Research Article

Integrated use of Organic and Inorganic Fertilizers on the Growth and Yield of Radish

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Abstract | Two year research trials were designed to check the enhancing effect of NPK with various organic manures on radish production at Agricultural Faculty, Gomal University, D.I.Khan, during 2011-13. Experiments were conducted in pots using completely randomized design, comprising 6 treatments (control, NPK + FYM, NPK + PM, NPK + GM, NPK + PrM and NPK + SS) and 3 replications. Data for leaves' count plant^{-1}, leaf length (cm), leaves weight (g plant^{-1}), root size (length & diameter), root weight (g plant^{-1}), total biomass (g plant^{-1}), root yield (t ha^{-1}) were collected and analysed. Results showed significant improvement in almost all studied parameters with the application of NPK and different organic manures. Highest mean data for all the parameters studied were recorded in NPK + PM, as maximum leaves' count (21.67 and 22.33 plant^{-1}), leaf length (32.20 and 38.33 cm), leaves weight (66.00 and 63.67 g plant^{-1}), root length (29.87 and 29.37 cm), root diameter (4.01 and 3.83 cm), root weight (285.00 and 274.00 g plant^{-1}), total biomass (351.00 and 337.67 g plant^{-1}) and root yield (80.42 and 77.80 t ha^{-1}) were produced in it both the years, respectively. It was trailed by NPK + GM and NPK + SS amongst all the other treatments used.

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Introduction

Radish (*Raphanus sativus*) is a vital edible root vegetable of the Cruciferae family. It is usually grown for its young tenderous root, either used as raw in salads or in pickles. It contains mustard oils which give it pungency. It may be grown as a cool-season annual crop when sown in the spring and early summer or as a biennial if sown in fall. Its easy cultivation approaches and wide-ranging climatic variations and uses might be the reasons for its popularity (Shrestha and Shakya, 2004).

In Pakistan, it is an important income generating vegetable crop, as it yielded as an average production of 16.166 t/ha, whereas, in KPK province, it yielded an average production of 16.116 t/ha during 2011-12. Average yield of radish in Pakistan is far less as compared to its potential (Anonymous, 2013). Amongst several elements accountable for radish low production, proper nutrient application is of key importance for sustaining higher crop yield and soil

richness. Application of fertilizers by farmers without information on soil- fertility status and crop nutrient requirement affects both the soil and the crop adversely (Ray et al., 2000). Maximum yield cannot be 0btained by the optimum use of chemical fertilize only due to non-availability of suitable soil and favourable environment for many years (Khan et al., 2008). The rising amounts of inorganic fertilizers and its negative effect on human health, soil structure and texture and environment insisted the farmer to apply integrated plant nutrient that increase the fertility of soil and yield of crops (Sentiyangla et al., 2010). Other than chemical fertilizers, many organic material such as FYM, mustard oil cake, vermicompost, poultry manure and bio-slurry are composed of many plant nutrients which improve soil physical and chemical properties that are necessary for plant (Synman et al., 1998. Variable responses of manures and inorganic fertilizers have been observed on the performance of radish. Heavy metal accumulation was reported in radish roots with the usage of sewage sludge ((Pathak and Joshi, 2001; Gaspar and Anton, 2002; Ghafoor, 2004; Bigdeli and Seilsepour, 2008) while Khan and Khan (2006) recorded higher yields of radish with higher rates of SS (150 t ha^{-1}). Edmeades (2003) revealed that organically produced radishes were better in quality and safer from NO3 accumulation whereas Dong et al. (2005) reported that the usage of poultry, chicken and pig manure resulted in better quality radishes which contained lesser heavy metals and were safer for health. Noor et al. (2007) received highest yield of radish by the usage of 75% PM+ RDF at 5.0 t/ha. Sharma et al. (2012) achieved excellent yield of radish with ½ RDF+ vermicompost while Khan (2010) recommended optimum rate of PM (5 t ha^{-1}) along with 50-75% RDF of chemical fertilizers for higher and profitable production of radish. Sentiyangla et al. (2010) observed that a combined application of organic manures, NPK and vermicompost had significantly enhanced radish development and production, as it yielded maximum root yield (534.66 q ha^{-1}) with net returns (Rs.77,932/-). Kiran et al. (2016a) revealed that all the growth and production parameters were considerably enhanced by the application of organic manures and NPK. However, maximum leaves/plant, tallest leaves, leaf weight, root length, diameter and yield was observed in NPK treated plots for carrot and radish (Kiran et al., 2016b). Shah et al., (2018) recorded maximum radish plant height, leaves/plant, root length, diameter and yield per hectare with the combined application of NPK 50% along with poultry manure. Highest values for the parameters regarding radish growth and production were recorded when vermicompost (12.5 t/ha) + Azospirllum (5 kg ha) + Humic acid (0.2% ha) were used (Jaisankar, 2018).

