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Expression of Turnip (*Brassica rapa* L.) Cultivar Purple Top White Red under the influence of solid and liquid organic manures

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ABSTRACT
Present experiment was carried out during 2021-22 at Horticulture Research Block, School of Agriculture Sciences, SGRRU, Dehradun, Uttarakhand to investigate the "Expression of Turnip (Brassica rapa L.) Cultivar "Purple Top White Red" under the influence of solid and liquid organic manures". The experiment was laid out in randomized block design with three replications and ten treatments. The treatments comprised following levels of different organic manures with different concentrations viz. T_1 (Control), T_2 (vermicompost@ 10t/ha), T_3 (FYM@ 5t/ha), T_4 (vermiwash@50%), T_5 (Cow-urine@ 50%), T_6 (rhizobium@500ml/ha), T_7 (FYM @ 5 tons/ha + vermicompost @ 5 tons/ha), T_8 (FYM@ 5 t/ha + vermicompost@ 2.5t/ha + vermiwash @ 25%) and T_9 (FYM@5t/ha + vermicompost@2.5t/ha + vermiwash@ 25% + Cow urine@ 25%), T_{10} (FYM @ 5 t/ha + vermicompost @ 2.5 t/ha + vermiwash @ 25 % + Cow urine @ 25% + Rhizobium @ 250ml. The sowing of Turnip was done on 15/11/2021 and final harvest at 09/02/2022. Observations on various attributes viz. Growth, yield and economics were recorded at 30, 60 days after sowing and at final harvest. The results revealed that the treatment T_4 (Vermiwash@50%) was found to be most effective in terms of vegetative characters such as Plant height, Leaf width, Total fresh leaf weight, Total dry leaf weight. Whereas, treatment T_5 (Cow urine @ 50%) was recorded maximum root length and treatment T_6 (Rhizobium @ 500ml/ha) was found to be most effective in terms for TSS and plant weight. However treatment T_7 (FYM @ 5t/ha + vermicompost @ 5tons/ha) was found to be most effective for increasing root diameter and T_8 (FYM @ 5t/ha + vermicompost @ 2.5t/ha + vermiwash @ 25%) found to be most effective in number of leaves and yield t/ha. Treatment T_{10} (FYM @ 5ton/ha + vermicompost @ 2.5tons/ha + vermiwash 25 % + Cow urine 25 % + Rhizobium @ 250ml) was reported maximum leaf length, root weight, yield kg/ha and maximum B: C ratio (1:26.13) was recorded in T_1(Control).
Keywords: *Organic manure, vermicompost, Rhizobium, vermiwash, leaf length, root weight*

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INTRODUCTION

Turnip is a root vegetable which belongs to the family Brassicaceae. Turnips are mainly used as an ingredient in soups and stews consumed mostly in winter, but they have other potential uses as well. The turnip was brought to America by Jacques Cartier, who planted it in Canada in 1541. It was also planted in Virginia by the colonies in 1609 and in Massachusetts in the 1620s. The Indians adopted its culture from the colonists and soon grew it generally. It was little known in England in 1664 when it was grown in the royal gardens. Turnips can be cooked as a mashed Dish, baked, fried, boiled, or used to make wine. Turnip bolt if exposed to heat, which means that they don't produce the edible root. They tolerate frost well and can flower early the next spring. The European type of turnip was grown in France for both food and stock feed at least as early as the first century after Christ. The organics are the indigenous source of nutrients which can help in increasing production and productivity along with improvement in soil physical conditions [1]**.** Use of such organic materials, which are being wasted in large amounts without proper use, can help in reducing cost of cultivation, increasing productivity and improving soil as well as human and livestock health. Vermicomposting is a cost-effective and eco-friendly process used to treat organic waste. Vermicompost is rich in NPK (2-3%: 1.55-2.25 % :1.85-2.25 %). This process increases the rate of

degradation of the organic waste matter, modifies the physico- chemical properties of the matter and leads to formation of humus in which unstable waste matter is completely oxidized [2]**.** The use of organic manure like farmyard manure, vermicompost, consortium of biofertilizers and bio stimulants like Panchagavya, effective microorganisms, humic acid were found to enhance and improve soil health, growth and yield of many crops. It can also achieve the large goal of sustainable production and to affect the recycling of nutrients in an eco-friendly manner [3]**.** Vermiwash were tested against synthetic auxin IBA to evaluate the plant growth regulatory activity of vermiwash in terms of bean and radish root tip length increase. Vermiwash increased the root tip length of bean and radish seedlings. Cow Urine has a special significance in Indian tradition. Indian Cow breeds are unique and distinct species, popularly known as *"Kamdhenu"*and *"Gaumata"*. Cow urine contains nitrogen, Sulphur, phosphate, sodium, manganese, iron, silicon, chlorine, magnesium, maleic, citric, tartaric, and calcium salts, vitamin A, B, C, D, E, minerals, lactose, enzymes, creatinine, hormones and gold acids. Ingredients of cow urine are similar with human body. Hence these substances and cures incurable diseases [4]. Rhizobium has also the ability to fix nitrogen which is available in atmosphere that is has direct association with legumes and non-legumes plants like Parasponia. Each legume required specific species of Rhizobium to form effective nodules [5]. There are few reports, which indicate that the combined application of solid and liquid organic manures enhances the growth and yield of vegetables [6]. Therefore, an investigation was carried out to assess the performance of solid and liquid organic manures in knol-khol.

