil *et al.* (6) in turmeric. The beneficial effects of these treatments on yield and yield attributes of both varieties of turmeric could be attributed to the fact that after decomposition and mineralization, the organic manures supply available nutrients directly to the plants and also had stabilizing effect on fixed form of nutrients in soil, besides, the nutrients supplying capacity. These organic manures build the soil organic matter reservoir, which increases the water holding capacity, porosity, structural stability in the soil. Thus, improvement in soil physical and chemical environment must have helped in proliferation of beneficial soil microbial population, improved enzymatic activity, encouraged proliferation of roots which helped in absorption of more water and nutrients from larger area. This must have been responsible for higher biomass production *vis-a-vis* more rhizome yield. The difference in yield, yield parameters and dry

matter production could also be attributed to the significant increase in the growth components like plant height, number of leaves, leaf size, leaf area and number of tillers. All these parameters have an indirect positive impact on the yield components and yield of turmeric. The data in Table 1 revealed that application of treatment T_6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria) recorded significantly wider rhizome in both the turmeric varieties Padrauna Local and NDH-18 (2.17 cm. and 3.25 cm, respectively), which was closely followed by T_9 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria + 50% Nitrogen through carpet waste) over all treatments. In treatment T_7 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + 50% Nitrogen through carpet waste) and treatment T_{10} (25% inorganic nitrogen + 25% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria + 75% Nitrogen through carpet waste) was found similar. In the respect of width of rhizome turmeric variety NDH-18 was found superior over Padrauna Local. In the present investigation, application of treatment T6 (100% inorganic nitrogen + 100% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria) recorded significantly higher values for length of rhizome in both the turmeric varieties Padrauna local and NDH-18 (5.00 and 7.49 cm, respectively), which was closely followed by T_9 (50% inorganic nitrogen + 50% inorganic phosphorus + *Azotobacter* + Phosphorus solublizing bacteria + 50% Nitrogen through carpet waste) (4.87 and 6.30 cm, respectively) over all treatments. In all, length of rhizome turmeric variety NDH-18 was found superior over Padrauna Local. Similar trend was also observed in case of yield of rhizome per plant in both the varieties of turmeric.

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