The basic principle underlying in integrated nutrient managements is to supply all the basic nutrients required for achieving the optimum crop yield. The basic motive of INM is to minimize chemical fertilizer usage, more efficient use of nutrients, restoring soil organic matter and improve the soil qualities. Therefore, the present study was designed to evaluate the potential of integrated use of chemical fertilizer (NPK) along with various organic manures (FYM, PM, GM, PrM, SS) for improving radish production.

Materials and Methods

These experiments were carried out in pots to check the enhancing effect of NPK with various organic manures on radish production at Agricultural Faculty, during 2011-13. Two year experiments were conducted using completely randomized design, comprising 6 treatments (with no fertilizer added), (100% NPK + 50% FYM), (100 % NPK + 50% Poultry manure), (100% NPK + 50 % Goat manure), (100 % NPK + 50 % Press mud) and (100% NPK + 50% sewage sludge). In each experiment, the treatments were replicated three times. Equivalent and constant amount (20kg) of sandy loam soil along with the pre assigned combination of NPK along with various organic manure were used to fill up the pots. Required amount of manures was applied well before sowing of seeds (10 days) whereas mineral fertilizers (Phosphorus and Potash) were added as single superphosphate (SSP) and sulphate of potash (SOP), respectively, at seed sowing time. Whereas Urea (nitrogen source) was incorporated in two divided doses, firstly at seed sowing time and secondly one month after seed sowing. Five seeds of radish (cv. Mino early) were seeded in assigned pots (35 cm diameter) in October (second week) and after the seed emergence they were thinned to two plants to avoid plant competition. Regular irrigation was given to pots and all other cultural practices were conducted as usual. Results for leaves' count/plant, leaf length (cm), leaves weight/plant (g), root size (length and diameter), root weight (g),

total biomass/plant (g) and root yield (t/ha) were collected. A computer software "MSTATC" was used to analyse the data, following the procedure given by Steel et al. (1997).

Results and Discussion

Leaves count plant^{-1}

Leaves' count plant^{-1} was considerably affected by the combined use of NPK and different organic manures of radish (Table 1). During 2011-12, all integrated treatments produced significantly similar number of leaves plant^{-1}, which varied statistically from control. During 2012-13, similar leaf count (22.33) was observed in NPK + GM, NPK +PrM, NPK + SS and NPK + FYM, while 21.33 leaves were counted in T5 (PrM + NPK) that varied considerably from other integrated treatments. Lowest leaves' count (8.50 and 7.47 plant^{-1}) was found in control pots during both the years that contrasted considerably from all other treatments (Figure 1). Parallel outcomes were quoted by Chapagain et al. (2010) and Kumar et al. (2017) reporting an increase in number of leaves in radish under NPK along with organic manure was used.

These results clearly depicted that integrated usage of NPK+ organic manures considerably boosted leaves count plant^{-1}; this might be attributed to availability of balanced nutrition to the growing crop that enhanced leaves' count (plant^{-1}). The addition of NPK along with organic manures increased 146.3% to 154.9% leaves' count plant^{-1} during 2011-12 and 185.7% to 199.1% in 2012-13, as compared to control, Kamalakannan and Manivannan (2002); Asghar et al. (2006); Sentiyangla et al. (2010); Sharma et al. (2012) and Khalid et al. (2016) also reported an increment in leaves' count (plant^{-1}) when a combination of NPK along with various manures were used.

