International Journal of Plant & Soil Science

Volume 35, Issue 15, Page 265-271, 2023; Article no.IJPSS.101673
ISSN: 2320-7035

Impact of Various Organic Manure and Age of Seedling on Yield and Quality of Hybrid Cabbage (*Brassica oleracea* var. *capitata* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i153105

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/101673

Original Research Article

Received: 09/04/2023
Accepted: 13/06/2023
Published: 14/06/2023

ABSTRACT

An investigation entitled "Impact of Various Organic Manure and age of Seedling on Yield and Quality of Hybrid Cabbage *(Brassica oleracea* var. *capitata* L.*)* under field conditions was conducted in winter season of 2020-2021 and 2021-2022 at Department of Horticulture, Faculty of Agriculture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (U.P.), India. The investigation was laid out in Factorial RBD with eighteenth treatments replicated

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three times with spacing 60×45 cm. The eighteenth treatments combinations were T_1:FYM 0 t/ha + VC 0 t/ha D_1 25th , T_2:FYM 0 t/ha + VC 10 t/ha D_1 25th , FYM 0 t/ha + VC 15 t/ha D_1 25th , T_4:FYM 10 t/ha + VC 0 t/ha D_1 25th , $_5$:FYM 10 t/ha + VC10 t/ha D_1 25th , T_6:FYM 10 t/ha + VC 15 t/ha D_1 25th , T_7:FYM 15 t/ha + VC 0 t/ha D_1 25th, T_8:FYM 15 t/ha + VC 10 t/ha D_1 25th , T_9:FYM 15t/ha + VC15 t/ha D_1 25th, T_{10}:FYM 0 t/ha + VC 0 t/ha D_2 35th, T_{11}:FYM 0 t/ha + VC10 t/ha D_2 35th T_{12}:FYM 0 t/ha + VC 15t/ha D_2 35th, T_{13}:FYM 10t/ha + VC 0 t/ha D_2 35th, T_{14}:FYM 10 t/ha + VC10 t/ha D_2 35th, T_{15}:FYM10 t/ha + VC15 t/ha D_2 35th, T_{16}:FYM 15 t/ha + VC 0 t/ha D_2 35th, T_{17}:FYM 15 t/ha + VC 10 t/ha D_2 35th and T_{18}:FYM 15t/ha + VC 15 t/ha D_2 35thDAT. Among various treatments T1 (RDF) proved to be significantly superior over rest of the treatments as it registered maximum growth parameters. Maximum Net head weight (g), Polar diameter (cm), Equatorial diameter (cm),Whole plant fresh weight in (kg), Gross head yield (t ha^{-1}) and Net head yield (t ha^{-1}), Moisture in leaf, Ascorbic acid (mg/100g) and TSS (^{0}Brix) was obtained in T_{18}:[FYM 15t/ha + VC 15 t/ha D_2 35th], which further improved the yield and quality of cabbage and also gave maximum returns as compared to other combinations.

Keywords: Cabbage; B:C ratio; vermicompost; FYM; age of seedling; yield and quality.

1. INTRODUCTION

"Cabbage *(Brassica oleracea* var. *capitata* L.*)* is one of the esteemed leafy vegetable, which is widely cultivated throughout the globe. The Food and Agriculture organization has identified cabbage among one of the top twenty vegetables" [1]. "India is the second largest producer of cabbage in the world, next to China, accounting for 17.55 per cent of the world area and 13.79 per cent of the world production" (NHB, 2019). "Use of organic manure not only reduces the requirement of chemical fertilizers but also supplements of all essential nutrients to the plants besides improving the soil properties and processes" [2]. "Besides farmyard manure, recently vermicompost has attracted the attention of both researchers and farmers due to its immense production potential and efficient utilization of farm residues" [3]. Sharma and Banik [4] reported that "use of vermicompost enhanced overall soil quality and health parameters. Higher baby corn productivity with greater soil health can be obtained by application of 100% recommended doses of fertilizers with vermicompost". "Many studies report that vermicompost is an excellent soil conditioner and can increase the growth and yield of vegetables such as tomatoes" [5], peppers [6], "However, the effect of vermicompost on the growth and yield is highly variable. The variability may depend on the cultivation system and the characteristics of vermicompost. The physical, chemical and biological characteristics of vermicompost vary depending on the original feedstock, the earthworm species used, the production process, and the age of vermicompost" [7,8,9].

