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EFFECT OF ORGANIC MANURES AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF RADISH (*RAPHANUS SATIVUS* L)

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ABSTRACT:- A pot experiment was carried out to check the response of different organic manures and inorganic fertilizers on the growth and yield of radish, at Horticulture Departmental experimental area, Faculty of Agriculture, Gomal University, D.I. Khan. The experiment was laid out in RCD with seven treatments replicated thrice. The treatments included control, farm yard manure (FYM) @ 25 t ha^{-1}, poultry manure (PM) @ 10 t ha^{-1}, goat manure (GM) @ 15 t ha^{-1}, press mud (PrM) @ 20 t ha^{-1}, sewage sludge (SS) @ 20 t ha^{-1} and nitrogen, phosphorus, potassium (NPK) @ 120-65-100 kg ha^{-1}. Data on leaf plant^{-1}, leaf length (cm), fresh leaf weight plant^{-1} (g), dry leaf weight plant^{-1}(g), root length (cm), root diameter (cm), fresh root weight plant^{-1} (g), dry root weight plant^{-1}(g), total biomass plant^{-1} (g), root yield pot^{-1} (g) and root yield (t ha^{-1}) were recorded and analyzed statistically. The results revealed that all growth attributes and yield were significantly enhanced by the application of organic manures and NPK. The highest values were found in NPK treated plants followed by PM, GM, SS, PrM and FYM, respectively.

Key Words: Raphanus sativus; Organic Manures; Inorganic Fertilizers; Growth Parameter; Crop Yield; Yield Components; Pakistan.

INTRODUCTION

Radish (*Raphanus sativus* L.) is an edible root vegetable of the Cruciferae family. It has been used in a variety of culinary preparations since ancient times and is a staple vegetable in many tropical countries. The most commonly eaten portion is the napiform taproot, although the entire plant is edible and the tops can be used as a leaf vegetable. Radish has gained popularity because of its wide use and high nutritive value, as it is an excellent source of carbo-hydrates, protein and Vitamins A & C (Bakhsh et al., 2006).

The high nutritive value of radish has forced farmers to use the chemi-cals in the form of fertilizers and pesticides to increase the yield. These chemicals in turn are deteriorating the soil health and environ-ment. Due to an increase in demand of the leafy vegetables as well as their economic importance in the tropics, it is very common that excessive doses of nitrogen (N) and other inorganic fertilizers are applied to vegetable gardens and fields to attain high yield (Baitilwake et al., 2011 and Stewart et al., 2005). Pervez et al. (2004) repor-ted that on application of N @ 200 kg ha^{-1}and constant doses of P and K (@ 100 and 50 kg ha^{-1} respectively) the radish had maximum plant height (83 cm), root length (38.4 cm), root diameter (4.5 cm) and root yield (16.6

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kg). Bilekudari et al. (2005) were of the view that higher growth and yield parameters were due to greater amount of nutrients (130:55:55 kg NPK ha^{-1}) provided to radish. The higher yield of radish was also recorded by applying higher rates of sewage sludge (SS) application (@ 150 t ha^{-1}). Khan and Khan (2006). Ram et al. (2001) applied various levels of N along with different rates of $ZnSO_4$ and found that length and girth of roots were improved significantly by application of 75 kg N ha^{-1} alone while the root yield was highest (25.021 t ha^{-1}) @ 90 kg N ha^{-1} +20 kg ha^{-1} $ZnSO_4$. Edmeades (2003) and Qin et al. (2005) compared radish produces obtained from organic manures vs inorganic fertilizers application and revealed that organically produced radishes were better in quality and safer from NO_3 accumulation. Panwar et al. (2001) achieved better yields of harvest with the application of N in combination with rhizosphere bacteria. Kezia and David (2013) revealed that inorganic fertilizer had significant impact on the weight and number of leaves of white radish plant. Kumar et al. (2014) suggested that application of poultry manure (PM) (50%) + vermicompost (50%) was found more beneficial for significantly improving growth and yield of radish var. Japanese White.

The present study was conducted to evaluate the effect of organic manures farm yard manure (FYM), poultry manure (PM), goat manure (GM), press mud (PrM), sewage sludge (SS) and chemical fertilizers on the growth and yield of radish.