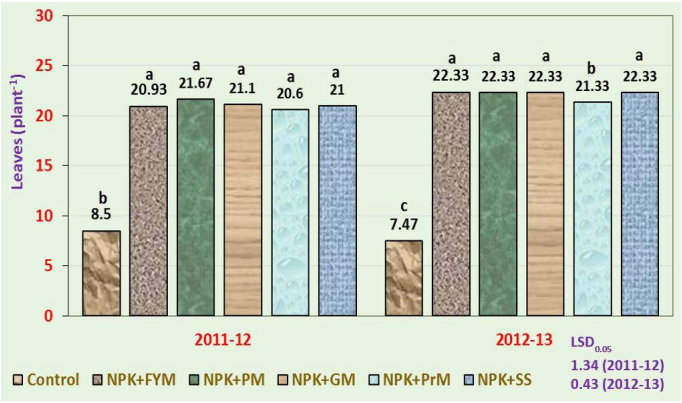

Figure 1: *No. of leaves (plant^{-1}) of radish as affected by NPK in combination with different organic manures.*

Leaf length (cm)

Combined application of NPK with different organic manures significantly enhanced the leaf length of radish during both the years (Table 1). During 2011-12, all integrated treatments produced leaves of statistically identical length but differed significantly from control. In 2012-13 year, that longest leaves (38.33 cm) were found in plants amended with NPK+ PM and NPK+GM succeeded by NPK+SS with 37.67 cm long leaves, correspondingly. These were followed by NPK+FYM and NPK+PrM, which differed statistically. Control plants exhibited the shortest leaf length (11.67 and 11.20 cm) both the years, respectively and they varied considerably from all other treatments (Figure 2).

Results exhibited that use of NPK along with different organic manures profoundly enhanced the length of leaves. During 2011-12, all integrated treatments were equally effective while in 2012-13, NPK+PM was most productive and NPK+PrM was least effective while NPK+GM, NPK+SS and NPK+FYM were intermediate in enlarging leaves of radish. Comparing to control treatment, combination of NPK along with organic manures increased leaves length by 170.0% to 176.0% in 2011-12 and 217.3% to 242.3% during 2012-13. Our results are in agreement with previous outcomes of Shah et al. (2016) who too testified an increment in leaf length when NPK along with PM was used in onion. Similarly, Kamalakannan and Manivannan (2002) and Asghar et al. (2006), Khalid et al. (2016) and Kumar et al. (2017) found considerable improvement in radish leaf length when organic manures were supplemented with chemical fertilizers.

Leaf weight plant^{-1} (g)

Data concerning leaf weight plant^{-1} exhibited significant differences, both the years (Table 1). The leaf weight plant^{-1} ranged from 11.33 to 66.00 g during 2011-12 and 10.33 to 63.67 in 2012-13. Significantly highest leaf weight plant^{-1} (66.00 and 63.67 g) were recorded in NPK+PM followed by NPK+ GM with 64.80 and 62.67 g, during both the years, respectively and both these treatments behaved alike. During 2011-12, NPK+GM produced 64.8 g leaf weight plant -1, which did not differ significantly from NPK+SS (63.67 g) which was also statistically similar to NPK+ FYM, which produced 62.00 g leaf weight. The smallest leaf weight (60.67 g) was observed in NPK+ PrM among integrated treatments, which was significantly similar to NPK+ FYM. During 2012-13, NPK+ GM

Table 1: *Leaves plant^{-1}, leaf length (cm) and leaf weight plant^{-1} of radish as affected by NPK along with different organic manures for two consecutive years.*

Treatments	Leaves plant^{-1}		Leaf length (cm)		leaf weight plant^{-1}	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_1: Control	8.50 b	7.47 c	11.67 b	11.20 d	11.33 e	10.33 e
T_2:100% NPK + 50% FYM	20.93 a	22.33 a	31.75 a	36.47 b	62.00 cd	56.67 c
$T_3$100% NPK + 50% PM	21.67 a	22.33 a	32.20 a	38.33 a	66.00 a	63.67 a
$T_4$100% NPK + 50%GM	21.10 a	22.33 a	32.00 a	38.33 a	64.80 ab	62.67 ab
$T_5$100% NPK + 50% PrM	20.60 a	21.33 b	31.50 a	35.53 c	60.67 d	54.33 d
$T_6$100% NPK + 50% SS	21.00 a	22.33 a	31.93 a	37.67 a	63.67 bc	61.00 b
LSD @ $P_{0.05}$	1.349	0.435	1.410	0.724	1.884	2.292

