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Effect of integrated nutrient management on growth, yield and shelf life of turnip (*Brassica rapa* L.) cv. purple top white

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Abstract
A field experiment was conducted at the Research Farm, Department of Horticulture, National Post Graduate College, Barhalganj, Gorakhpur (U.P.), India, in 2019-2020. The experiment was laid out in RBD with ten treatments replicated three times. Treatments were consisted of control (no fertilizer added), F.Y.M., Vermicompost and Azotobacter and RDF (NPK @ 150kg: 100kg: 50kg per ha). The observations were recorded on various growth, yield related traits and shelf life of turnip and subjected to statistical analysis. The results revealed that maximum plant height T_9 (56.33cm), no. of leaves (20.33), leaf length (52.07cm), Leaf width (17.67cm), Crown diameter (5.55cm), Tuber weight (388.55g), tuber length (8.09cm), root diameter (12.25cm), Fresh weight of whole plant (645.85g), Tuber yield/plot (5.05kg) and Yield/ha (41.41tn), Shelf life (17.11days) were recorded with the treatment T_9 (RDF 20% + Vermicompost @ 40% + Azotobacter @ 40%), while control exhibited very poor performance for these traits. These findings have drawn the conclusion that integrated nutrient management significantly enhanced the growth, yield and shelf life of turnip with more profitable cost benefit ratio (3.70).

Keywords: Turnip, FYM, Vermicompost, Azotobacter, yield and shelf life

Introduction
Turnip is a member of the cruciferous family of vegetables. The turnip or purple top white turnip (*Brassica rapa* L.) cv. Purple Top White is a root vegetable commonly grown in temperate climates worldwide for its white, fleshy taproot. It is a native of central and southern Europe and has now spread all over the world. In India, turnip cultivation is mostly confined to north western parts of the country like Punjab, Haryana, Rajasthan, and Western U.P. as an early winter season crop. Green Top, Purple Top and 'Kenshin-Kaba' are important varieties of turnip for fodder production. Turnip has tremendous potential as a short duration, high yielding fodder crop. Its fodder is rich in readily available carbohydrate and crude protein as well as it is highly palatable, succulent and easily digestible.

It has considerable nutritive value considering other cole crops. The fleshy root and young leaves are edible portion and nutritionally not so poor as commonly believed. A thousand gram of edible roots contain 1.4 g protein, 6.2 g carbohydrate, little fat, 0.6 g mineral salt, 0.03 mg vitamin B-l, 0.02 mg vitamin B-2, 15 mg vitamin-C, 24 mg calcium, 0.4.mg, iron and 21 Kg. One hundred gram of edible leaf contains-4 g protein, 9.4 g carbohydrate, 1.5 g fat, 2.2 g minerals salt, 0.31 mg vitamin B-l, 0.57 mg vitamin B-2, 180 mg vitamin C, 710 mg calcium, 28.4 mg iron, 9396 pg calcium, 28.4 mg carotene and 67 kg energy (Purseglove, 1988) [9]. The fresh roots are used in salad consumed as cooked vegetable and use in pickle. A decoction of the leaves or stems is used in the treatment of cancer the root when boiled with lard is used for breast tumors. A salve derived from the flowers is said to help skin cancer (Duke 1983) [5]. It increases visual keenness and is used to treat night blindness. Turnip's syrup strengthens the memory (Khashayar, 2007) [10]. Turnip root peelings contain a natural insecticide (Allardice, 1993) [3].

An integrated nutrient management makes a good side dressing. The chemical fertilizers give the initial boost required by young plants; organic fertilizers provide nutrients uniformly throughout the season and biofertilizer sustain the soil microbial activity, evenly moist and the nutrients more uniformly available (Sam and Frank, 2006) [18]. The soil with its content in macro and micro elements, enhanced by the use of organic fertilizers, play an essential role in the plants growing and development, in biosynthesis of the organic substances

(Marculescu *et al.* 2002) [18]. Chemical fertilizers are inorganic fertilizers which are formulated in appropriate concentrations and combinations which supply three main nutrients: nitrogen, phosphorus and potassium (N.P.K) for various crops and growing conditions. Nitrogen (N) promotes leaf growth and forms proteins and chlorophyll. Phosphorus (P) contributes to root, flower and fruit development. Potassium (K) contributes to stem and root growth and the synthesis of proteins (Ginindza *et al.,* 2015) [6].