MATERIALS AND METHOD

A pot experiment was conducted to evaluate the effect of the sole application of different organic manures and NPK on the growth and yield of radish at Department of Horticulture, Faculty of Agriculture, Gomal University, D.I. Khan. The experiment was laid out in CRD with seven treatments repeated five times. The treatments included control (T1), FYM @ 25 t ha^{-1} (T2), PM @ 10 t ha^{-1} (T3), GM @ 15 t ha^{-1} (T4), PrM @ 20 t ha^{-1} (T5), SS @ 20 t ha^{-1} (T6) and NPK @ 120-65-100 kg ha^{-1} (T7). All pots were filled with an equal and uniform amount (20 kg) of river soil along with the calculated amount of pre assigned organic manure FYM @ 250g pot^{-1}, PM @ 100g pot^{-1}, GM @ 150g pot^{-1}, PrM @ 200g pot^{-1}, SS @ 200 pot^{-1}, and NPK (2.609 g urea + 3.421 g SSP + 2.00 g SOP pot^{-1}). A set of pots without any additives (manures and fertilizers) served as control. The required amount of manures were applied well before sowing of seeds (10 days), mineral fertilizers (phosphorus and potash) were applied in the form of Single Super Phosphate (SSP) and Sulphate of Potash (SOP), respectively, at the time of sowing, whereas N was applied in the form of urea in two split doses, first at the time of seed sowing and second a month after. Five seeds of radish (mino early white) were sown on October 20, in the pot (35 cm dia) and then were thinned to two plants at equidistance to avoid plant competition. Pots were irrigated manually and all the cultural practices were conducted as usual. Data regarding leaves $plant^{-1}$, leaf length (cm), fresh leaf weight $plant^{-1}$ (g), dry leaf weight $plant^{-1}$(g), root length (cm), root diameter (cm), fresh root weight $plant^{-1}$ (g), dry root weight $plant^{-1}$(g), total biomass $plant^{-1}$ (g), root yield pot^{-1} (g) and root yield (t ha^{-1}) were recorded and analyzed statistically by com-

puting analysis of variance technique (ANOVA) and means were compared by Duncan's multiple range (DMR) test (Steel et al., 1997).

RESULTS AND DISCUSSION

Number of Leaves Plant^{-1}

Significant variation existed in number of leaves plant^{-1} of radish due to application of different organic manures and inorganic fertilizers (Table 1). Maximum number of leaves plant^{-1} (17.30) was found in plants receiving NPK which differed significantly from all other treatments, followed by PM, GM and SS with 14.62, 13.10 and 11.50 leaves plant^{-1}, respectively and all these differed significantly from each other. Intermediate results were obtained in pot with FYM and PrM producing 10.32 and 9.08 leaves plant^{-1}, respectively. The plants from control pots produced least number of leaves plant^{-1} (7.983). The data indicated that incorporation of manures as well as NPK resulted in greater number of leaves plant^{-1}. NPK fertilizers were more productive due to readily available nutrients as compared to organic manures, which resulted in an increase in vegetative growth of radish. However, manured plants were also superior to control. The increment in number of leaves due to manures was 29.24%, 83.10%, 64.11%, 13.78% and 43.42% with FYM, PM, GM, PrM and SS, respectively, whereas NPK enhanced 116.71% leaves plant^{-1} as compared to control. These results agree with the findings of Baloch et al. (2014) who found significant increase in number of leaves of radish with the sole application of NPK.

Leaf Length (cm)

Leaf length of radish was significantly enhanced by the application of organic manures and NPK (Table 1). The maximum leaf length (23.88 cm) was recorded on application of NPK which differed significantly from

Table 1. Leaves plant^{-1}, leaf length (cm), fresh leaf weight (g) plant^{-1}, dry leaves weight plant^{-1} (g), root length (cm) and root diameter (cm) of radish as affected by different organic manures and NPK