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

Table 2: *Root length (cm), root diameter (cm), root weight plant^{-1} (g) of radish as affected by NPK along with different organic manures for two consecutive years.*

Treatments	Root length (cm)		Root diameter (cm)		Root weight plant^{-1}	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
T_1: Control	13.03 d	12.09 d	1.45 b	2.20 b	62.00 c	82.90 d
T_2:100% NPK + 50% FYM	25.47 c	27.20 c	3.87a	3.63 a	276.67 b	260.00 c
$T_3$100% NPK + 50% PM	29.87 a	29.37 a	4.01 a	3.83 a	285.00 a	274.00 a
$T_4$100% NPK + 50%GM	27.20 b	28.63 b	3.97 a	3.70 a	282.37 ab	266.00 b
$T_5$100% NPK + 50% PrM	26.03 c	27.35 c	3.91 a	3.63 a	274.67 b	260.20 c
$T_6$100% NPK + 50% SS	27.00 b	28.27 b	3.95 a	3.67 a	278.67 ab	264.67 b
LSD @ $P_{0.05}$	0.739	0.531	0.289	0.220	8.175	2.820

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

was also statistically identical to NPK+ SS resulting 61.00 g leaf weight plant^{-1}. It was succeeded by NPK + FYM and NPK + PrM producing 56.67 and 54.33 g leaf weight/plant, accordingly. For both the years, minimum leaf weight plant^{-1} (11.33 and 10.33 g) was detected in plants of control pots which were statistically lowest from all other treatments (Figure 3).

The results revealed that incorporation of NPK+ different organic manures markedly enhanced the leaves weight plant^{-1} of radish. Among integrated treatments, NPK+PM was superior to others but was statistically similar to NPK+GM while NPK+PrM was least efficient. The combined application of NPK plus organic manures elevated the leaf weight plant^{-1} from 447.1% to 435.3% over control during 1st year and 425.8% to 516.1% in 2nd year, being maximum in NPK+PM and minimum in NPK+PrM. The reason for elevated leaves weight might be due to the fact that metabolic activity has been encouraged by timely application of organic manures while NPK had readily supplied nutrients in greater amount, which in turn had encouraged the overall leaves development and weigh. Similarly, Shah et al. (2016) also informed an increment in fresh leaves weight, when a combination of NPK and PM was used, in onion. Our results are also in agreement with the previous conclusions drawn by Asghar et al. (2006), Noor et al. (2007) and Sharma et al. (2012) and Khalid et al. (2016) who found considerable increment in leaves weight with mutual usage of organic and inorganic manures.

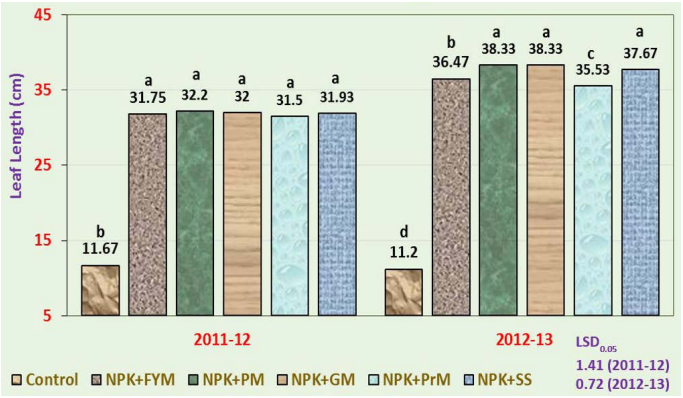

Figure 2: *leaf length (cm) of radish as affected by NPK in combination with different organic manures.*