F.Y.M. and Vermicompost is a slow releasing and organic manure which have most of the macro as well as micro nutrients in chelated form and fulfill the nutrients requirement of plant for longer period. Vermicompost helps in reducing C:N ratio, increasing humic acid content, action exchange capacity and water soluble carbohydrates. It also contains biologically active substances such as plant growth regulators (Krishnamoorthy and Vajranabhaiah, 1986) [13]. Bio-fertilizers or Plant Growth Promoting Rhizobacteria consists of one or more types of preservatives with a dense population of beneficial soil microbes, which are exploited in order to supply nutrients required by plants, and/or control soil-borne disease and maintain structural stability (Vessey, 2003; Dadrasan *et al.,* 2015) [4].

Materials and Methods

An investigation entitled “Effect of integrated nutrient management on growth, yield and shelf life of turnip (*Brassica rapa* L.)” cv. Purple Top White was planned for the execution of present experiment. A field experiment was conducted at the research farm, Department of Horticulture, National Post Graduate College, Barhalgang, Gorakhpur (U.P.) in 2019-2020. The experiment was conducted in a randomized complete block design with 3 replications and 10 treatments. Treatments were consisted of control (no fertilizer added), F.Y.M., Vermicompost, Azotobacter and RDF (NPK @ 150kg: 100kg: 50kgper ha). The plot size was 1.0 x 1.0 m and spacing followed was 30 x 15cm. The land was brought to a fine tilth through ploughing and tillage and ridges were made of 15cm height. Irrigation channels and bunds were maintained properly. The seeds were sown on ridges on10th Dec. 2019 and covered with thin layer of vermicompost. Light irrigation was given after sowing. The organic manures were applied one week before transplanting, for proper decomposition, full dose of phosphorus and potassium and half dose of nitrogen as per treatment were applied just before the sowing. The remaining half dose of nitrogen was applied 30 days after sowing. All cultural practices were followed regularly during crop growth and observations were recorded on growth characters at different stages i.e., plant height (cm), No. of leaves, leaf length (cm) and leaf width (cm) and yield parameters like fresh weight of whole plant (gm), crown diameter (cm),tuber length (cm), tuber diameter (cm), tuber weight (gm),yield per plot (kg), yield per hectare (tn) and shelf life of turnip roots were recorded. The data on these parameters were subjected to statistical analysis to draw logical conclusions.

Results and Discussion

The present investigation entitled Effect of integrated nutrient management on growth, yield and shelf life of turnip (*Brassica rapa* L.) cv. Purple Top White was carried out during Dec. 2019 to Feb, 2020 in Departmental Research Field of Department of Horticulture, National Post Graduate College, Barhalgang, Gorakhpur (U.P.) India. The results of the present investigation, regarding the effect of integrated nutrient management on growth, yield and shelf life of turnip, have been discussed and interpreted in the (table 1, 2 and 3) and in light of previous research work done in India and abroad. The results of the experiment are summarized below:

Growth parameters

Data regarding vegetative growth is presented in table 1 and showed that At 25 days after planting the maximum plant height was recorded in T_9 (RDF 20% + Vermicompost @ 40% + Azotobactor @ 40%) which is (31.12cm) followed by T_8 which were at par to each other while the minimum plant height was recorded in the treatment T_0 (control) is (16.43cm). At 45 days after transplanting the maximum plant height was recorded statistically significant in T_9 (RDF 20% + Vermicompost @ 40% + Azotobactor @ 40%) is (44.89cm) which was par with T_8 while the minimum plant height was recorded in the treatment T_0 (control) which is (24.64cm). At harvest stage, the maximum plant height was recorded statistically significant in T_9 (RDF 20% + Vermicompost @ 40% + Azotobactor @ 40%) which is (56.33cm) which is at par with T_8 while the minimum plant height was recorded in T_0 (control) which is (38.16cm). Similar results were reported by Ingole *et al.* (2018) [8]. This might be due to fact that RDF 20% + Vermicompost @ 40% + Azotobactor @ 40% act as a nutrilink to plants increase hormonal, nutritional condition and contribute to a considerable extent for better plant height.

More no. of leaves per plant was counted in T_9 (RDF 20% + Vermicompost @ 40% + Azotobactor @ 40%) (6.50 and 13.14) at 25 DAS and 45 DAS respectively, which was closely followed by T_8while the minimum was found in T_0 (control) at 25 DAS and 45 DAS which was (4.12 and 8.44, respectively). At harvest stage, the maximum no. of leaves per plant was recorded statistically significant (20.33) in T_9 (RDF 20% + Vermicompost @ 40% + Azotobactor @ 40%) which were at par with T_8 while the minimum no. of leaves per plant was recorded in T_0 (control) which was (11.67). Similar results were also reported by Kezia and David *(*2013) [11] and Rajwade and Bahadur (2018) [20]. This might be due to fact that RDF + VAM @ 25% + PSB @ 50% + AZ @ 25% enhances the microbial activity into the soil and supplied required nutrient demand of plants to increase hormonal, nutritional condition and contribute considerable extent for more no. of leaves per plant.