Treatments	Leaves plant^{-1}	Leaf length (cm)	Fresh leaf wt plant^{-1} (g)	Dry leaf wt plant^{-1} (g)	Root length (cm)	Root dia (cm)
T_1: Control	07.98^{g}	11.43^{g}	09.80^{f}	2.79^{f}	12.56^{e}	1.83^{f}
T_2: FYM @ 25t ha^{-1}	10.32^{e}	14.50^{e}	13.10^{e}	3.61^{e}	15.70^{de}	2.18^{e}
T_3: PM @ 10 t ha^{-1}	14.62^{b}	19.75^{b}	24.00^{b}	6.28^{b}	19.17^{b}	2.80^{b}
T_4: GM @ 15 t ha^{-1}	13.10^{c}	18.40^{c}	21.80^{b}	6.00^{b}	18.36^{bc}	2.54^{c}
T_5: PrM @ 20 t ha^{-1}	09.08^{f}	12.87^{f}	16.50^{d}	4.42^{d}	16.45^{d}	2.26^{de}
T_6: SS @ 20 tha^{-1}	11.45^{d}	16.32^{d}	19.95^{c}	5.30^{c}	17.77^{c}	2.43^{cd}
T_7: NPK @ 100-65-100 kg ha^{-1}	17.30^{a}	23.88^{a}	28.00^{a}	7.50^{a}	23.35^{a}	3.69^{a}
LSD Value @0.05	00.49	00.53	03.23	0.67	01.03	0.22

Means followed by similar letter(s) do not differ significantly at 5% level of significance

all other treatments. It was followed by PM, GM, SS, FYM and PrM with 19.75, 18.40, 16.32, 14.50 and 12.67 cm leaves length respectively. All of these treatments varied significantly from each other in enlarging leaves. The shortest leaves (11.43 cm) were found in control plants. The results implied that the increment in leaf length with addition of NPK, FYM, PM, GM, PrM and SS was 108.91%, 26.84%, 72.76%, 60.95%, 12.55% and 42.75%, respectively over control. These results coincide with the previous findings of Islam et al. (2011) who found maximum leaf length in radish when NPK was used, as the plants received more readily available applied nutrients, which might had increased the vegetative growth and leaf length in radish. Similar results were also reported by Hasan and Solaiman (2012) stating an increase in cabbage leaf length, when inorganic fertilizers were used.

Fresh Leaf Weight Plant^{-1} (g)

Sole application of organic manures and NPK significantly affected the fresh leaf weight plant^{-1} of radish (Table 1). The significantly highest fresh leaf weight plant^{-1} (28.00 g) was recorded in NPK which varied significantly from all other treatments. It was followed by PM and GM with 24.00 and 21.80 g plant^{-1} respectively and both were statistically at par. These were succeeded by SS, PrM and FYM with 19.95, 16.50 and 13.10 g fresh leaf weight plant^{-1} respectively. However, all these three treatments differed significantly from each other. The lowest fresh leaf weight (9.80 g) was found in check plants. The data indicated that application of organic manures as well as NPK significantly increased the fresh leaf weight plant^{-1} of radish. The application of FYM, PrM, SS, GM and PM increased fresh leaf weight by 33.67%, 68.36%, 103.57%, 122.44% and 144.89% respectively, over control. The differ-ence in leaf weight due to application of different manures differed in nu-trients contents and their efficiency in enhancing leaf weight. However, the application of NPK enhanced leaf weight by 185.71% over control which was considerably greater than organic manures. The presence of adequate amount of NPK might be the major cause of enhancing the soil fertility level which promoted plant growth thus causing an increased leaf weight plant^{-1}. The enhancements in growth parameters of radish were also reported by the application of NPK (Hussain et al., 1997 and Baloch et al., 2014).

Dry Leaf Weight Plant^{-1}

Sole application of organic manures and NPK significantly affected the dry leaf weight plant^{-1} of radish (Table 1). Similar pattern of results were recorded for dry leaf weight plant^{-1} as was reported for fresh leaf weight plant^{-1}. Maximum dry leaf weight plant^{-1} (7.50 g) was recorded in NPK that varied statistically from all other treatments. It was followed by PM and GM with 6.28g and 6.00 g respectively and both treatments were statistically identical. Similarly SS, PrM and FYM were significantly at par with 5.30g, 4.42g and 3.61 g dry leaf weirgt plant^{-1}respectively. The plants from control had produced minimum dry leaf weight (2.79 g). The sole application of FYM, PrM, SS, GM and PM increased 29 %, 58 %, 90 %, 115 % and 125%, dry leaf weight^{-1} respectively while the

application of NPK alone increased 169 % weight of dry leaf as compared to control. The effectiveness of NPK was obvious due to greater nutrients content and their readily availability. Our results agree with the findings of Hussain et al. (1997), Asghar et al. (2006) who reported a significant increase in the weight of leaves plant^{-1} with the application of manures and chemical fertilizers in radish.