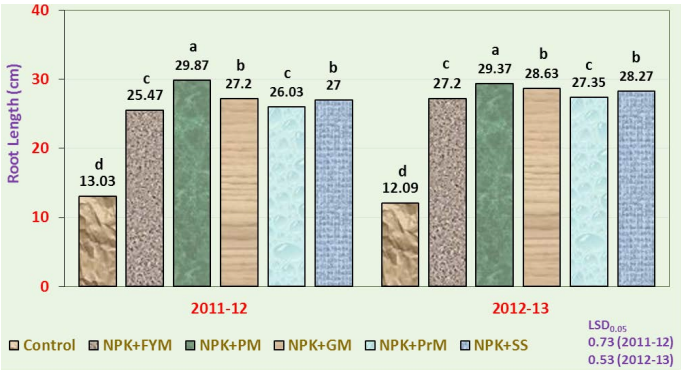

Figure 3: *Leaf weight (plant^{-1}) of radish as affected by NPK in combination with different organic manures.*

Root length (cm)

Root length of radish was significantly affected by integrated application of NPK along with different organic manures during two successive years of study (Table 2). The response of treatments was similar during both years. The significantly lengthiest roots (29.87 and 29.37 cm) were recorded in plants containing NPK+PM that varied considerably from all other treatments. It was succeeded by NPK+ GM (27.20 and 28.63cm) and NPK+ SS (27.00 and 28.27 cm) both the years, respectively and both the treatments produced non- significant results against each other. Likewise, significantly identical root length was recorded in plants receiving NPK+PrM (26.03 and 27.35 cm) and NPK + FYM (25.47 and 27.20 cm) both the years, respectively. The shortest roots of 13.03 and 12.09 cm were found in plants grown in control pots (Figure 4).

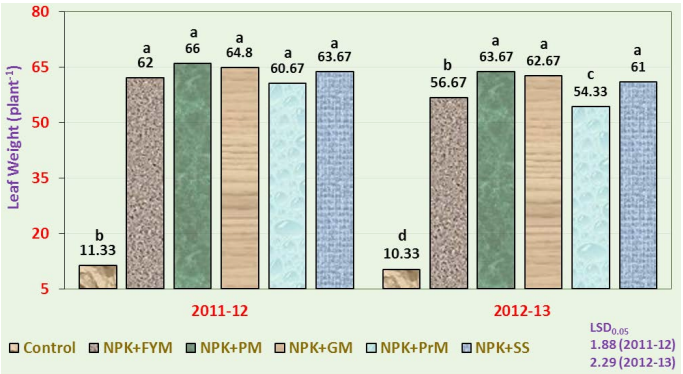

Figure 4: *Root length (cm) of radish as affected by NPK in combination with different organic manures.*

These results clearly showed that application of NPK in association with different organic manures substantially improved the root length of radish, suggesting considerable positive effect of fertilizers and manures on roots elongation. The increment in root length was 95.4%, 129.2%, 108.7%, 99.7% and 107.2% due to integrated use NPK with FYM, PM, GM, PrM and SS over control, accordingly, during 2011-12, whereas an increase of 124.9%, 142.8%, 135.9%, 126.2% and 133.7%, respectively was recorded in 2012-13. Among integrated treatments, NPK+PM was most efficient in promoting root length of radish while NPK+FYM and NPK+PrM were least effective and NPK+GM and NPK+SS were intermediate. Increment in onion root length was also reported by Shah et al. (2016) when a combined effect of NPK along with PM was tested. In agreement with these results, Kamalakannan and Manivannan (2002), Asghar et al. (2006) and Sharma et al. (2012) and Patel et al. (2016) also recorded remarkable increase in root length when inorganic fertilizers were used in combination with organic manures.