"Nutrient management plays a vital role for the improvement of cabbage yield and production. A remarkable effect on the physiological attributes after the incorporation of organic nutrients especially in the form of vermicompost, farmyard manure, age of Seedling has been noticed in various vegetables. Apparently, inorganic fertilizers impair the crop health due to of residual effect, however, such kinds of issues are not evident in case of organic fertilizer" [10]. "Despite of the balanced use of sole chemical fertilizer, high yield level could not be attained over years due to deterioration in soil physical, chemical and biological properties" [11]. "However, some studies have suggested that excessive use of those agrochemicals may actually aggravate pest problem in the long run" [12].

2. MATERIALS AND METHODS

The field experiment was conducted at the experimental farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Science, Prayagraj during winter season of 2020-2021 and 2021-2022. Prayagraj has subtropical climate, which prevails in the South East part of U.P., with the both extremes of temperature i.e. the winters and the summers. In fairly cold winters (during Oct-Feb), the temperature falls to 3-4^{0}C, sometimes below -1^{0}C. During summer (March-June), the temperature rises upto 45^{0}C, sometimes 47-48^{0}C with low relative humidity (20%) and dust laden winds. During monsoon (June-Sept) 85% of average rainfall of 1100mm with fall in temperature 40-45^{0}C on rainy days in order to work influence of various source of organic manures for obtaining higher head yield of cabbage. The soil of an experimental plot was

sandy loam in texture with pH 7.40, organic carbon (0.40-0.75%), medium in available N (0.28%), available P (16 kg/ha) and available K (175 kg/ha). The experiment was laid in a randomized block design with three replications having 18 treatments comprising different combinations of organic sources *viz.* (FYM – Farm Yard Manure, VC – Vermicompost, D_1 -25 days Age of seedling, D_2 – 35 days age of seedling) T_1:FYM 0 t/ha + VC 0 t/ha D_1 25th , T_2:FYM 0 t/ha + VC 10 t/ha D_1 25th , T_3 :FYM 0 t/ha + VC 15 t/ha D_1 25th , T_4:FYM 10 t/ha + VC 0 t/ha D_1 25th , T_5:FYM 10 t/ha + VC10 t/ha D_1 25th , T_6:FYM 10 t/ha + VC 15 t/ha D_1 25th , T_7:FYM 15 t/ha + VC 0 t/ha D_1 25th, T_8:FYM 15 t/ha + VC 10 t/ha D_1 25th , T_9:FYM 15t/ha + VC15 t/ha D_1 25th, T_{10}:FYM 0 t/ha + VC 0 t/ha D_2 35th, T_{11}:FYM 0 t/ha + VC10 t/ha D_2 35th T_{12}:FYM 0 t/ha + VC 15t/ha D_2 35th, T_{13}:FYM 10t/ha + VC 0 t/ha D_2 35th, T_{14}:FYM 10 t/ha + VC10 t/ha D_2 35th, T_{15}:FYM10 t/ha + VC15 t/ha D_2 35th, T_{16}:FYM 15 t/ha + VC 0 t/ha D_2 35th, T_{17}:FYM 15 t/ha + VC 10 t/ha D_2 35th and T_{18}:FYM 15t/ha + VC 15 t/ha D_2 35thDAT. “Cabbage Pusa hybrid-1was transplanted at 60 × 45 cm spacing done of October and harvested at fully matured stage. Selected and tagged plants were left in the field for head production during winter. All other cultural practices were followed as per standard recommendations. The economics of different cultural practices, input and returns for cabbage variety Pusa hybrid-1 under each treatment combination was worked out to find the most effective and economical treatment. The benefit:cost ratio was calculated with the help of following formula: B:C ratio=Gross return÷Total cost of cultivation. The data were analyzed as per the standard procedure for Analysis of Variance (ANOVA). The difference in the treatment mean was tested by using critical difference (CD) at 5% level of probability” [13].