MATERIAL AND METHODS

The experiment was conducted at the Horticulture Research Block of Department of Horticulture, School of Agricultural Sciences, Dehradun, Uttarakhand during the year 2021-2022. The Experiment was laid out in randomized block design with three replications. Total ten treatments were tried namely T_1 (Control), T_2 (Vermicompost@5tons/ha), T_3 (FYM@10tons/ha), T_4(Vermiwash@50%), T_5(Cowurine@50%), T_6 (Rhizobium@500ml/ha),T_7 (FYM@5tons/ha+Vermicompost@2.5tons/ha), T_8(FYM@5tons/ ha+ Vermicompost@2.5tons/ha+Vermiwash@25%),T_9(FYM@5tons/ha+Vermicompost@2.5tons/ha+Vermi wash@25%+ Cow urine@25%) and T_{10} (FYM@5tons/ha+ Vermicompost@2.5tons/ha+ Vermiwash@ 25%+ Cow urine@25%+ Rhizobium@250ml). The turnip cultivar Purple Top White Globe was taken for research purpose. The seeds were sown in raised nursery bed on 15thNovember 2021. The seeds were sown at a depth of 1-2 cm maintaining a distance of 30 cm from row to row and 10 cm from seed to seed. All the precautions were taken regarding nursery management till the seedlings were ready for transplanting. All the growing media i.e., FYM, vermicompost, Vermiwash, Rhizobium and cow urine were prepared according to the treatments. All the cultural practices were done at regular intervals as per the requirement of crop during the period of experiment. During the research trial, from each replication, randomly selected five plants were used for recording various observations on growth, and yield parameters during whole of the cropping period at 30, 60 DAT and at Final harvest stage. The economics of Turnip crop was calculated as per the fundamental market prices of the input and produced during the *winter* season 2022. The obtained data were subjected to the statistical analysis by adopting analysis of variance technique as described by [7] for the Randomized Block Design.

Table 1: Treatment details

Treatment Symbol	Combination
T_1	Control
T_2	Vermicompost@ 5 tones/ha
T_3	FYM @ 10 tones/ha
T_4	Vermiwash @ 50%
T_5	Cow urine @ 50%
T_6	Rhizobium @ 500ml/ha (seed treatment)
T_7	FYM @ 5 tones/ha + Vermicompost @ 2.5 tones/ha
T_8	FYM @ 5 tones/ha +Vermicompost @ 2.5 tones/ha +Vermiwash @ 25%
T_9	FYM @ 5 tones/ha +Vermicompost @ 2.5 tones/ha +Vermiwash @ 25% + Cow urine 25%
T_{10}	FYM @ 5tones/ha + Vermicompost @2.5 tones/ha +Vermiwash @ 25% + Cowurine @ 25% + Rhizobium @ 250 ml

RESULTS AND DISCUSSION

Plant height (cm)

Data pertaining to plant height was recorded at 30 DAS, 60 DAS and at final harvest stage were statistically analyzed and presented in table 2 and depicted in Figure 1. At 30 DAS, the maximum plants height (15.78

cm) was recorded in T_{10}. The treatment T_9 (14.41 cm) and T_8 (14.49 cm) was at par with each other. However, significant differences were observed with treatment T_1 (11.21 cm), T_6 (13.16 cm) and T_8(14.49 cm). The minimum plant height was recorded in T_3 (9.59 cm). At 60 DAS the maximum plants height (34.99 cm) was recorded in T_5, which at par T_6 (34.14 cm), T_7 (34.02 cm) and T_{10} (34.13 cm). However, significant differences were observed with treatment T_1 (29.56 cm), T_2 (28.3 cm), T_3 (31.11 cm), T_4 (32.3 cm) and T_{10} (34.13 cm). The minimum plant height was recorded in T_2 (28.3 cm). At final harvest the maximum plants height was recorded in T_4 (45.93 cm) with FYM @ 5 tones/ha + V.C @ 2.5 tones/ha which was at par with T_6 (45.68 cm) and T_{10} (45.56 cm). However, significant difference was observed with treatment T_3 (42.88 cm), T_9 (43.66 cm), T_8 (35.92 cm) and T_2 (37.79 cm). While, the minimum plant height was recorded in T_1 (35.74 cm).The probable reasons for enhanced a greater plant height may be due to promotive effect of macro and micro nutrients on vegetative growth ultimately led to more photosynthetic activities. The findings are in agreement with [8, 9].

Number of leaves

At 30 DAS the number of leaves per plant ranged from 6.2 to 6.3. On the basis of mean the maximum number of leaves per plant was counted in T_1, $T_2$and T_{10} (6.3) which at par with each other. However, significant differences were observed in T_1 (6.2) and T_3 (5.8). The minimum number per plant was recorded in the treatment T_7 and T_8 (5.5). In the case of 60 DAS, the mean value for number of leaves per plant were found maximum in T_9 (12.36).The treatments T_1 (11.8), T_4 (11.63), T_6 (11.3), T_7 (11.5) and T_{10} (11.46) was at par with each other. However, significant differences were found in T_1, T_3 and T_9. The minimum numbers of leaves per plant were recorded in the treatment T_7 or T_8 (5.5). At final harvest after sowing significant differences and on the basis of mean the maximum number of leaves per plant were counted in the treatment T_8 (17.06) which were at par with T_2 (17.6). However, significant differences were found with rest of the treatment T_1 (15.26), T_2 (17.6), T_3 (12.93), T_4 (14.26), T_5 (15.4) and T_7 (13.45). The minimum numbers of leaves per plant were recorded in the treatment T_3 (12.93). The probable reasons for increase in number of leaves might be due to effect of macro and micro nutrients on vegetative growth ultimately led to more photosynthetic activities. The findings are in agreement with [10,11].