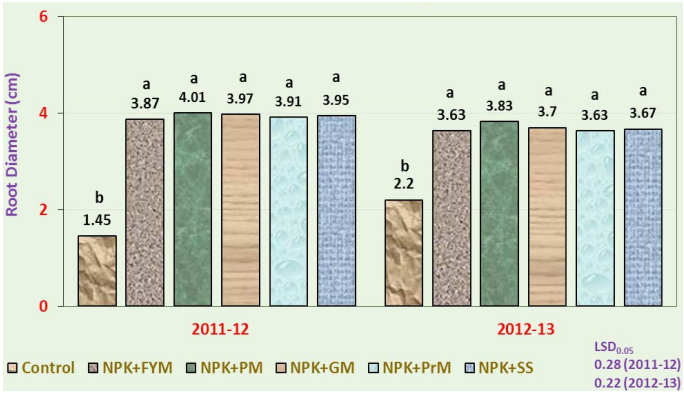

Figure 5: *Root diameter (cm) of radish as affected by NPK in combination with different organic manures.*

Root diameter (cm)

The perusal of data showed that root diameter was significantly affected by integrated use of NPK with different organic manures over control (Table 2). During both years, all integrated treatments were equally effective over control. The significantly lowest root diameters of 1.45 and 2.20 cm were reported in control which varied considerably from all other treatments. Results revealed that combined application of NPK along with different manures though improved the girth of radish roots as compared to control, but they did not differ significantly among themselves (Figure 5). The integrated management of NPK with manures enhanced root diameter by 166.6% to 176.7% during 2011-12 and 65.1% to 74.2% in 2012-13, being maximum in NPK + PM and minimum in NPK + FYM. Similar results were quoted by Vithwel and Kanaujia (2013) who recorded maximum values for carrot root diameter (4.14 cm), when a combination of NPK and organic manure was used. These results are also in analogous to findings of Kamalakannan and Manivannan (2002); Asghar et

al. (2006); Islam et al. (2011) and Kumar et al. (2017) who reported significant enhancement in radish root diameter when both inorganic fertilizers and organic manures were used in combination.

Root weight plant^{-1} (g)

Root weight plant^{-1} (g) of radish was significantly improved by integrated application of NPK and different manures over control (Table 2). The highest root weight plant^{-1} (285.00 and 274.00 g) was observed in NPK+PM, during both the years, respectively. During 2011-12, NPK+PM was succeeded by NPK+GM and NPK+SS by giving 282.37 and 278.67g root weight plant^{-1}, accordingly and all these treatments were statistically akin. Among integrated treatments NPK+FYM produced the lowest root weight plant^{-1} (276.67 g) and were significantly similar to all integrated treatments except NPK+PM. During 2012-13, NPK+PM contrasted considerably from all other treatments and trailed by statistically identical NPK+GM and NPK+SS by producing 266.0 and 264.67g root weight plant^{-1}, respectively. Likewise, NPK+Prm and NPK+FYM produced roots of significantly similar weight. The least response for root weight plant^{-1} (62.00 and 82.91 g) were recorded in control plants during 2011-12 and 2012-13, respectively that varied significantly from all other treatments (Figure 6).

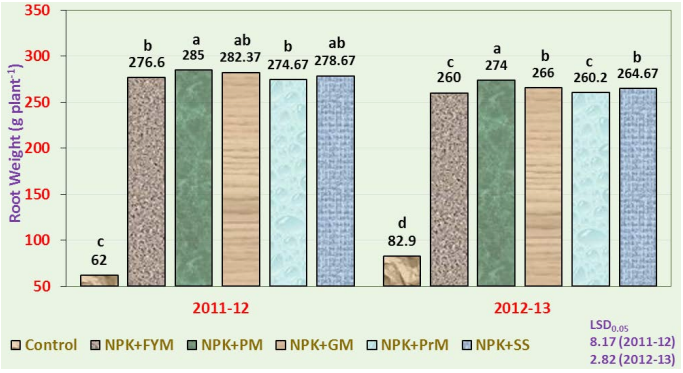

Figure 6: *Root weight (g plant^{-1}) of radish as affected by NPK in combination with different organic manures.*

These results once again revealed that combined application of NPK with organic manures substantially improved the root weight plant^{-1} of radish over control. The increment in root weight due to integrated use of NPK with FYM, PM, GM, PrM and SS was 346.2%, 359.7%, 355.4%, 299.5% and 349.5%, respectively over control during 2011-12, while the enhancement in 2012-13 was 213.6%, 230.5%, 220.8%, 213.8% and 219.2%, respectively. The combined use of inorganic and organic manures might have enhanced the nutrient availability by improving the fertilizer use efficiency, which might have contributed to higher root weights. These results got support from the earlier findings of Kamalakannan and Manivannan (2002), Asghar et al. (2006), Noor et al. (2007), Sharma et al. (2012) and Kiran et al. (2016a) who also concluded an increment in radish root weight plant^{-1}, as influenced by combined usage of organic manures with chemical fertilizer.