Root Length (cm)

Root length differed significantly due to application of manures and chemical fertilizers (Table 1). The longest roots (23.35 cm) were registered in plants receiving NPK that varied significantly from all other treatments. Amongst manures, PM surpassed all others in enlarging the radish roots (19.17 cm), followed by GM with 18.37 cm long roots and both were significantly alike. Pots treated with GM in turn were statistically at par with SS with root length of 17.77 cm. The FYM amended plants produced the shortest roots (15.70 cm) amongst the manures used, followed by PrM with 16.45 cm long roots. The significantly shortest roots (12.56 cm) were recorded in control plants. The results indicated significantly positive effects of manures and fertilizers on root length. The response of NPK was more pronounced compared to organic manures, which might be due to the proper supply of nutrients creating favorable nutritional conditions for better radish root growth and development (Islam et al., 2011). Almost 24.97%, 52.55%, 46.-19%, 30.94% and 41.42% increase in root length were recorded by the application of FYM, PM, GM, PrM and SS, respectively, as compared to control whereas the enhancement in root length with NPK was 108.91%. Similar results was reported Asghar et al., (2006), Islam et al., (2011) and Baloch et al., (2014) who also found longer roots in radish which were applied 100% recommended dose of inorganic fert-ilizer as compared to control.

Root Diameter (cm)

The data revealed that significantly highest root diameter (3.69 cm) was observed in plants amended with NPK that differed significantly from all other treatments (Table 1). Amongst manures, PM superseded all the other manures used, with 2.80 cm root diameter succeeded by GM and SS possessing 2.54 cm and 2.43 cm root diameter and both treatments were statistically at par. The SS in turn was significantly similar to PrM with 1.73 cm root diameter. The FYM treated plants possessed 1.93 cm root diameter, which was statistically lowest among manured treatments. The significantly lowest root diameter (1.83 cm) was found in control plants that differed significantly from all other treatments. The results suggested that root diameter of radish was significantly enhanced by the application of different organic manures and NPK. The increment of root diameter with the application of FYM, PM, GM, PrM, SS and NPK was 19.34%, 53.15%, 39.01%, 23.56%, 33.09% and 101.81%, respectively over control. The organic manures were less efficient than NPK fertilizers, which might be due to low nutrient contents and their slow release, probably for delayed decomposition. Among manures PM proved superior followed by GM, SS and PrM while FYM was the least effective. These results were supported by

Hussain et al. (1997), Ram et al. (2001) and Kapourchal et al. (2009) who reported considerable increase in diameter of roots of radish due to addition of organic manures and inorganic fertilizers.

Fresh Root Weight Plant^{-1} (g)

It was significantly affected by the application of different organic manures (FYM, PM, GM, PrM, SS) and mineral fertilizers (NPK) (Table 2). The maximum fresh root weight plant^{-1} (203.62 g) was recorded in NPK that differed significantly from all other treatments. It was succeeded by PM, GM and SS with 155.86, 147.74 and 144.72 g fresh root weight plant^{-1}, respectively, where PM produced significantly greater fresh root weight than GM and SS, which were significantly similar. Application of FYM recorded statistically lowest fresh root weight plant^{-1} (113.73 g) amongst the manures followed by PrM with 128.67 g root weight plant^{-1}. The significantly minimum fresh root weight (73.50 g) was noticed in control plants that differed significantly from all other treatments. The data indicated that incorporation of recommended dose of NPK and manures significantly improved fresh root weight of radish. The results revealed that addition of NPK recorded greatest fresh root weight as compared to organic manures. The reason may be the greater amount of readily available nutrients in NPK and their uptake which might have enhanced fresh root weight of radish. The application of manures enhanced root weight by 54.73%, 75.10 %, 96.89 %, 101.0 % and 112.0 % with FYM, PrM, SS, GM and PM, respectively, as compared to control while the increment in roots weight with NPK was 177.03%. The variation in root weight due to different manures application indicated that manures varied in nutrient contents and their efficacy of enhancing root weight. The manure containing greater nutrient contents produced higher root weight. Among different manures, PM proved superior, followed by GM which was at par with SS succeeded by PrM and FYM. These results are in agreement with those of Tennakoon and Bandara (2003) who reported that animal manures vary in nutrient contents. Significant variation in nutrients availability of different organic sources was noted by Lester (2006). Hussain et al. (1997) recorded increased root weight of radish with various levels of N alone and in combination with constant doses of P and K while Ram et al. (2001) found significant improvement in radish root weight with different levels of N.