Leaf length (cm)

At 30 DAS, the maximum value of leaf length was recorded in the treatment T_4 (8.92 cm) which were at par with T_5 (8.57 cm), T_6 (8.34 cm), T_9 (8.00 cm) and T_{10} (8.52 cm). The significant differences were observed with the treatments T_1, T_2, T_3, T_4, T_5 and T_6. The minimum value (7.1 cm) of leaf length was recorded under the treatment T_3. In 60 DAS, the maximum number of leaf length was recorded in treatment T_4 (23.89 cm). The treatments T_5, T_6, T_7, T_8 and T_9 were at par with each other. The significant differences were observed with the treatment T_1 (18.16 cm), T_3(20.78 cm), T_4 (23.89 cm), T_8 (21.75 cm) and T_{10} (22.45 cm). The minimum leaf length (18.16 cm) was recorded under the treatment T_1. At final harvest DAS, the leaf length was maximum in T_{10} (26.82 cm) which was at par with T_4 (26.44 cm). However, significant differences were observed with treatment T_1 (20.81 cm), T_2 (19.34 cm), T_3 (25.38 cm) T_6 (25.68 cm), T_8 (22.46 cm) and T_9 (24.62 cm). While minimum leaf length was recorded in the treatment T_2 (19.34 cm). The increase in leaf length of turnip may be due to application of major and minor nutrients, through organic manures in various levels, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately increase the leaf length. The finding is also in agreement with the findings of [12].

Leaf width (cm)

The leaf width on 30 days after sowing differs significantly and was ranging from 3.7 to 4.85 cm. The maximum leaf width was recorded in T_6 (4.85 cm) which was statistically at par with T_5 (4.66 cm) and T_4 (4.53 cm). However, significant differences were observed with the treatments T_1 (3.9 cm), T_2(4.01 cm), T_3 (3.71 cm). The minimum leaf width was recorded in the treatment T_1 (3.9 cm). In 60 DAS after sowing the maximum leaf width was recorded in T_4 (10.81 cm) which was at par with treatment T_6 (10.02 cm). However, significant differences were observed with treatment T_1 (8.50 cm), T_4 (10.81 cm), T_5(9.69 cm) and T_9(8.7 cm). At final harvest, the data showed that leaf width of different treatment ranged from 8.7 cm to 13.02 cm. The maximum leaf width was recorded in T_4 (13.02 cm). The treatment T_2 (11.17 cm), T_5 (11.44 cm), T_6 (11.62 cm), T_7 (11.2 cm) and T_8 (11.68 cm) was at par with each other. However, significant differences were observed with the treatment T_1, T_2, T_3, T_4 and T_9. The minimum leaf width was recorded in the treatment T_9 (8.7 cm). This is found to be accordance with findings of [13] reported that addition of vermicompost and vermiwash provides much needed food for the microorganisms in soil thereby, stimulating their activities that are necessary for soil improving most vegetative growth, yield and nutrition status of lettuce plants.

Root length (cm)

The maximum root length (9.25 cm) was recorded in the treatment T_4 with treatment V.C @ 5 tones/ha which was at par with T_1(9.06 cm) indicating significantly superior to all other treatments. The minimum

root length was recorded in T_3 (6.79cm). The significantly highest root length might be due to beneficial effect of organic nutrient sources. The organic nutrient sources, particularly vermicompost improves the soil structure and soil quality which might have resulted in length of root. The findings are in similar with the results of [14].

Root diameter (cm)

The maximum root diameter (8.35 cm) was recorded in $T_7$with FYM @ 5 tones/ha + V.C @ 2.5 tones/ha + V.W @ 25 %. The treatments T_1 (7.21 cm), T_4 (7.70 cm), T_5 (7.51 cm), and T_8 (7.25 cm) was at par with each other. The minimum root diameter was recorded in T_3(6.43 cm) and T_{10}(6.49 cm). The decrease in bulk density and increase in porosity and water holding capacity of the soil due to organic nutrient source might have contributed in increasing root diameter of plants. The findings are similar with [14, 15].

Total fresh weight of plant (g)

The maximum total fresh weight of plant (125.00 g) was recorded in T_6 and the minimum total fresh weight of plant was recorded in T_9 (72.78 g). The results show significant differences between the treatments.

Total fresh weight of leaves (g)

The maximum total fresh weight of leaves (66.44 g) was recorded in T_4 with Vermiwash @ 50% which was significantly superior to all other treatments. The minimum total fresh weight of leaves was recorded in T_8. The results show significant differences between the treatments. The increase in total fresh weight of leaves may be due to the excellence of high level of organic manures was producing good growth of turnip plants which show higher total fresh weight of leaves. The findings are in similar with [16].

Total dry weight of leaves (g)

The maximum total dry weight of leaves (16.12 g) was recorded in T_4 with vermiwash @ 50 %which was significantly superior to all other treatments. The minimum total dry weight of leaves was recorded in T_4. The results show significant differences between the treatments. The increase in total fresh weight of leaves may be due to the excellence of high level of organic manures was producing good growth of turnip plants which show higher total fresh weight of leaves. The findings are in similar with [2, 14].

Root weight (g)

The maximum root weight of turnip (135.74 g) was recorded in T_{10} with FYM @ 5 tones/ha +Vermicompost @ 2.5 tones/ha + Vermiwash @ 25% + Cow-urine @ 25% + Rhizobium @ 250ml significantly superior to all other treatments. The minimum root weight was recorded in T_7. The results show significant differences between the treatments. The increase in total fresh weight of leaves may be due to the excellence of high level of organic manures was producing good growth of turnip plants which show higher total fresh weight of leaves. The findings are in similar with [17].

Root yield (kg/plot)

The maximum root yield of turnip (17.46 kg) was recorded in T_{10}FYM @ 5 tones/ha +Vermicompost @ 2.5 tones/ha + Vermiwash @ 25% + Cow urine @ 25% + Rhizobium @ 250ml with significantly superior to all other treatments. However, the minimum root yield was recorded in T_5. The results show significant differences between the treatments. The increase in total fresh weight of leaves may be due to the excellence of high level of organic manures was producing good growth of turnip plants which show higher total fresh weight of leaves. The findings are in similar with [18, 19].