Total biomass weight plant^{-1} (g)

The application of NPK in combination with different manures (FYM, PM, GM, PrM, SS) significantly increased the biomass weight plant^{-1} (Table 3). During 2011-12, maximum biomass weight plant^{-1} (353.83 g) was found in plants receiving NPK+GM followed by NPK+PM with 351.00 g biomass and both the treatments were significantly alike. These were followed by NPK+SS and NPK+ FYM with 344.67 and 338.67g total biomass weight plant^{-1}, respectively and both these treatments were statistically alike. Among integrated treatments, NPK+PrM produced the lowest biomass weight plant^{-1} (336.67 g) but was statistically akin to NPK+FYM. During 2012-13, the maximum biomass weight plant^{-1} (337.67 g) was recorded in NPK+PM followed by significantly similar NPK+GM and NPK+SS with 328.67 and 325.67 g total biomass weight plant^{-1}, correspondingly. Least response for biomass weight plant^{-1} (313.33 g) was reported in NPK+FYM which was significantly at par with FYM+PrM (317.03 g). The significantly minimum biomass weights plant^{-1} (73.33 and 93.24) were found in control plants during 2011-12 and 2012-13, respectively that differed significantly from all other treatments (Figure 7).

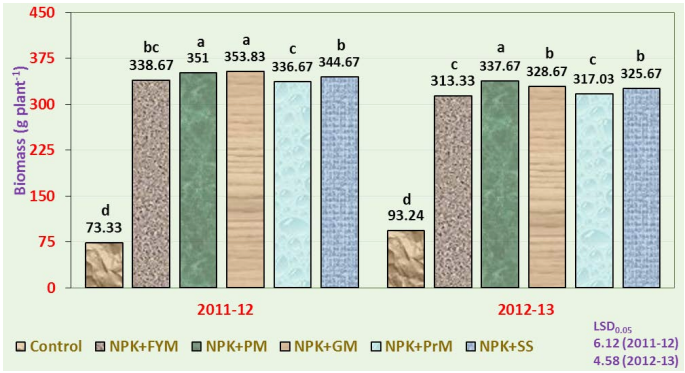

Figure 7: *Biomass (g plant^{-1}) of radish as affected by NPK in combination with different organic manures.*

Results revealed that integrated use of FYM along with different manures considerably enhanced the biomass weight plant^{-1} of radish. The enhancement in

Table 3: *Total biomass weight plant^{-1} and root yield (tha^{-1}) of radish as affected by NPK along with different organic manures for two consecutive years.*

Treatments	Total biomass weight plant^{-1}		Root yield (tha^{-1})	
	2011-12	2012-13	2011-12	2012-13
T_1: Control	73.33d	93.24 d	11.60e	25.23 d
T_2: 100% NPK + 50% FYM	338.67 bc	313.33 c	73.33 d	70.00 c
$T_3$100% NPK + 50% PM	351.00 a	337.67 a	80.42 a	77.80 a
$T_4$100% NPK + 50%GM	353.83 a	328.67 b	78.47 b	75.20 b
$T_5$100% NPK + 50% PrM	336.67 c	317.03 c	73.93 d	71.04 c
$T_6$100% NPK + 50% SS	344.67 b	325.67 b	76.57c	74.57 b
LSD @ $P_{0.05}$	6.123	4.582	1.120	1.714

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

biomass weight plant^{-1} was highest (382.5%) in NPK+GM during 2011-12 while in 2012-13 the highest increase (337.7%) was noticed in NPK+PM; however, both treatments were statistically akin both years. The minimum enhancement of 359.1% and 236.0% were observed in NPK+PrM during 2011-12 and NPK+FYM in 2012-13, respectively. Combined usage of chemical fertilizers and manures has been suggested by several scientists like Kamalakannan and Manivannan (2002), Asghar et al. (2006), Noor et al. (2007), Sharma et al. (2012), Kiran et al. (2016b) and Jaisankar (2018) who reported considerable enhancement in plant growth and biomass production with combined use of organic, inorganic and bio-fertilizers.