3. RESULTS AND DISCUSSION

3.1 Yield and Yield Attributes

An examination of data displayed in above Table 1 due to combine use of FxVCxD proved to be significantly effective in Net head weight (g), Polar diameter (cm), Equatorial diameter (cm), Whole plant fresh weight in (kg) and Gross head yield (t ha^{-1}) Net head yield (t ha^{-1}), Moisture in leaf (%), Ascorbic acid (mg/100g) and TSS (^{0}Brix). Further it was highlighted that maximum values i.e. (1458.32, 14.78, 15.17, 2.05, 66.58, 48.61, 90.52, 46.97 and 6.33) was found in treatment T_{18} $F_2VC_2D_2$: FYM 15 t/ha + Vermicompost 15 t/ha + 35 DAT and T6 $F_1VC_2D_1$: FYM 10 t /ha + Vermicompost 15 t/ha + 25 DAT. Where as the minimum number of leaves per plant (846.67, 11.92, 12.30, 1.50, 48.56, 28.22, 28.72 and 4.12) was obtained in treatment T_1:$F_0VC_0D_1$: FYM 0 t /ha + Vermicompost 0 t/ha + 25 DAT. Application of organic manures increased the physical and chemical properties of the soil thereby helping the crop to produce good vegetative growth. Result revealed that integrated application of nutrients by adding organic manures helps in increasing the growth of the crop as well as contributing to soil health properties. The results are similar with the findings of Gupta and Samnotra [14], Yadav et al. [15] and Singh and Singh [16] in cabbage where 25 per cent inorganic fertilizers can be saved without affecting the yield of the crop while at the same time reduced the harmful effects of chemical fertilizers on soil health. “Reason may be young seedlings resumed their growth faster after transplanting than advanced seedlings, as the impact of the transplant shock on them is less compared to seedlings grown at the age of 25 days, and that the speed of cell division and root renewal for these seedlings is faster compared to advanced seedlings” McKee, J. M. T. [17]. While the old seedlings remained for a long time inside the seedling tray before being transferred to the open field, which led to the stop of root growth and the seedlings became more woody and lost their ability to start growing quickly when transplanted in the field] Thompson,H.C. and Kelly,W.C. [18], which negatively affected the vegetative growth. In this connection, Obaid,F.I. [19] Compared to cabbage seedlings planted at age 25, those planted at 35 days showed a considerable improvement in vegetative development characteristics (number of leaves, leaf area dry, weight of the vegetative growth, fresh weight of the plant, and dry weight of the plant).

The data from Table 1 indicated that significant variation was observed in Net head weight (g) of cabbage due to application of different treatments comprising of organic manures. Maximum Net head weight (g) of 1458.32g was recorded in T18 ($F_2VC_2D_2$: FYM 15 t /ha + Vermicompost 15 t/ha + 35 DAT) which was statistically at par with T17 ($F_2VC_1D_2$: FYM 15 t /ha + Vermicompost 10 t/ha+35 DAT). However, the lowest head length was recorded in control treatment (T1) with 846.67g. Similar results were also concluded by Moyin-jesu [20] in their study regarding use of different organic fertilizers in cabbage. Higher Net head weight (g) in T18 i.e.

Table 1. Interaction effect between FYM, vermicompost and age of seedling on growth and yield of cabbage (*Brassica oleracea* var*. capitata* L.)

Treatments	Net head weight (g)	Polar diameter (cm)	Equatorial diameter (cm)	Whole plant fresh weight in (kg)	Gross head yield (t ha^{-1})	Net head yield (t ha^{-1})	Moisture in leaf	Ascorbic acid (mg/100g)	TSS (^{0}Brix)
T_1	846.67	11.92	12.30	1.50	48.56	28.22	81.40	28.72	4.12
T_2	978.41	12.27	12.64	1.61	52.23	32.61	82.54	31.37	4.48
T_3	1043.33	12.34	12.74	1.67	54.19	34.78	82.60	32.39	4.59
T_4	1156.02	12.36	12.76	1.78	57.81	38.53	83.97	33.45	4.70
T_5	1388.04	13.89	14.27	2.00	65.32	46.27	83.97	40.75	5.56
T_6	1384.95	13.98	14.36	2.00	65.15	46.16	83.54	42.02	5.85
T_7	1094.71	12.62	13.00	1.71	55.43	36.49	82.71	34.07	4.75
T_8	1155.24	12.83	13.25	1.76	57.36	38.51	87.99	35.13	4.92
T_9	1289.56	13.45	13.85	1.90	61.80	42.98	89.50	37.25	5.18
T_{10}	1307.24	13.56	13.94	1.91	62.33	43.57	86.64	38.13	5.36
T_{11}	1404.04	14.12	14.52	2.01	65.52	46.80	86.19	42.96	5.89
T_{12}	1417.38	14.21	14.60	2.03	65.93	47.25	85.29	44.11	5.63
T_{13}	1211.92	12.91	13.31	1.81	59.01	40.40	85.86	35.99	5.06
T_{14}	1283.84	13.30	13.68	1.88	61.22	42.79	86.59	36.77	5.14
T_{15}	1336.35	13.62	14.00	1.93	62.93	44.54	86.68	38.98	5.41
T_{16}	1396.06	13.75	14.14	1.99	64.81	46.53	85.90	39.78	5.53
T_{17}	1445.34	14.53	14.91	2.04	66.41	48.18	88.93	45.14	6.31
T_{18}	1458.32	14.78	15.17	2.05	66.58	48.61	90.52	46.97	6.33
F – test	S	S	S	-	S	S	S	S	-
S. Ed. (±)	2.529	0.215	0.063	-	0.488	0.383	0.588	0.587	-
CD=(P=0.05)	5.139	0.438	0.128	-	0.993	0.778	1.195	1.192	-

Table 2. Pooled data in different treatments of Benefit Cost ratio under FYM, vermicompot and age of seedling of cabbage (*Brassica oleracea* var*. capitata* L.)