Table.1: Effect of organic manures on plant height and number of leaves of turnip at different harvesting stages

Treatments	Plant height (cm)				Number of leaves			
	30 DAS	60DAS	At final Harvest	Mean	30 DAS	60DAS	At final harvest	Mean
T_1	11.21	29.56	35.74	25.50	6.2	11.8	15.26	11.08
T_2	10.67	28.3	37.79	25.58	6.3	10.66	17.6	11.52
T_3	9.59	31.11	42.88	27.86	5.8	10.0	12.93	9.57
T_4	11.86	32.3	45.93	30.03	6.3	11.63	14.26	10.73
T_5	11.61	34.99	44.66	30.42	6.3	10.83	15.4	10.84
T_6	13.16	34.14	45.68	30.99	6.2	11.3	14.66	10.72
T_7	13.51	34.02	41.96	29.83	5.5	11.5	13.45	10.15
T_8	14.49	31.61	35.92	27.34	5.5	10.86	17.06	11.14
T_9	14.41	32.21	43.66	30.09	5.9	12.36	13.27	10.51
T_{10}	15.78	34.13	45.56	31.82	6.3	11.46	15.13	10.96
C.D (5%)	3.83				N/A			
SE (m)	1.28				0.58			
SE (d)	1.81				0.82			
C.V	7.65				5.43			

Root yield (t/ha)

The maximum root yield of turnip (17.15 t/ha) was recorded in T_3 with FYM @ 10 tons/ha significantly superior to all other treatments. The minimum root yield was recorded in T_5. The results show significant differences between the treatments. The increase in total fresh weight of leaves may be due to the excellence of high level of organic manures was producing good growth of turnip plants which show higher total fresh weight of leaves. The findings are in similar with [17, 20].

Table.2: Effect of organic manure on leaf length and leaf width of turnip at different harvesting stages

Treatments	Leaf length (cm)				Leaf width (cm)			
	30 DAS	60DAS	At final Harvest	Mean	30 DAS	60DAS	At final harvest	Mean
T_1	7.48	18.16	20.81	15.48	3.9	8.50	12.3	8.23
T_2	7.24	18.82	19.34	15.13	4.01	8.95	11.17	8.04
T_3	7.1	20.78	25.38	17.75	3.71	8.90	10.54	7.71
T_4	8.92	23.89	26.44	19.75	4.53	10.81	13.02	9.45
T_5	8.57	21.21	24.5	18.09	4.66	9.69	11.44	8.59
T_6	8.34	21.32	25.68	18.44	4.85	10.02	11.62	8.83
T_7	7.81	21.26	25.13	18.06	4.37	9.43	11.2	8.33
T_8	7.73	21.75	22.46	17.31	4.3	9.44	11.68	8.47
T_9	8.00	21.53	24.62	18.05	3.97	7.71	8.7	6.79
T_{10}	8.52	22.45	26.82	19.27	4.11	8.03	10.62	7.58
C.D (5%)	2.01				1.04			
SE (m)	0.67				0.35			
SE (d)	0.95				0.49			
C.V	6.57				7.31			

Table.3: Effect of organic manure on root length, root diameter, total weight of plant, total fresh weight of leaves, total dry weight of leaves, root weight, root yield (kg/plot) and root yield (t/ha) of turnip

Treatments	Root length (cm)	Root diameter (cm)	Total weight of plant (g)	Total fresh weight of leaves (g)	Total dry weight of leaves (g)	Root weight (g)	Root yield (kg/plot)	Root yield (t/ha)
At Final Harvest								
T_1	9.06	7.21	85.58	62.04	15.49	122.58	13.40	16.22
T_2	7.58	6.72	90.41	64.03	15.34	130.92	15.06	15.25
T_3	6.79	6.43	97.67	57.79	14.13	123.61	15.20	17.15
T_4	9.25	7.70	84.25	66.44	16.12	128.55	14.70	14.85
T_5	8.15	7.37	89.76	57.47	13.22	121.33	13.36	13.82
T_6	8.20	7.51	125.00	38.08	15.95	94.10	15.16	15.88
T_7	7.60	8.35	99.980	37.89	14.80	86.78	17.00	14.56
T_8	8.48	7.25	106.13	32.45	15.15	110.11	14.43	17.82
T_9	8.48	6.59	72.78	55.29	14.69	109.23	15.23	14.62
T_{10}	7.59	6.49	97.76	49.98	15.95	135.74	17.46	15.25
C.D (5%)	1.18	1.07	14.24	8.68	N/A	18.854	1.971	2.115
SE (m)	0.39	0.36	4.76	2.90	0.84	6.30	0.66	0.71
SE (d)	0.56	0.50	6.73	4.10	1.19	8.90	0.93	0.99
C.V	8.42	8.62	8.69	9.63	9.64	9.38	7.55	7.87

Fig.1: Plant height (cm) of turnip as influenced by organic manure at various stages of harvesting