Root yield (t ha^{-1})

Root yield (t ha-1) of radish was significantly affected by integrated use of NPK with organic manures, during both the years (Table 3). During 2011-12, considerably highest root yield (80.42 t ha-1) was achieved from plants amended with NPK+PM, followed by NPK+GM and NPK+SS with 78.47 and 76.57 t ha-1 root yield, respectively. However, statistically similar results were recorded in NPK+PrM and NPK+FYM with 73.93 and 73.33 t ha-1, respectively. Significantly lowest root yield (11.60 t ha-1) was recorded in control. During 2012-13, significantly maximum root yield (77.80 t ha-1) was observed in NPK+PM, trailed by NPK+GM and NPK+SS with root yield of 75.20 and 74.57 t ha-1, respectively. Statistically alike results regarding root yield were also found in NPK+PrM and NPK+FYM which produced 71.04 and 70.00 t ha-1 root yield, respectively. Minimum root yield of 25.23 t ha-1 was recorded in control pots that varied considerably from all the other treatments (Figure 8).

These results revealed that incorporation of NPK in combination with organic manures remarkably augmented root yield of radish. This increment might be due reduction in nutrients losses, improved fertilizer use efficiency and increased soil nutrient availability to plants, resulting higher crop yield. The integrated use of NPK in association with FYM, PM, GM, PrM and SS enhanced 532.2%, 593.2%, 576.5%, 537.3% and 560.1% root yield over control during 2011-12, while in 2012-13 the increment was 177.4%, 208.3%, 198.0%, 181.5% and 195.5%, respectively, suggesting that manures varied significantly among each other in enhancing root yield. The remarkable increased yields of radish with INM practices have been reported by Panwar et al. (2001), Ram et al. (2001), Kamalakannan and Manivannan (2002), Asghar et al. (2006), Noor et al. (2007), Khan, (2010), Sharma et al. (2012) and Kumar et al. (2017) which correspond to these findings.

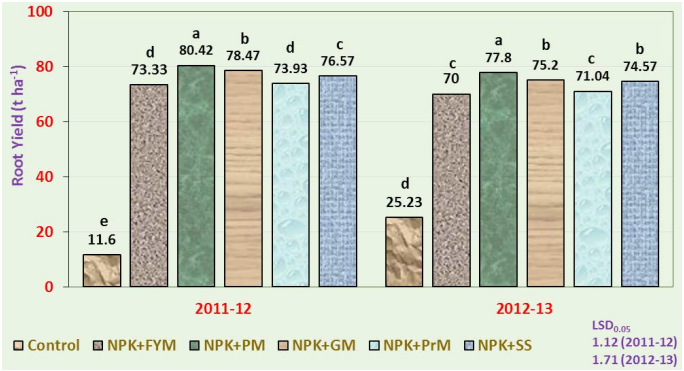

Figure 8: *Root yield (t ha^{-1}) of radish as affected by NPK in combination with different organic manures.*

Conclusions and Recommendations

It can be concluded from the study, that the combined application of NPK along with different organic ma-

nures has a profound effect on the growth and yield of radish. During both years, a combined effect of NPK (100%) + Poultry manure (50%) has out yielded all the other treatments used, followed by NPK (100%) + Goat manure (50%).

Novelty Statement

Thes study is novel from the results that the combined application of NPK along with different organic manures has a profound effect on the growth and yield of radish.

Author's Contribution

Present research work is part of Ph.D. dissertation of the principal author. Muhammad Saleem Jilani was the research supervisor for two consecutive years. Kashif Waseem and Muhammad Sohail Khan helped in designing the experiments and data analysis. Fazal Haq and Muhammad Amjad Nadim contributed during writing up and correction of manuscript. Ghazanfarullah and Salma Shaheen helped in data collection and tabulation. All the authors read and approved the final manuscript.

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