Treatments	Cost of cultivation (Rs/ha)	Pooled yield (t/ha)	Gross return (Rs/ha)	Net return Rs./ha)	Benefit cost ratio
T_1	75,775.4	48.56	437040	361,265	1:4.77
T_2	84,719.4	52.23	470070	385,351	1:4.55
T_3	88,879.4	54.19	487710	398,831	1:4.49
T_4	80,351.4	57.81	520290	439,939	1:5.48
T_5	86,175.4	65.32	587880	501,705	1:5.82
T_6	90,335.4	65.15	586350	496,015	1:5.49
T_7	81,391.4	55.43	498870	417,479	1:5.13
T_8	87,215.4	57.36	516240	429,025	1:4.92
T_9	91,375.4	61.8	556200	464,825	1:5.09
T_{10}	78,271.4	62.33	560970	482,699	1:6.17
T_{11}	84,719.4	65.52	589680	504,961	1:5.96
T_{12}	88,879.4	65.93	593370	504,491	1:5.68
T_{13}	80,351.4	59.01	531090	450,739	1:5.61
T_{14}	86,175.4	61.22	550980	464,805	1:5.39
T_{15}	90,335.4	62.93	566370	476,035	1:5.27
T_{16}	81,391.4	64.81	583290	501,899	1:6.17
T_{17}	87,215.4	66.41	597690	510,475	1:5.85
T_{18}	88,671.4	66.58	599220	510,549	1:5.76

$F_2VC_2D_2$: FYM 15 t /ha + Vermicompost 15 t/ha+35 DAT can be attributed to the rapid availability of nutrients by inorganic sources which promoted rapid growth, increased leaf size and quality. The results summarized above in respect to Net head weight (g) are closely in consonance with findings reported earlier by Parmar et al*.* [21] and Jha et al*.* [22]. Table 1 describe that the highest value for Equatorial diameter (cm) of cabbage i.e. 15.17 cm was obtained in T18 ($F_2VC_2D_2$: FYM 15 t /ha + Vermicompost 15 t/ha+35 DAT) which remained statistically similar to with T17 ($F_2VC_1D_2$: FYM 15 t /ha + Vermicompost 10 t/ha+35 DAT). Whereas, the lowest head diameter 12.30 cm was observed in T1 i.e. ($F_0VC_0D_1$: FYM 0 t /ha + Vermicompost 0 t/ha+25DAT). The results in respect of Equatorial diameter (cm) are in complete agreement with the findings of Devi et al*.* [23] in cabbage finding market that quality characters of cabbage head was significantly increased with application of FYM and vermicompost. The increase in ascorbic acid content in cabbage might be due to increase in microbial activity of soil which might have added growth regulators, vitamins and hormones to the plants. Similar findings have also been observed by Gupta et al. [24] in onion. "The beneficial effects of organic matter on protein content are also reported due to increased N content in seeds" by Kumar et al*.* [25]. "The increase in protein may also be due to the increased activity of nitrate reductase enzymes which might helped in synthesis of amino acids and protein" [26,27]. The increase in Vitamin-C content in cabbage might be due to increase in microbial activity of soil which might have added growth regulators, vitamins and hormones to the plants. Similar findings have also been observed by Sharma et al*.* [28], Tanwar et al*.* [29] and Mohapatra et al*.* [30].

"On the other hand, in case of organic manures and age of Seedling combinations, the treatment T6 ($F_2VC_2D_2$: FYM 15 t /ha + Vermicompost 15 t/ha + 35 DAT) was found to be more economical as it solved the purpose both ways one being changing the trend of using more organic manures and second being getting higher returns (510,549)" [13,31-34].

4. CONCLUSION

The variety Pusa Hybrid-1 sown in the Rabi seasons of the year, 2021 and 2022 of Prayagraj agro-climatic conditions was determined to be the best, as well as the interaction effect of FYM, Vermicompost, and Age of seedling T18 (Farm yard manure 15 (t/ha) + Vermicompost 15 (t/ha) + 35 Days age of seedling). As a consequence, Pusa Hybrid-1 and these fertilizer-dosed cultivars can be suggested for commercial cultivation in the agro-climatic conditions of Prayagraj.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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