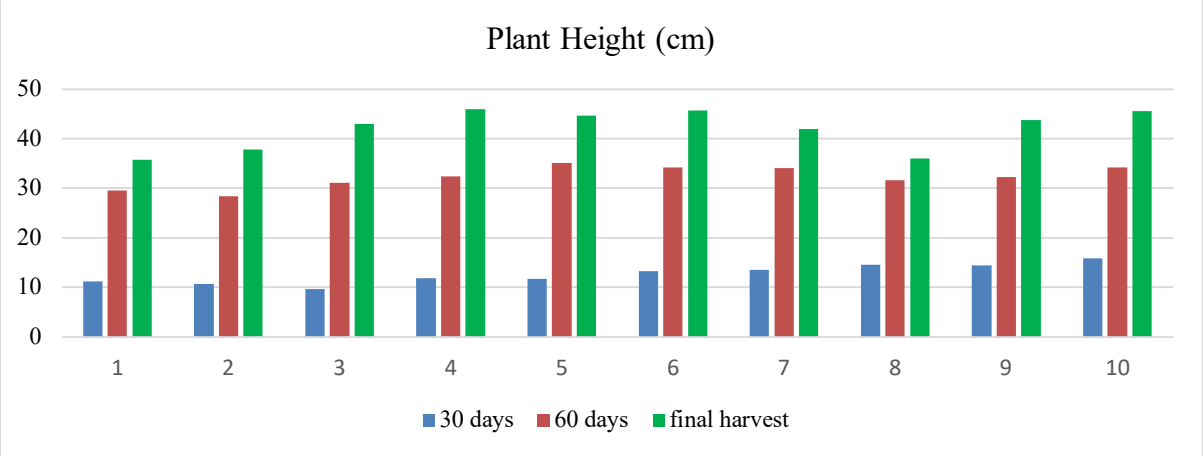


Fig.2: Number of leaves per plant of turnip as influenced by organic manure at various stages of harvesting

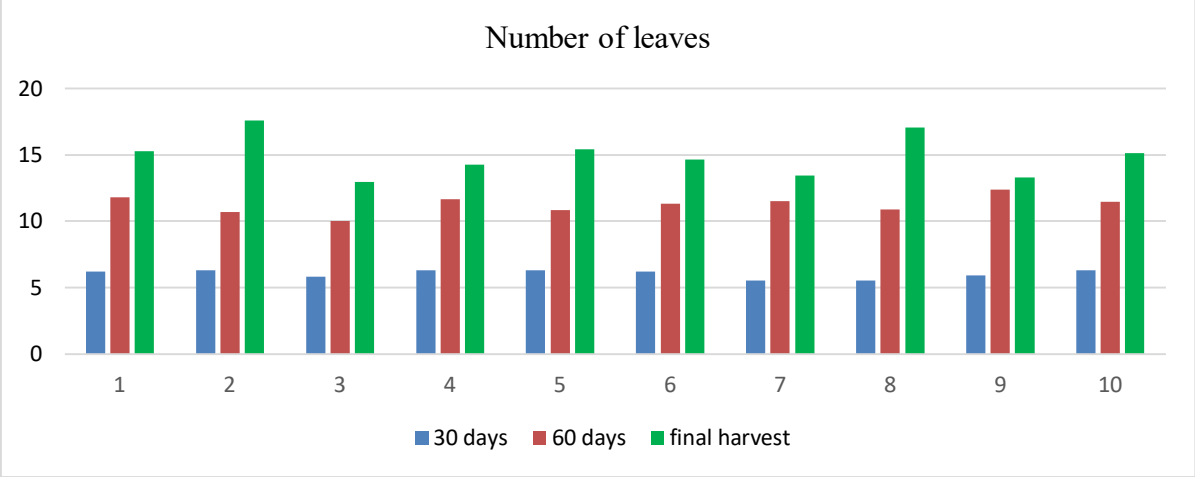


Fig.3: Leaf length (cm) of turnip as influenced by organic manure at various stages of harvesting

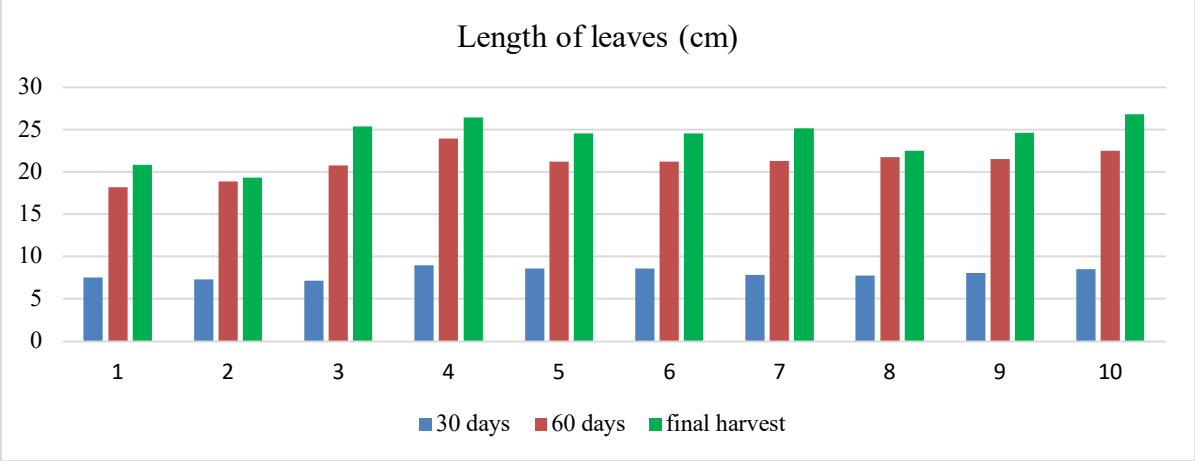


Fig.4: Leaf width (cm) of turnip as influenced by organic manure at various stages of harvesting