Dry Root Weight Plant^{-1} (g)

Similar trend of results were observed for dry root weight plant^{-1} as was recorded for fresh root weight plant^{-1}. The significantly highest dry root weight plant^{-1} (12.00 g) was recorded in plants amended with NPK that varied significantly from all other treatments (Table 2). Amongst manures, PM recorded significantly highest dry root weight plant^{-1} (10.10 g) followed by GM and SS with 8.80 and 8.60 g and both these treatments (GM and SS) were statistically identical. Statistically significant results were also recorded in PrM and FYM which produced dry root weight plant^{-1} of 7.65 and 7.00 g, respectively. The minimum dry root weight plant^{-1} (4.56 g) was found in control plants. The sole application of PM,

GM, SS, PrM and FYM increased dry root weight by 121.49%, 92.98%, 88.59%, 67.76% and 53.50%, respectively, whereas application of NPK alone enhanced dry root weight by 163.15% over control which was greater than all organic manures. Inorganic source of nutrients was more effective as compared to organic sources due to the readily available nutrients. These results are in agreement with the findings of Hussain et al. (1997), Khan and Khan (2006) and Ram et al. (2007) who reported significant improvement in dry root weight of radish with the application of recommended rates of NPK and organic manures.

Total Biomass Plant^{-1} (g)

Total biomass plant^{-1} included root weight with leaves weight of radish. Total Biomass plant^{-1}of radish was significantly affected by incorporation of organic manures as well as NPK (Table 2). The significantly highest biomass plant^{-1} (231.-62 g) was recorded in plants amended with NPK that differed significantly from all other treatments. It was succeeded by PM, GM, SS, PrM and FYM treated plants with 179.86 g, 169.54 g, 164.67 g, 145.17 g and 12-6.83 g biomass plant^{-1}, respectively. However, all manures varied significantly from each other. The significantly lowest biomass (83.29 g plant^{-1}) was observed in control. It can be inferred from the results that sole incorpo-ration of inorganic fertilizers (NPK) and organic manures considerably enhanced the total biomass plant^{-1} of radish. The effectiveness of NPK was pronounced due to their greater nutrient contents and steady availability. PM surpassed all the other manures which was followed by GM, SS, PrM and FYM suggesting that PM and GM supplied more nutrients to crops while FYM provi-ded the least. Incorporation of

Table 2. Fresh root weight plant^{-1} (g), dry root weight plant^{-1} (g), total biomass plant^{-1}(g), root yield pot^{-1}(g)and root yield (t ha^{-1}) of radish as affected by different organic manures and NPK

Treatments	Fresh root wt plant^{-1} (g)	Dry root wt plant^{-1} (g)	Total biomass plant^{-1} (g)	Root yield pot^{-1} (g)	Root yield (t ha^{-1})
T1: control	073.5^{f}	04.56^{f}	83.29^{g}	184.17^{g}	18.42^{g}
T2: FYM @ 25 tha^{-1}	113.73^{e}	07.00^{e}	126.83^{f}	289.00^{f}	28.90^{f}
T3: PM @ 10 tha^{-1}	155.86^{b}	10.10^{b}	179.86^{b}	379.00^{b}	37.90^{b}
T4: GM @ 15 tha^{-1}	147.74^{c}	08.80^{c}	169.54^{c}	366.67^{c}	36.67^{c}
T5: PrM @ 20 tha^{-1}	128.67^{d}	07.65^{d}	145.17^{e}	302.60^{e}	30.26^{e}
T6: SS @ 20 tha^{-1}	144.72^{c}	08.60^{c}	164.67^{d}	322.00^{d}	32.20^{d}
T7: NPK @ 120-65-100 kg ha^{-1}	203.62^{a}	12.00^{a}	231.62^{a}	463.33^{a}	46.33^{a}
LSD Value @0.05	006.28	00.30	003.21	007.38	01.15