Leaf length was recorded maximum in treatment T_9 (RED 20% + Vermicompost @40% + Azotobactor @40%) (28.33cm and 40.17cm) at 25 DAS and 45 DAS respectively, which was closely followed by T_8 while the minimum was noted with T_0 (control) at 25 DAS and 45DAS which is (11.80cm and 20.15cm, respectively). At harvest stage, the maximum leaf length per plant was recorded statistically significant in T_9 (RDF 20% + Vermicompost @ 40% + Azotobactor @ 40%) which was (52.07cm) and at par with T_8 while the minimum leaf length was recorded in T_0 (control) which was (33.41cm). Similar results were reported by Kezia and David *(*2013) [11], Ingole *et al.* (2018) [8] and Rajwade and Bahadur (2018) [20].

Leaf width was recorded maximum in treatment T_9 (RED 20% + Vermicompost @40% + Azotobactor @40%) (7.50cm and 14.97cm) at 25 DAS and 45 DAS respectively, which was closely followed by T_8 while the minimum was noted with T_0 (control) at 25 DAS and 45 DAS which is (5.28cm and 8.96cm, respectively). At harvest stage, the maximum leaf width per plant was recorded statistically significant in T_9 (RDF 20% + Vermicompost @ 40% + Azotobactor @ 40%)

which was (17.67cm) and at par with T_8 while the minimum leaf width was recorded in T_0 (control) which was (14.81cm). Similar results were reported by Aisha *et al.* (2014) [2], Ingole *et al.* (2018) [8] and Rajwade and Bahadur (2018) [20].

Yield parameters

Data regarding yield traits is presented in table 2 and showed that fresh weight of whole plant and tuber weight was found maximum in treatment T_9 (RDF 20% + Vermicompost @40% + Azotobacter @40%) with (645.85g) and (388.15g) respectively, followed by treatment T_8which is significantly superior over all the treatments. The statistically lowest fresh weight of whole plant and tuber weight was observed in Treatment T_0 (control) which is (230.50g) and (157.33g) respectively. Similar results were reported by Aisha *et al.* (2014) [2] and Kiran *et al.* (2010) [12].

The application of different manures and fertilizers through integrated nutrient management also affected the crown diameter, tuber length and tuber diameter of turnip. The maximum crown diameter (5.55cm), tuber length (8.09cm) and tuber diameter (12.25cm) was observed with T_9 (RDF 20% + Vermicompost @40% + Azotobactor @40%), further reveled that different fertility levels also significantly influenced the yield related traits of turnip. Where minimum crown diameter (3.56cm), tuber length (4.33cm) and tuber diameter (7.62cm) recorded in the treatment T_0 (control), these findings were statistically at par with each other. Similar results were reported by and Kumar *et al*. (2013) [14, 15].

The perusal of data further revealed that different treatment combinations influenced significantly the tuber yield (kg/plot) and yield per hectare (tn) at harvest. The maximum tuber yield per plot (5.05kg) and yield per hectare (41.44tn) was recorded with T_9 (RDF 20% + Vermicompost @40% + Azotobactor @40%), which were significantly at par with T_8, whereas control recorded minimum yield /plot (1.95kg) and yield per ha (17.16tn). These findings are in close conformity with Ahmad *et al.* (2014) [1], Kumar *et al.* (2018) [14, 15] and Ghimire *et al.* (2020) [7].

The data regarding maximum Self life of tuber (17.11days) was also recorded with T_9 (RDF 20% + Vermicompost @40% + Azotobactor @40%), which were significantly at par with T_8 and other treatments. while control recorded minimum Self life of tuber (11.23days). These findings are in close conformity with Kushwah *et al.* (2019) [16, 17].

Economics

Data regarding economics is presented in table 3. The Maximum gross returns, Net Return and Cost Benefit Ratio Rs. 248640.00/ha, Rs. 176890.00/ha and (1:3.47) respectively was recorded in treatment T_9 with RDF 20% + Vermicompost @40% + Azotobacter @40% and the minimum Net Return and Cost Benefit Ratio (Rs. 28390.00/ha and 1:1.32) respectively was recorded in treatment T_2 (FYM). These estimated economics are in close association with Islam *et al.* (2020) [9] and Kushwah *et al.* (2020) [16, 17].