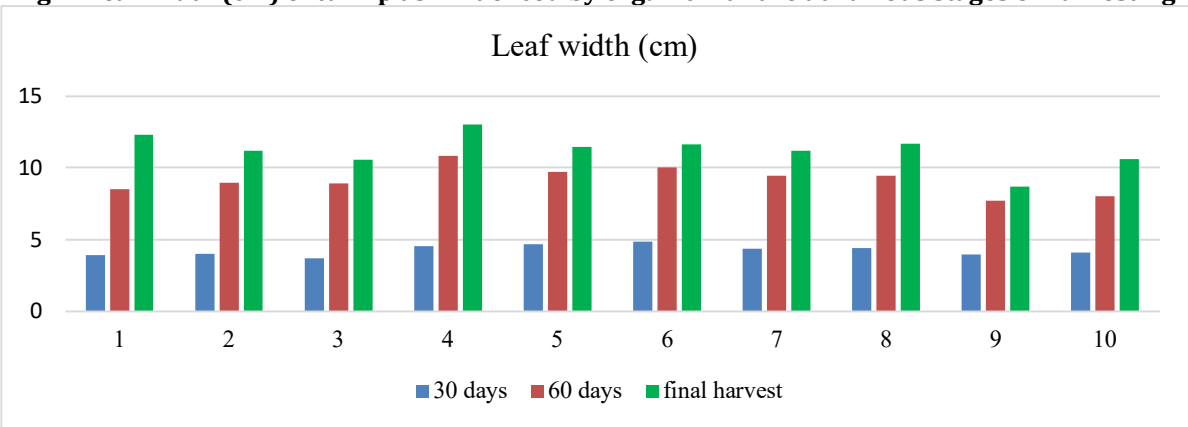


Fig.5: Root length (cm) of turnip as influenced by organic manure at final stage of harvesting

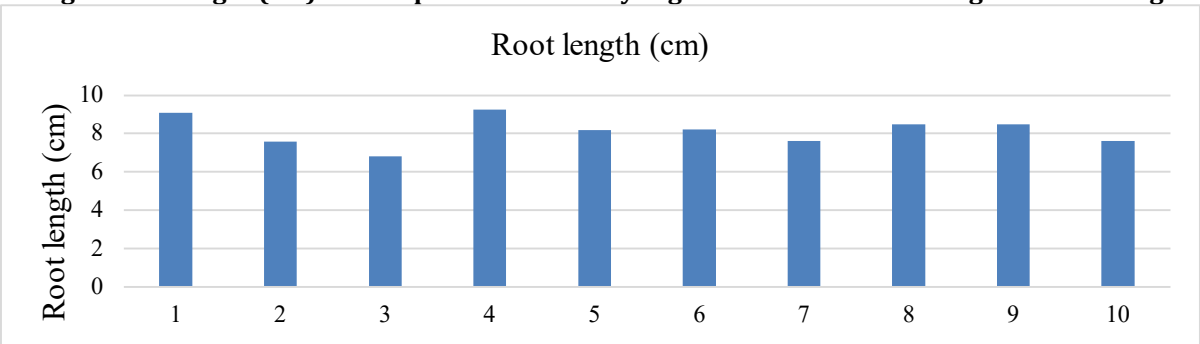


Fig.6: Root diameter (cm) of turnip as influenced by organic manures at final stage of harvesting

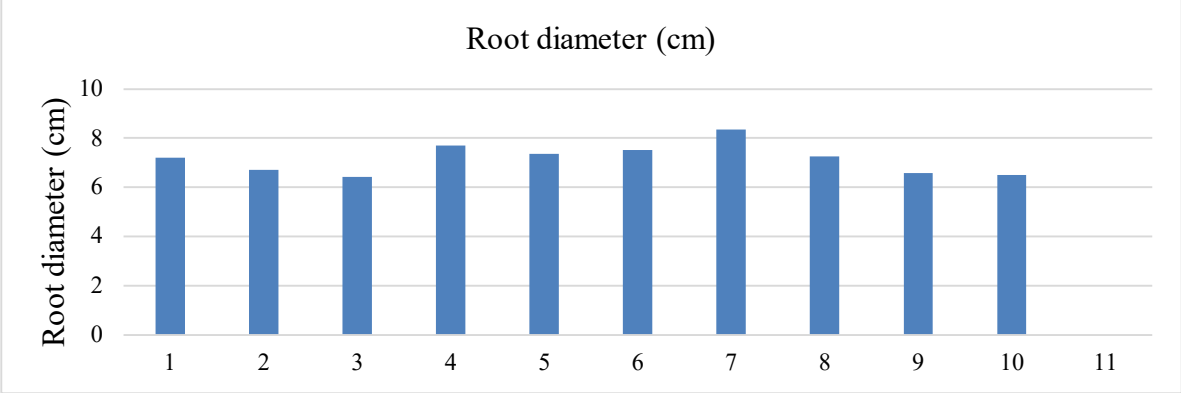


Fig.7: Total fresh weight of plant (g) of turnip as influenced by organic manures at final stage of harvesting

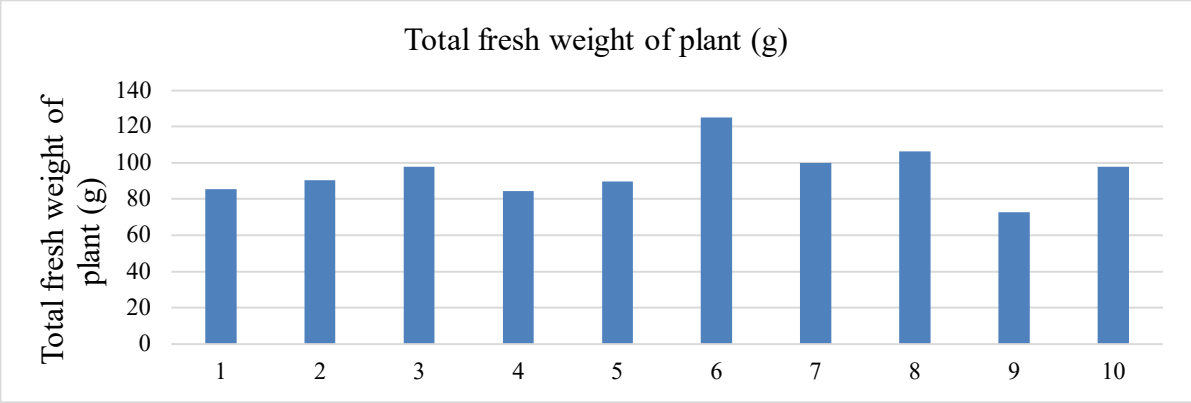


Fig.8: Fresh weight of leaves per plant (g) of turnip as influenced by organic manures at final stage of harvesting