Means followed by similar letter(s) do not differ significantly at 5% level of significance
Control = Check treatment, FYM = Farm Yard Manure, PM = Poultry Manure
GM = Goat Manure, PrM = Press Mud, SS = Sewage Sludge, NPK = 120 kg N + 65 kg P + 100 kg K

FYM, PM, GM, PrM and SS increased 52.28%, 115.95%, 103.55%, 74.29% and 97.71% biomass plant^{-1} as compared to control plant respectively, whereas NPK increased 178.09% total biomass plant^{-1} over check. These results are in line with the findings of Baloch et al. (2014) who reported maximum total biomass plant^{-1} when NPK @ 150-75-100 were applied for radish.

Root Yield Pot^{-1} (g)

Significant variations were observed in root yield pot^{-1} of radish with different organic manures and NPK (Table 2). The significantly highest root yield pot^{-1} (463.33 g) was obtained with NPK amended plants that differed significantly from all other treatments. It was followed by PM, GM, SS, PrM and FYM yielding 379.00 g, 366.67 g, 322.00 g, 302.60 g and 289.00 g roots pot^{-1}, respectively and all treatments varied significantly from each other. The lowest root yield pot^{-1} (184.17 g) was received from control plants. The results indicated that root yield pot^{-1} of radish was substantially increased by the incorporation of organic manures and inorganic fertilizers (NPK). The sole application of NPK, FYM, PM, GM, PrM and SS produced 151.58%, 56.92%, 105.79%, 99.09%, 64.30% and 69.61% more root yield pot^{-1} as compared to control. The higher yield recorded in NPK treated plants might be due to greater and readily available nutrients while manures possessed lesser amount of nutrients as compared to NPK and the release of nutrients from organic manures was also slow due to decomposition. This is why generally high amount of inorganic fertilizers are used for vegetable to get maximum yield (Sewart et al. 2005). Among manures, PM and GM surpassed others in enhancing root yield pot^{-1}. These results are in line with the findings of Hussain et al. (1997), Ram et al. (2001), Tennakoon and Bandara (2003), Lester (2006) and Kapourchal et al. (2009) who reported considerable increase in root yield of radish with the incorporation of recommended rates of NPK and manures.

Root Yield (t ha^{-1})

Radish yield was considerably increased due to the application of organic manures and NPK (Table 2). The maximum root yield (46.33 t ha^{-1}) was achieved from plants amended with NPK that differed significantly from all other treatments. It was succeeded by PM, GM and SS with root yield of 37.90 t ha^{-1}, 36.67 t ha^{-1} and 32.20 t ha^{-1}, respectively, and all the three treatments differed significantly. The application of FYM yielded the lowest root yield (28.90 t ha^{-1}) amongst manures. However, the minimum root yield (18.42 t ha^{-1}) was obtained from check plants. The results illustrated that root yield (t ha^{-1}) of radish was substantially boosted by the sole application of organic and NPK. The increment in root yield due to incorporation of FYM, PM, GM, PrM, SS and NPK over control was 56.92%, 105.79%, 99.09%, 64.30%, 69.41% and 151.58%, respectively. The application of NPK proved superior in improving radish root yield. Amongst manures, PM surpassed all manures in enhancing root yield which was followed by GM.

It is concluded from the study that application of organic manures and inorganic fertilizers considerably improved the growth and yield of radish. The incorporation of inorga-

nic fertilizers (NPK) recorded the highest values for all the growth and yield parameters studied for radish. Amongst the different organic manures used, PM and GM produced better results as compared to SS, PrM and FYM for radish growth and yield. These results need further confirmation as the present findings are based upon one year data.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

S.No	Author Name	Contribution to the paper
1.	Ms. Mehwish Kiran	Concived the idea, Wrote Abstract, Introduction Data collection
2.	Mr. Muhammad Saleem Jilani	Supervised the Research Work
3.	Mr. KashifWaseem	Data entry in SPSS and analysis
4.	Mr. Muhammad Sohail	Technical input at every step

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