As the economics is the need of the farmers while taking decision regarding the adoption of the techniques and scientific knowledge Hence, T_9 with RDF 20% + Vermicompost @40% + Azotobacter @40% gave the highest gross return, net return, and cost benefit is due to higher productivity and enhanced shelf life of tubers, which increase the market value of the roots.

Table 1: Effect of integrated nutrient management on vegetative growth of turnip at 25, 45 DAS and Harvest

Treatments No.	Plant height (cm)			No. of leaves			Leaf length (cm)			Leaf width (cm)		
	25 DAS	45 DAS	At harvest	25 DAS	45 DAS	At harvest	25 DAS	45 DAS	At harvest	25 DAS	45 DAS	At harvest
T_0	16.43	24.64	38.16	4.12	8.44	11.67	11.80	20.15	33.41	5.28	8.96	10.78
T_1	27.74	38.25	52.38	5.78	11.25	17.17	23.56	33.89	47.27	6.46	12.24	15.00
T_2	18.66	30.15	45.33	4.94	9.81	13.29	15.20	26.48	41.56	5.46	10.63	12.76
T_3	20.13	31.46	47.68	5.15	9.36	13.85	16.51	26.92	42.16	5.65	10.49	13.23
T_4	21.86	33.33	49.06	5.33	10.43	15.08	17.76	29.08	44.67	5.96	11.01	13.56
T_5	23.67	34.46	50.84	5.48	10.47	15.89	18.89	30.50	45.30	6.12	11.36	14.17
T_6	25.06	36.64	51.97	5.64	10.86	16.66	21.64	32.10	46.58	6.25	11.85	14.87
T_7	28.85	39.75	53.14	5.98	11.66	18.10	24.45	35.36	48.74	6.89	12.78	15.43
T_8	29.57	41.40	54.20	6.20	12.07	18.70	25.17	37.25	49.70	7.21	13.53	16.55
T_9	31.12	44.89	56.33	6.50	13.14	20.33	28.33	40.17	52.07	7.50	14.97	17.67
F-test	S	S	S	S	S	S	S	S	S	S	S	S
C.D. (5%)	1.16	1.68	2.29	0.26	0.51	0.76	0.97	1.48	2.12	0.30	0.56	0.68
S.Ed (±)	0.55	0.80	1.09	0.12	0.24	0.36	0.46	0.70	1.01	0.14	0.26	0.32

Table 2: Effect of integrated nutrient management on yield related traits of turnip

Treatments No.	Fresh weight of whole plant (gm)	Crown diameter (cm)	Tuber length (cm)	Tuber diameter (cm)	Tuber weight (gm)	Tuber yield/plot (kg)	Yield/ha (tn)	Shelf life (days)
T_0	230.50	3.56	4.33	7.62	157.33	1.95	17.16	11.23
T_1	474.55	4.81	6.57	10.98	308.75	3.86	33.97	15.30
T_2	290.72	3.98	4.76	.7.96	298.74	2.22	19.54	12.68
T_3	331.15	4.16	5.15	9.44	213.67	2.55	22.44	13.70
T_4	369.86	4.21	5.48	9.88	238.55	2.98	26.22	13.24
T_5	402.90	4.45	5.84	10.17	266.20	3.36	29.57	14.50
T_6	440.11	4.69	6.13	10.69	298.20	3.65	32.12	14.19
T_7	525.30	5.18	6.95	11.35	320.00	4.00	35.20	15.82
T_8	596.67	5.37	7.66	11.80	342.12	4.21	37.05	16.32
T_9	645.85	5.55	8.09	12.25	388.15	5.05	41.44	17.11
F-test	S	S	S	S	S	S	S	S
C.D. (5%)	2.13	0.22	0.29	0.48	2.55	0.16	1.42	0.70
S.Ed (±)	1.01	0.10	0.14	0.23	1.21	0.08	0.67	0.33

Table 3: Economics of the crop

Treatments	Cost of cultivation	Fruit yield (t/ha)	Selling price (Rs./t)	Gross return (Rs./ha)	Net profit (Rs./ha)	Benefit cost ratio
T_0	58850	17.16	6000	102960	44110	1.75
T_1	70150	33.97	6000	203820	133670	2.91
T_2	88850	19.54	6000	117240	28390	1.32
T_3	83850	22.44	6000	134640	50790	1.61
T_4	60450	26.22	6000	157320	96870	2.60
T_5	86350	29.57	6000	177420	91070	2.05
T_6	60900	32.12	6000	192720	131820	3.16
T_7	83240	35.20	6000	211200	127960	2.54
T_8	79740	37.05	6000	222300	142560	2.79
T_9	71750	41.44	6000	248640	176890	3.47

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