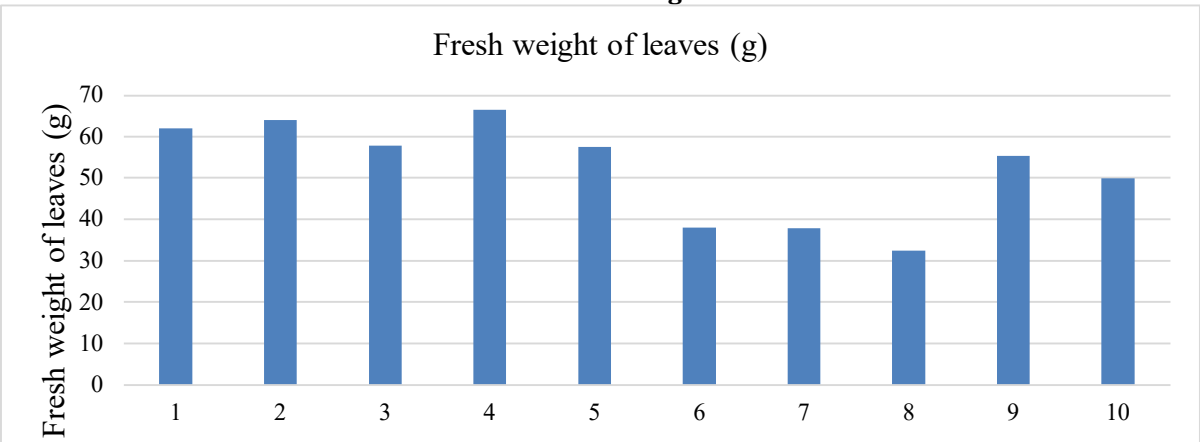


Fig.9: Total Dry Weight of leaves (g) of turnip as influenced by organic manures at final stage of harvesting

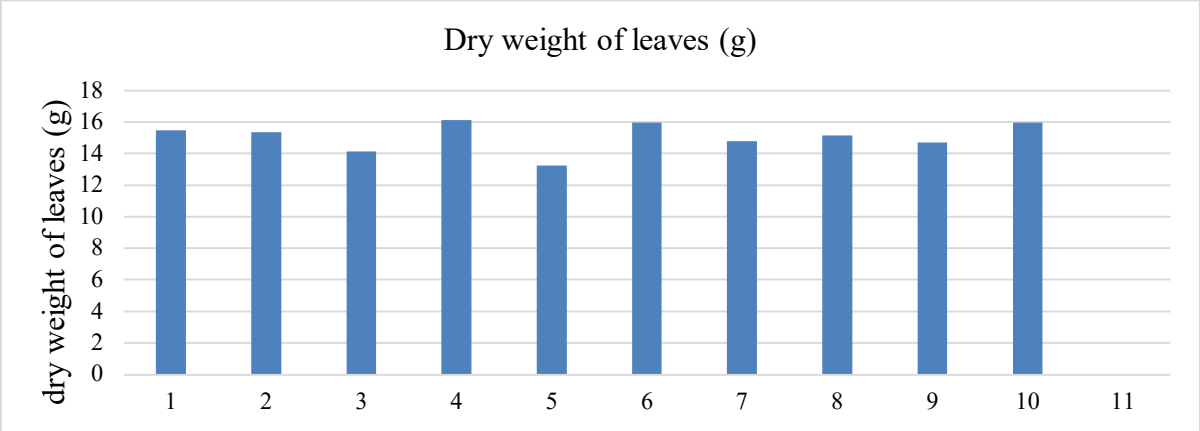


Fig.10: Effect of organic manures on root weight (g) of turnip at final stage of harvesting

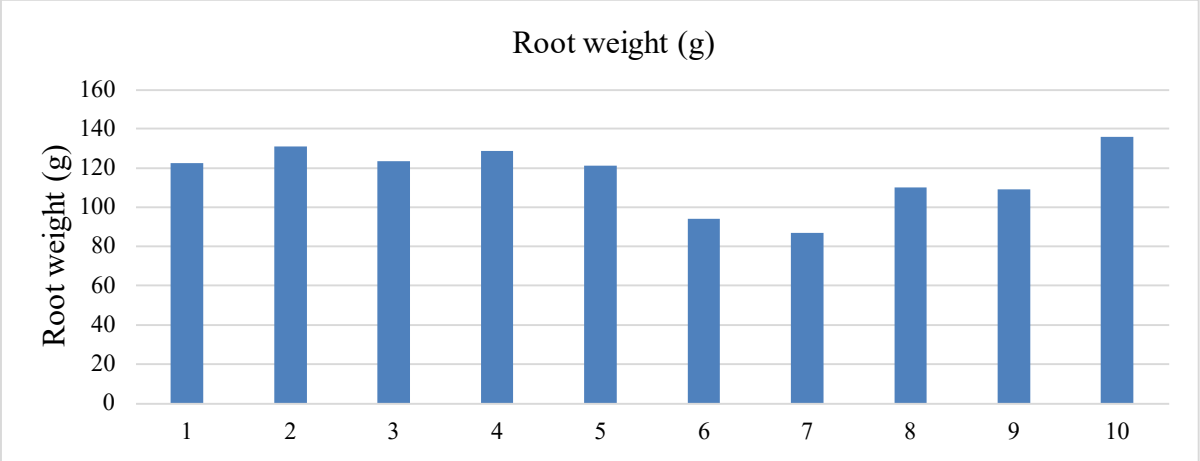


Fig.11: Effect of organic manures on root yield (kg/ha) of turnip at final stage of harvesting

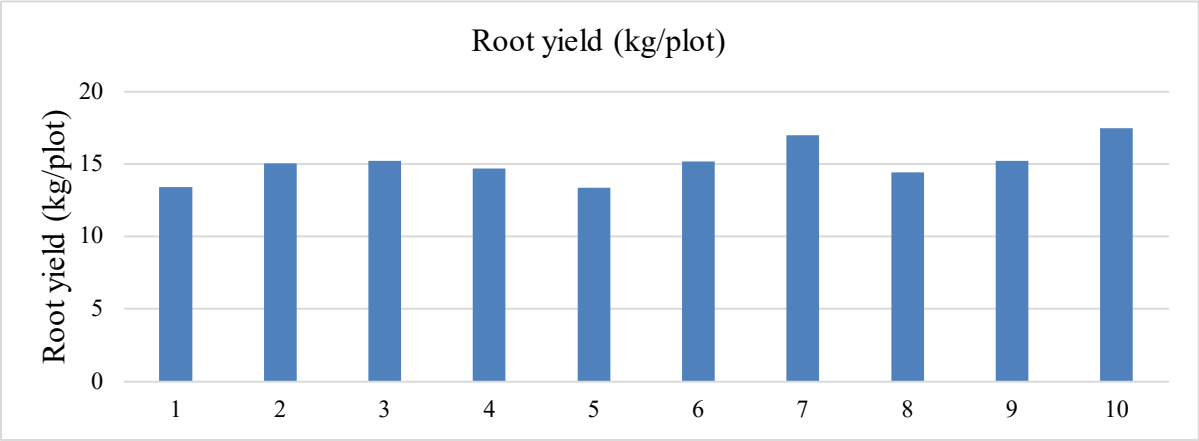
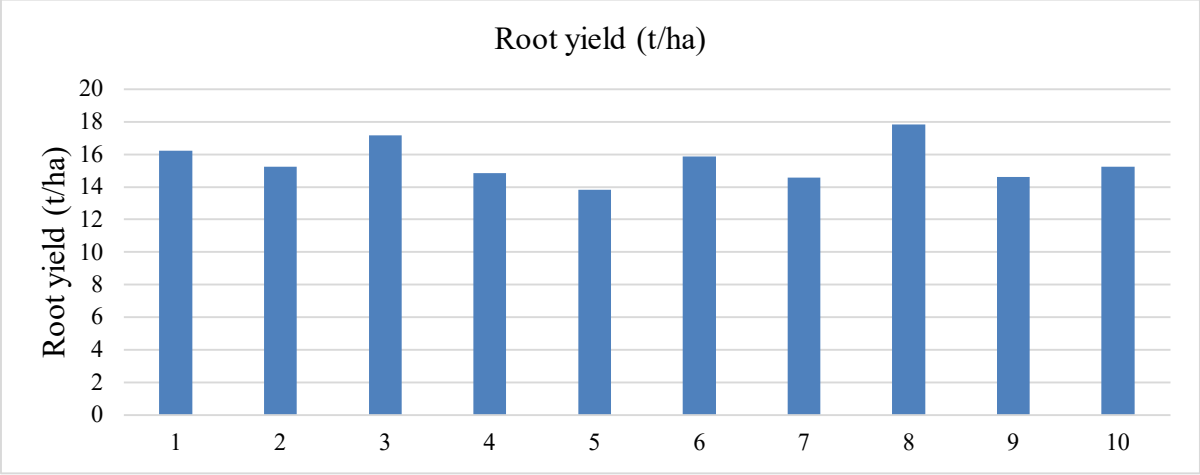


Fig.12: Effect of organic manures on root yield (t/ha) of turnip at final stage of harvesting



T_1 - Control ; T_2- Vermicompost @ 5 tones/ha; T_3 - FYM@ 10 tones/ha
T_4 – Vermiwash @ 50%; T_5 – Cow urine @ 50% ; T_6 – Rhizobium@ 500 ml/ha
T_7 – FYM @ 5 tones/ha + Vermicompost @ 5 tones/ha
T_8 - FYM @ 5 tones/ha + Vermicompost @ 2.5 tones/ha + Vermiwash @ 25 %
T_9 – FYM @ 5 tones/ha + Vermicompost @ 2.5 tones/ha + Vermiwash @ 25 % + Cow urine @ 25%
T_{10} – FYM @ 5 tones/ha + Vermicompost @ 2.5 tones/ha + Vermiwash @ 25 % + Cow urine @ 25% + Rhizobium @ 250 ml

CONCLUSION

On the basis of present investigation on "Expression of Turnip (*Brassica rapa* L.) cultivar Purple Top White Red under the influence of solid and liquid organic manures" it can be concluded that different organic manures with application of Vermiwash 50% at T_4 found to be the most effective treatment for increasing plant height, leaf width, total fresh weight of leaves. The combination of FYM @ 5 tons/ha + Vermicompost @ 5 tons/ha at T_7 found to be most effective to increasing the root diameter and the combination of FYM @ 5 tons/ha + Vermicompost @ 2.5 tons/ha + Vermiwash @ 25 % at T_8 found to be the most effective treatment for increasing number of leaves and yield t/ha. The combination of FYM @ 5 tons/ha + Vermicompost @ 2.5 tons/ha +Vermiwash @ 25 % + Cow-urine @ 25 % + Rhizobium @ 250ml at T_{10} found to be the most effective treatment for increasing leaf length, yield kg/plot and root weight. In the present investigation, supplementation of FYM, Vermicompost along with cow urine and Vermiwash improved soil fertility status which resulted in higher yield performance.

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